SPECIFICATIONS

Warner Park Community Recreation Center Expansion

City of Madison Parks Division

Madison, Wisconsin

Exhibit C - Specifications

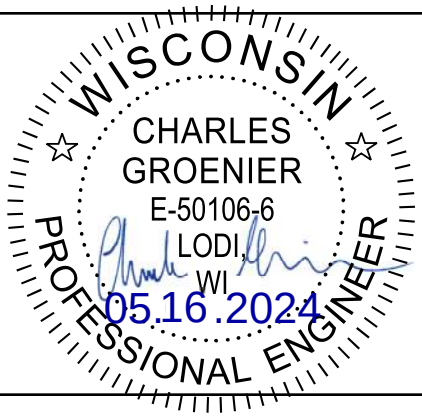
Contract #9502
Munis #17196

Engberg Anderson Project No. 223471.00 May 16, 2024

ARCHITECTURE | INTERIOR DESIGN | PLANNING
305 W WASHINGTON AVE | MADISON, WISCONSIN 53703 | (608) 250-0100

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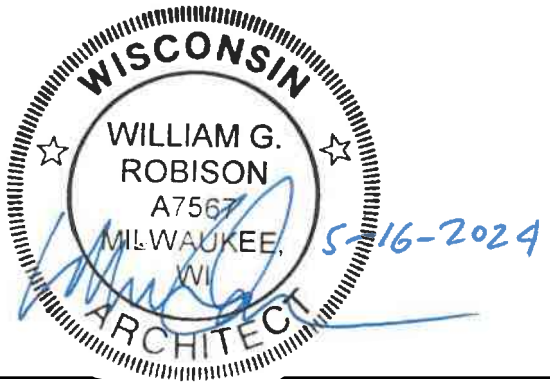
CIVIL
JSD PROFESSIONAL SERVICES, INC.
507 W VERONA AVE #500
VERONA, WI 53593
PH 608-848-5060



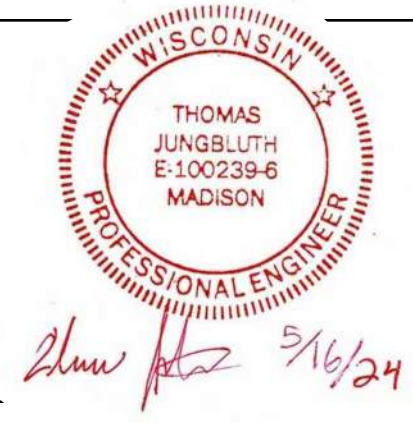
LANDSCAPE
JSD PROFESSIONAL SERVICES, INC.
507 W VERONA AVE #500
VERONA, WI 53593
PH 608-848-5060



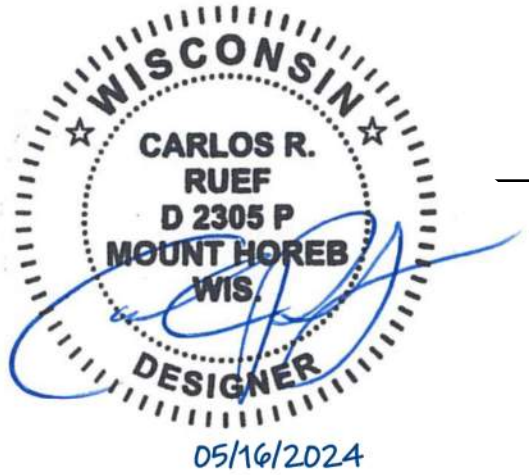
ARCHITECTURAL
ENGBERG ANDERSON, INC.
305 W WASHINGTON AVE
MADISON, WI 53703
PH 608-250-0100



STRUCTURAL
ONEIDA TOTAL INTEGRATED ENTERPRISES
1033 N MAYFAIR RD #200
MILWAUKEE, WI 53226
PH 414-257-4200



FIRE PROTECTION
JDR ENGINEERING, INC.
5525 NOBEL DR #110
MADISON, WI 53711
PH 608-277-1728



PLUMBING
JDR ENGINEERING, INC.
5525 NOBEL DR #110
MADISON, WI 53711
PH 608-277-1728

MECHANICAL
JDR ENGINEERING, INC.
5525 NOBEL DR #110
MADISON, WI 53711
PH 608-277-1728



ELECTRICAL
JDR ENGINEERING, INC.
5525 NOBEL DR #110
MADISON, WI 53711
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WARNER PARK COMMUNITY RECREATION CENTER EXPANSION

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PART 1 – GENERAL

1.1. SUMMARY

A. Each project has varying requirements for permits, inspections, and fees based on the scope, size, and location of the project.

B. The City of Madison (Owner) is subject to all permits, inspections and associated fees for construction, demolition, utility connection, storm water management, and other similar requirements that may be required to complete the scope of work associated with these contract documents.

C. The General Contractor (GC) shall be responsible for obtaining all permits, inspections and paying for all associated fees unless specifically identified within this specification.

1.2. REFERENCES

A. The following references are not intended to be all inclusive. It shall be the GC's responsibility to determine all requirements based on the scope of work in the contract documents.

B. City of Madison Ordinances: Review all ordinances that may require a permit or fee that may be connected with a required permit. Contact the following City Agencies to determine the exact requirements during bidding
   1. Building Inspection
   2. Zoning
   3. Engineering
   4. Water Utility
   5. Traffic Engineering
   6. Others as may be specified by the contract documents.

B. State Statutes

C. Other Regulatory Regulations

D. Other Agencies or companies that may have related requirements
   1. Madison Metropolitan Sewerage District
   2. Local gas and electric utility companies
   3. Other utility companies

1.3. GENERAL CONTRACTORS REQUIREMENTS

A. The GC shall be responsible for all of the following:
   1. Execute application for all required permits as may be required by the scope of work described within the contract documents.
   2. Scheduling all required inspections that may be conditions of any required permits.
   3. Paying for other permits not explicitly stated as excluded in this section.

B. The GC is not responsible for paying for the City Building, City HVAC, City Electrical, City Plumbing, Madison Fire Department Sprinkler and Madison Fire Department Fire Alarm permits.

C. The GC shall provide high quality scanned images of all required permits and inspections and upload them to the Contract Documents-Regulatory Documents Library on the Project Management Web Site.

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 – EXECUTION – THIS SECTION NOT USED

END OF SECTION

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SECTION 00 43 25
SUBSTITUTION REQUEST FORM (DURING BIDDING)

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PART 1 – GENERAL

1.1. SUMMARY

A. The City of Madison uses a specific list of preferred products for various specification items to establish standards of quality, utility, and appearance required.

B. The City of Madison will not allow substitutions for specified Products except as follows:

1. The Product is no longer produced or the product manufacturer is no longer in business.
2. The manufacturer has significantly changed performance data, product dimensions, or other such design criteria for the specified Product(s).
3. Products specified by naming one or more Products or manufacturer's and "or approved equal" or "approved equivalent."

C. The procedures in this specification shall apply to all proposals by Contractors, Suppliers, Vendors, and Manufacturers when the conditions in item 1.1.B. above have been met during the bidding phase.

1.2. RELATED SPECIFICATIONS

A. 01 25 13 Product Substitution Procedures

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. REQUESTING A SUBSTITUTION DURING BIDDING

A. In the event that a substitution is requested during the bidding phase the Contractor, Supplier, Vendor, or Manufacturer shall do all of the following:

1. Submit a Substitution Request Form for each different product. Use a printed/scanned copy of the form at the end of this specification as a cover sheet.
2. Support your request with complete data, drawings, specifications, performance data and samples as appropriate. A complete submission shall include the following:
   a. Substitution Request Form as a cover sheet
   b Comparison of qualities of the proposed substitutions with that specified.
   c. Changes required in other elements of the Work because of the substitution.
   d. Effect on the construction schedule.
   e. Cost data comparing the proposed substitution with the Product specified.
   f. Any required license fees or royalties.
   g. Availability of maintenance service and source of replacement materials.
3. Submit the Substitution Request Form and all required supporting documentation to the City Project Manager and Project Architect.
   a. Submissions to be done as complete PDF files for each product, appropriately titled
   b. Email submissions to the Project Architect and City Project Manager at the email addresses provided on the last page of Section D of the contract documents.
      i. The subject line shall include the contract number and "Request for Substitution". Example: Contract 1234 – Request for Substitution
4. Submissions must be received by the substitution request deadline specified in Section A of the Contract Documents.

3.2. SUBMISSION REVIEW

A. The Project Architect, City Project Manager, members of the design team, and the Owners staff shall review all submissions for substitutions during the bidding phase.

3.3. SUBSTITUTION APPROVAL

A. All requests for substitutions that have been approved shall be published by Addenda to the bid documents.

NOTE SEE NEXT PAGE FOR SAMPLE SUBSTITUTION REQUEST FORM.

3.4. SUBSTITUTION REQUEST FORM

For Pre-bid Substitution Requests all text boxes on this form are required information for a complete request.

Substitution Request

Today's Date:

Project Title:

Project Number: *Contract Number:*

By completing and submitting this form for review the General Contractor affirms that all of the following statements are correct:

1. The General Contractor affirms that this request is in compliance with the requirements described in ***Specification 01 25 13 Product Substitution Procedures.***
2. The function, appearance, and quality of the proposed substitution are equal or superior to the specified item.
3. The proposed substitution does not affect dimensions shown on the drawings.
4. The proposed substitution will have no adverse affects on other trades, the construction schedule, or any specified warranty requirements.
5. Maintenance and service parts will be locally available for the proposed substitution. (GC shall provide supporting documentation in the attachments section below.)
6. The General Contractor shall be responsible for any and all costs associated with this substitution request if approved. This includes but is not to limited to fees for building design, engineering design fees, detailing fees, plan review fees, construction costs, and inspection fees.

GC Substitution Request:

General Title:

Related Specification:

Reason for Substitution:

Proposed Substitution:
(include Name, Model, etc.)

Submitted By: *Phone:*

Company: *Email:*

END OF SECTION

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SECTION 00 43 43
WAGE RATES FORM

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PART 1 – GENERAL

1.1. SUMMARY

A. The Reimbursable Hourly Worksheet is a contractor provided document that indicates the basic rate of pay, fringe benefits, and each companies cost of required insurance for all Trades and Classifications that will be performing productive labor during the execution of this contract.
   1. Rates shall be similar to recognized rates published by the Bureau of Labor Statistics, Associated General Contractors (AGC), Associated Builders and Contractors (ABC), appropriate union contracts, and other similar organizations or documents.

B. The Reimbursable Labor Rate Worksheet shall provide the basis for labor rates being used on Change Order Request forms.

1.2. RELATED SPECIFICATIONS

A. Section 01 26 57 Change Order Request
B. Section 01 29 76 Progress Payment Procedures
C. Section 01 31 23 Project Management Web Site (PMWS)
D. Section 01 32 19 Submittals Schedule

PART 2 – PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1. GENERAL REQUIREMENTS

A. Prior to the Pre-Construction Meeting the City Project Manager (CPM) or the City Construction Manager (CCM) shall provide the GC a copy of the *Reimbursable Labor Rate Worksheet.xls*.
   1. See the last page of this specification for an example of the worksheet.

B. The GC shall provide all subcontractors that will be performing productive labor during the execution of this contract with additional copies of the worksheet as needed.

C. All contractors shall be required to fill out and submit completed worksheets for all Trades and Classifications of labor that will be performing productive labor during the execution of this contract.

3.2. GENERAL CONTRACTORS RESPONSIBILITIES

A. The GC shall consolidate all Trades and Classifications into one master Excel Workbook of all trades.

B. The GC shall provide the combined workbook as required by Section 1.6 of Specification 01 32 19 Submittals Schedule for review and approval by the Owners Representatives.
   1. Submittal shall be an Exported PDF of the completed Excel Workbook.
      a. As an Exported PDF the individual worksheets will be bookmarked and the document will be word searchable for easy reference.

C. The GC shall only use the rates posted in the approved submittal throughout the execution of this contract.

Reimbursable Hourly Rate Worksheet

(see bottm of page for instructions)

Project Name:
Project Location:
Project Number:
Contractor:
Rates are based on the following documentaton:

Enter TRADE Here:
Carpenter

Classification:		Foreman	Journeyman	Laborer	Apprt 1	Other	Other	Other
Base Rate (BR)		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Vacation		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Health Insurance		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Pension		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Apprenticeship		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Sub-total		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
BR Sub-total		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Work. Comp	% of BR	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Gen Liability	% of BR	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
WI Unemploy	% of BR	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Fed Unemploy	% of BR	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FICA	% of BR	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Sub-total		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
TOTAL COST		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Enter **YOUR** percentage of base rate in the column below.

% of BR	
0	- Work. Comp
0	- Gen Liability
0	- WI Unemploy
0.6	- Fed Unemploy
7.65	- FICA

Form Instructions:

1. Provide a work sheet for ALL Trade Classifications that will be performing on site productive labor during the execution of this project.

2. Responsible contractor to complete only boxes that are shaded, all non-shaded boxes are formula driven.

3. Contractor shall provide the name of the source used for these rates. (union contract, Bureau of Labor and Statistices, AGC, ABC, etc.) and be prepared to provide copies if so requested.

END OF SECTION

SECTION 00 62 76.13
SALES TAX FORM

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PART 1 – GENERAL

1.1. SUMMARY

A. The City of Madison is a qualifying tax exempt entity in the State of Wisconsin.

B. The Contractor shall refer to *Section 102.9 – Bidders Understanding* of the *City of Madison FACILITIES MANAGEMENT SPECIFICATIONs for Public Works Construction* for more information on Tax Exempt Status.

C. This project constructs or remodels facilities owned by the City of Madison in Madison, Wisconsin.

1.2. RELATED SPECIFICATION SECTIONS

A. Parts of this specification will reference articles within "The City of Madison FACILITIES MANAGEMENT SPECIFICATIONs for Public Works Construction".

1. Use the following link to access the FACILITIES MANAGEMENT SPECIFICATIONs web page: http://www.cityofmadison.com/business/pw/specs.cfm

a. Click on the "Part" chapter identified in the specification text. For example if the specification says "Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION **2**10.2" click the link for Part II, the Part II PDF will open.

b. Scroll through the index of Part II for specification 210.2 and click the text link which will take you to the referenced text.

1.3. TAX EXEMPT FORM

A. The Contractor can access Wisconsin Sales and Use Tax Exemption Certificates (form S-211, Wisconsin Department of Revenue) from the City of Madison Finance website.

1. City of Madison tax exempt information and signature by Purchasing Supervisor is already completed.

2. Website: http://www.cityofmadison.com/employeenet/finance/purchasing

a. Under the title *Purchasing Forms*, scroll down to the form link titled *Sales Tax Exempt Form S-211*.

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 – EXECUTION – THIS SECTION NOT USED

END OF SECTION

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SECTION 01 25 13
PRODUCT SUBSTITUTION PROCEDURES

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3.3. UNAUTHORIZED SUBSTITUTIONS 2

PART 1 – GENERAL

1.1. SUMMARY

A. The City of Madison uses a specific list of preferred products for various specification items to establish standards of quality, utility, and appearance required.

B. The City of Madison will not allow substitutions for specified Products except as follows:
   1. The Product is no longer produced or the product manufacturer is no longer in business.
   2. The manufacturer has significantly changed performance data, product dimensions, or other such design criteria for the specified Product(s).
   3. Products specified by naming one or more Products or manufacturer's and "or approved equal" or "approved equivalent."

C. The City of Madison will not allow substitutions for specified Products as follows:
   1. For Products specified by naming only one Product and manufacturer, no substitute product will be considered.
   2. For Products specified by naming several Products or manufacturers select any one of the products or manufacturers named, which complies with the specifications. No substitute product will be considered.

D. Request for substitutions from any party other than the General Contractor (GC) will not be accepted.

1.2. RELATED SPECIFICATIONS

A. Section 00 43 25 Substitution Request Form (During Bidding)
B. Section 01 26 13 Request for Information (RFI)
C. Section 01 31 23 Project Management Web Site (PMWS)
D. Section 01 33 23 Submittals

PART 2 – PRODUCTS

2.1. SUBSTITUTION REQUEST FORM

A. During bidding all contractors (General and Sub-contractors) and suppliers of materials or products shall reference Specification Section 00 43 25 and provide a pdf copy of the Substitution Request form located at the end of that section with all required attachments directly to the Project Architect.

B. After bidding only the GC shall submit a request and shall use the form located at the end of this specification and submit the request on the Project Management Web Site.

PART 3 - EXECUTION

3.1. REQUESTING A SUBSTITUTION DURING BIDDING

A. In the event that a substitution is requested during the bidding phase the Contractor or Supplier shall meet the substitution request deadline listed in the bidding documents. No substitution request will be considered during the bidding period after the stated substitution request deadline.

B. See specification 00 43 25 Substitution Request Form (During Bidding).

3.2. REQUESTING A SUBSTITUTION AFTER AWARD OF CONTRACT

A. A substitution request will only be considered after award of contract if it meets the qualifying provisions as described in 1.1.B.1 and .2 above.

B. The GC shall submit a substitution request using the digital form on the Project Management Web Site.

1. Consulting Staff, Owner and Owners Representatives will review the request and provide the appropriate approvals and feed back to the GC.

3.3. UNAUTHORIZED SUBSTITUTIONS

A. Any Contractor who substitutes products without proper authorization by the Owner and Architect will be required to immediately remove and replace the product and all costs required to conform to the Contract Documents shall be borne by the General Prime Contractor.

.

NOTE SEE NEXT PAGE FOR SAMPLE SUBSTITUTION REQUEST FORM.

1

For Pre-bid Substitution Requests all text boxes on this form are required information for a complete request.

Substitution Request

Today's Date:

Project Title:

Project Number: *Contract Number:*

By completing and submitting this form for review the General Contractor affirms that all of the following statements are correct:

1. The General Contractor affirms that this request is in compliance with the requirements described in ***Specification 01 25 13 Product Substitution Procedures***.
2. The function, appearance, and quality of the proposed substitution are equal or superior to the specified item.
3. The proposed substitution does not affect dimensions shown on the drawings.
4. The proposed substitution will have no adverse affects on other trades, the construction schedule, or any specified warranty requirements.
5. Maintenance and service parts will be locally available for the proposed substitution. (GC shall provide supporting documentation in the attachments section below.)
6. The General Contractor shall be responsible for any and all costs associated with this substitution request if approved. This includes but is not to limited to fees for building design, engineering design fees, detailing fees, plan review fees, construction costs, and inspection fees.

GC Substitution Request:

General Title:

Related Specification:

Reason for Substitution:

Proposed Substitution:
(include Name, Model, etc.)

Submitted By: *Phone:*

Company: *Email:*

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END OF SECTION

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SECTION 01 26 13
REQUEST FOR INFORMATION (RFI)

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1.3. PERFORMANCE REQUIREMENTS 1
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PART 2 – PRODUCTS 1
2.1. REQUEST FOR INFORMATION FORM 1
PART 3 - EXECUTION 1
3.1. CONTRACTOR INITIATED RFI 1
3.3. RFI RESPONSES 2
3.4. COMMENCEMENT OF WORK RELATED TO AN RFI 2

PART 1 – GENERAL

1.1. SUMMARY

A. Contractors shall use the RFI form/process to request additional information or clarification regarding the construction documents.

B. All RFI documentation will be processed through the through the Project Management Web Site (PMWS).

1.2. RELATED SPECIFICATIONS

A. Section 01 26 46 Construction Bulletin (CB)

B. Section 01 26 57 Change Order Request (COR)

C. Section 01 26 63 Change Order (CO)

D. Section 01 31 23 Project Management Web Site (PMWS)

E. Section 01 91 00 Commissioning

1.3. PERFORMANCE REQUIREMENTS

A. RFI issues initiated by any contractor shall be done through the General Contractor (GC).

1. RFIs submitted by any Sub-contractor under the GCs control shall be returned with no response.

B. Submit a new RFI for each issue. Only multiple questions that are of a similar nature may be combined into one RFI shall be allowed and responded to.

1.4. QUALITY ASSURANCE

A. The GC shall be responsible for all of the following:

1. Ensure that any request for additional information is valid and the information being requested is not addressed in the construction documents.
2. Ensure that all requests are clearly stated and the RFI form is completely filled out.
3. Ensure that all Work associated an RFI response is carried out as intended.

B. The Project Architect /Project Engineer (A/E PROJ MGR) shall be responsible for the following:

1. Ensure that all responses to contractor initiated RFIs are properly responded to in a timely fashion.
   a. The CPM, Owner, consulting staff, and other City staff shall be responsible for the initial review of the RFI. The A/E PROJ MGR shall be responsible for codifying all consultant and Owner/City staff comments into a unified RFI response.

PART 2 – PRODUCTS

2.1. REQUEST FOR INFORMATION FORM

A. The RFI form is located on the Project Management Web Site.

PART 3 - EXECUTION

3.1. CONTRACTOR INITIATED RFI

A. Immediately on discovery of the need for additional information or interpretation of the Contract Documents any contractor may initiate an RFI for additional information or clarification through the GC.

B. The GC shall use the Project Management Web Site and completely fill out the form.

1. Thoroughly explain the issue at hand, provide backup information (photographs, sketches, drawings, data, etc.) as necessary, and clearly state the question or problem that requires a resolution. Combine like or related issues but do not include multiple issues on one form.
    a. Example. If a duct interferes with other critical piping and electrical work include all issues into one RFI.
    b. Example. If you have a question regarding the chiller and another regarding toilet partitions create separate RFIs.

3.3. RFI RESPONSES

A. Responses to simple RFI issues shall be completed within five (5) working days of the RFI form being submitted.

B. Responses to more complex issues may require additional time or may require a Construction Bulletin to be published. The initial RFI shall be responded to within five (5) working days stating that the RFI is being reviewed and provide an estimated date for the response.

C. The following GC generated RFIs will be returned without action:
    1. Requests for approval of submittals
    2. Requests for approval of substitutions
    3. Requests for approval of Contractor's means and methods.
    4. Requests for coordination information already indicated in the Contract Documents.
    5. Requests for adjustments in the Contract Time or the Contract Sum.
    6. Requests for interpretation of A/E's actions on submittals.
    7. Incomplete RFI or inaccurately prepared RFI.

3.4. COMMENCEMENT OF WORK RELATED TO AN RFI

A. The GC shall only proceed with the Work of an RFI when additional information is not required.

B. The GC shall not proceed with any Work associated with an RFI while it is under review.

C. The GC shall not proceed with any Work associated with an RFI that clearly states a CB will be issued in response to the RFI.

D. The GC will be required to immediately remove and replace unauthorized Work and all costs required to conform to the Contract Documents shall be borne by the GC.

END OF SECTION

SECTION 01 26 46
CONSTRUCTION BULLETIN (CB)

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PART 3 - EXECUTION 2
3.1. WRITING THE CONSTRUCTION BULLETIN 2
3.2. EXECUTING THE CONSTRUCTION BULLETIN 2

PART 1 – GENERAL

1.1. SUMMARY

A. Construction Bulletins (CB) are formal published construction documents that modify the original contract bid documents after construction has commenced. CBs may be published for many reasons, including but not limited to the following:
   1. Clarification of existing construction documents including specifications, plans, and details
   2. Change in product or equipment
   3. A response to a Request for Information
   4. Change in scope of the contract as either an add or a deduct of work

B. CBs provide a higher degree of detail in response to a Request for Information (RFI) through directives, revised plans/details, and specifications as necessary.

C. The CB may change the original contract documents through additions or deletions to the Work.

D. Where the directives of a CB are significant enough to warrant a Change Order Request (COR) the GC shall use all information provided in the CB to assemble all required back-up documentation for additions and deletions of materials, labor and other related contract costs for the COR.

E. All CB documentation will be processed through the Project Management Web Site (PMWS).

1.2. RELATED SPECIFICATIONS

A. Section 01 26 13 Request for Information (RFI)
B. Section 01 26 57 Change Order Request (COR)
C. Section 01 26 63 Change Order (CO)
D. Section 01 31 23 Project Management Web Site (PMWS)
E. Section 01 91 00 Commissioning

1.3. PERFORMANCE REQUIREMENTS

A. Project Architect /Project Engineer (A/E PROJ MGR): The A/E PROJ MGR shall be the only person authorized to publish a CB as needed for any reason indicated in section 1.1.A above. The A/E PROJ MGR shall consult as necessary with any of the following while drafting the CB and shall confirm final direction with the CPM prior to issuing a CB:
   1. City Project manager (CPM)
   2. Owner
   3. Members of the consulting staff
   4. Members of city staff
   5. The General Contractor
   6. Sub-contractors
   7. Commissioning Agent (CxA)

B. General Contractor: The GC shall be responsible for the following as needed:
   1. Executing the directives of the CB when they believes that no changes in labor, materials, equipment, or contract duration will be required for additions or deletions.
   2. Submit a COR when they believes that a change in labor, materials, equipment or contract duration will be required for additions or deletions.

1.4. QUALITY ASSURANCE

A. The A/E PROJ MGR shall be responsible for ensuring the final CB sufficiently provides direction, details, specifications and other information as necessary for the GC to perform the intended Work.

B. The A/E PROJ MGR shall be responsible for ensuring the final CB is published as expeditiously as practical based on the complexity of the CB being written. CBs that may affect the GC critical path shall be given priority.

PART 2 – PRODUCTS

2.1. CONSTRUCTION BULLETIN FORM

A. The CB form is located on the Project Management Web Site.

PART 3 - EXECUTION

3.1. WRITING THE CONSTRUCTION BULLETIN

A. The A/E PROJ MGR shall draft a CB as needed using the Construction Bulletin form on the Project Management Web Site.

1. The A/E PROJ MGR and/or consulting staff as necessary shall provide specifications, model numbers and performance data, details and other such information necessary to clearly state the intentions of the CB.
2. The consulting staff, CPM, Owner, CxA and other City Staff shall review the draft and recommend changes as needed.
3. The A/E PROJ MGR shall amend the draft as necessary into a final CB for review.
4. Full plan sheets and entire specification sections referred to within a CB, shall be reissued with the CB.

B. Once the final CB has been approved the A/E PROJ MGR shall “Submit” the CB through the Project Management Web Site to the City Project Manager.

C. The City Project Manager will close and distribute the CB.

3.2. EXECUTING THE CONSTRUCTION BULLETIN

A. The GC shall acknowledge receipt of the CB on the Project Management Web Site as instructed in the Tutorial Manual provided to the awarded contractor.

B. The GC shall notify all Sub-contractors of the CB and publish the CB to all field sets of drawings and specifications as appropriate.

C. The GC shall execute the directives of the CB or submit COR documentation as necessary during the execution and implementation of the CB.

1. See Specification 01 26 57 Change Order Request (COR)

END OF SECTION

SECTION 01 26 57
CHANGE ORDER REQUESTS (COR)

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PART 1 – GENERAL

1.1. SUMMARY

A. Except in cases of emergency, no changes in the Work required by the Contract Documents may be made by the General Contractor (GC) without having prior approval of the City Engineer or their representative.

B. The City may at any time, without invalidating the Contract and without Notice to Sureties, order changes in the Work by written Change Order (CO). Such changes may include additions and/or deletions.

C. Where the City desires to make changes in the Work through use of written Change Order Request (COR), the following procedures apply:

1. If requested by the City, the GC shall prepare and submit a detailed proposal, including all cost and time adjustments to which the GC believes it will be entitled if the change proposed is incorporated into the Contract. The City shall be under no legal obligation to issue a Change Order for such proposal.
2. The parties shall attempt in good faith to reach agreement on the adjustments needed to the Contract to properly incorporate the proposed change(s) into the Work. In the event that the parties agree on such adjustments, the City may issue a Change Order and incorporate such changes and agreed to adjustments, if any.
3. In some instances, it may be necessary for the City to authorize Work or direct changes in Work for which no final and binding agreement has been reached and for which unit prices are not applicable. In such cases the following shall apply.
    a. Upon written request by the City, the GC shall perform proposed Work
    b. The cost of such change may be determined in accordance with this specification.
    c. In the event agreement cannot be accomplished as contemplated herein, the City may authorize the Work to be performed by City forces or to hire others to complete the Work. Such action on the part of the City shall not be the basis of a claim by the GC for failure to allow it to perform the changed Work.

D. Where changes in the Work are made by the City through use of a force account basis, the GC shall as soon as practicable, and in no case later than ten (10) working days from the receipt of such order, unless another time period has been agreed to by both parties, give the City written Notice, stating:

1. The date, circumstances and source of the extra work; and,
2. The cost of performing extra work described by such Order, if any; and,
3. Effect of the order on the required completion date of the Project, if any.

E. The giving of each Notice by the GC as prescribed by this specification, shall be a requirement to liability of the City for payment of any additional costs incurred by the GC in implementing changes in the Work. Under this specification, no order or statement of the City shall be treated as a Change Order, or shall entitle the GC to an equitable adjustment of the terms of this Contract or damages for costs incurred by the GC on any activity for which the Notice was not given.

F. In the event Work is required due to an emergency as described in this specification the GC must request an equitable adjustment as soon as practicable, and in no case later than ten (10) working days of the commencement of such emergency.

G. All GC requests for equitable adjustment shall be submitted to the CPM per the specifications below. Such requests shall set forth with specificity the amount of and reason(s) for the proposed adjustment and shall be accompanied by supporting information and documents.

H. No adjustment of any kind shall be made to this Contract, if asserted by the GC for the first time, after the date of final payment.

I. This specification shall be used by the GC when preparing documentation for any COR to ensure each has been properly and completely filled out as required by the City of Madison.

J. All COR documentation will be processed through the Project Management Web Site (PMWS).

1.2. RELATED SPECIFICATION SECTIONS

A. Section 01 26 13 Request for Information (RFI)

B. Section 01 26 46 Construction Bulletins (CB)

C. Section 01 26 63 Change Order (CO)

D. Section 01 31 23 Project Management Web Site (PMWS)

E. Section 01 91 00 Commissioning

F. Parts of this specification will reference articles within "The City of Madison FACILITIES MANAGEMENT SPECIFICATIONs for Public Works Construction".

1. Use the following link to access the FACILITIES MANAGEMENT SPECIFICATIONs web page:
   http://www.cityofmadison.com/business/pw/specs.cfm
   a. Click on the "Part" chapter identified in the specification text. For example if the specification says "Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION **2**10.2" click the link for Part II, the Part II PDF will open.
   b. Scroll through the index of Part II for specification 210.2 and click the text link which will take you to the referenced text.

1.3. DEFINITIONS AND STANDARDS

A. LABOR: The amount of time and cost associated with the performance of human effort for a defined scope of Work. Labor is further defined as follows:

1. Labor rate is the total hourly rate which includes the basic rate of pay, fringe benefits plus each company's cost of required insurance, also referred to as a reimbursable labor rate.
2. Unit labor is the labor hours anticipated to install the corresponding unit of material.
3. Labor cost is the labor hours multiplied by the hourly labor rates.

B. MATERIAL: Actual material cost is the amount paid, or to be paid, by the GC for materials, supplies and equipment entering permanently into the Work, including cost of transportation and applicable taxes. The cost shall not exceed the usual and customary cost for such items available in the geographical area of the project

C. LARGE TOOLS AND MAJOR EQUIPMENT: Large tools and major equipment are those with an initial cost greater than $1,500, whether from the GC or other sources.

1. Tool and equipment use and time allowed is only for extra work associated with change orders.
   a. Rental Rate is the machine cost associated with operating a piece of equipment for a defined length of time (hour, day, week, or month) and shall not exceed the usual and customary amount for such items available in the geographical area of the project.
   b. Rental cost is the rental rate multiplied by the anticipated duration the equipment shall be required.
2. The GC shall provide a breakdown of all rental rates to indicate what items and costs are associated with the rate. Examples of items to include in the breakdown would be fuel consumption, lubrication, maintenance and other similar expenses but not including profit and overhead.
3. When large tools and equipment needed for Change Order work are not already at the job site, the actual cost to get the item there is also reimbursable.

D. BOND COST: The cost shall be calculated at 1% of the total proposed change order.

E. SUB-CONTRACTOR COSTS: Sub-contractor costs are for those labor, material, and equipment costs required by subcontracted specialties to complete the Change Order work.

F. OVERHEAD AND PROFIT Markup: The allowable markup percentage to a COR by the GC and Sub-contractors for overhead and profit. All of the following are expenses associated with overhead and profit and shall not be reimbursable as individual items on any COR:

1. CHANGE ORDER PREPARATION: All costs associated with the preparing and processing of the change order.
2. DESIGN, ESTIMATING, AND SUPERVISION: All such efforts, unless specifically requested by Owner as additional Work to be documented as a COR or portion thereof.

3. INSTALLATION LAYOUT: The layout required for the installation of material and equipment, and the installation design, is the responsibility of the GC.
4. SMALL TOOLS AND SUPPLIES: The cost of small hand tools with an initial cost of $1,500 or less, along with consumable supplies and expendable items such as drill bits, saw blades, gasoline, lubricating or cutting oil, and similar items.
5. GENERAL EXPENSE: The general expense, which is those items that are a specific job cost not associated with direct labor and material such as job trailers, foreman truck, and similar items.
6. RECORD DRAWINGS: The preparation of record or as-built drawings.
7. OTHER COSTS: Any miscellaneous cost not directly assessable to the execution of the Change Order including but not limited to the following:
    a. All association dues, assessments, and similar items.
    b. All education, training, and similar items.
    c. All drafting and/or engineering, unless specifically requested by Owner as additional Work to be documented as a Change Order proposal or portion thereof.
    d. All other items including but not limited to review, coordination, estimating and expediting, field and office supervision, administrative work, etc.

G. Contract Extension: The necessary amount of time to be added to the contract deadlines for the completion of a change order.

1.4. CONTRACT EXTENSION

A. The GC shall not assume that every COR will require a Contract Extension. If the GC feels a contract extension is warranted, they shall provide sufficient scheduling information that shows how the COR being requested impacts the critical path of the project.

B. The City of Madison strongly encourages the GC to explore alternative methods and practices prior to submitting a COR with a request for contract extension.

1.5. OVERHEAD AND PROFIT MARKUP

A. Pursuant to the City of Madison FACILITIES MANAGEMENT SPECIFICATIONs for Public Works Construction, Section 104.7, Extra Work, the following maximum allowable markups shall be strictly enforced on all change orders associated with the execution of this contract.
1. The total maximum overhead and profit shall not exceed fifteen percent (15%) of the total costs.
2. The total maximum overhead and profit shall be distributed as follows:
    a. For work performed and materials provided solely by the General Contractor, fifteen percent (15%) of the total costs.
    b. For work performed and materials provided solely by Sub-contractors and supervised by the General Contractor:
        i. Supervision of the GC, five percent (5%) of the total Sub-contractor cost.
        ii. Sub-contractors work and materials ten percent (10%) of the total Sub-contractor cost.

1.6. PERFORMANCE REQUIREMENTS

A. The GC shall become thoroughly familiar with this specification as it will identify procedures and expenses that are or are not allowed under the Change Order and Change Order Request process.

B. The GC shall be responsible for all of the following:
1. Carefully reviewing the CB that is associated with the COR.
2. Collecting required supporting documentation from all contractors that quantify the need for a COR.
    a. Labor hours and wage rates
    b. Material costs
    c. Equipment costs

C. The following shall apply to establishing prices for labor, materials, and equipment costs:
1. Where Work to be completed has previously been established by individual bid items in the contract bid proposal the GC shall use the unit bid prices previously established.
2. Where Work to be completed was bid as a Lump Sum without individual bid items the GC shall provide a breakdown of all labor, materials, equipment including unit rates and quantities required.

D. The completion date is determined by Owner. The schedule, however, is the responsibility of the GC. Time extensions for extra Work will be considered when a schedule analysis of the critical path shows that the Change Order Request places the Work beyond the completion date stated in the Contract.

1.7. QUALITY ASSURANCE

A. The GC shall be responsible for ensuring that all COR supporting documentation meets the following requirements prior to completing the COR form on the Project Management Web Site:
   1. Sufficiently indicates labor, material, and other expenses related to completing the intent of the CB.
   2. No costs exceed the usual and customary amount for such items available in the geographical area of the project, and no costs exceed those established under the contract.

B. The Project Architect /Project Engineer A/E PROJ MGR, Commissioning Agent (CxA), City Project Manager (CPM), other members of the consulting staff, and city staff shall review all COR requests to ensure that the intent of the CB will be met under the proposal of the COR or request additional information as necessary.

PART 2 – PRODUCTS

2.1. CHANGE ORDER REQUEST FORM

A. The COR form is located on the Project Management Web Site.

PART 3 - EXECUTION

3.1. ESTABLISHING A CHANGE ORDER REQUEST

A. Upon receipt of a Construction Bulletin (CB) where the GC believes a significant change in contract scope warrants the submittal of a COR the GC shall do all of the following within ten (10) working days after receipt of the CB:
   1. Review the CB with all necessary trades and sub-contractors required by the change in scope.
      a. Additions or deletions to the contract scope shall be as directed within the CB.
      b. Additions or deletions of labor and materials shall be determined by the GC based on the directives of the CB.
   2. Assemble all required back-up documentation for additions and deletions of materials, labor and other related contract costs as previously outlined in this specification.
   3. Submit a COR request form on the Project Management Web Site.

B. Submitting a COR does not obligate the GC to complete the work associated with the COR nor does it obligate the Owner to approve the COR as a change to the contract.

3.2. SUBMIT A CHANGE ORDER REQUEST FORM

A. This specification shall provide a subject overview only. In depth instructions shall be provided to the awarded Contractor in a PDF Instructional Manual.

B. The GC shall select the appropriate link on the Project Management Web Site.

C. The software will open a new COR form and the GC shall provide all of the following information:
   1. DO NOT perform any calculations on this worksheet, only provide the raw data as requested below. All calculations, totals, and markups shall be computed as described within this specification.
   2. Provide a summary description of the COR request, and justification for any requested time extension to the contract, indicate the number of calendar days being requested for the extension and add any attachments to the form as needed.
   3. Provide all GC self-performance data including all of the following:
      a. Materials description, quantities, and unit costs.
      b. Labor hours and rates for all Foremen, Journeymen, and Apprentices by trade.
      c. Equipment descriptions, quantities, unit costs and rates.
   4. Provide all Sub-contractor data including all of the following:
      a. Materials description, quantities, and unit costs.
      b. Labor hours and rates for all Foremen, Journeymen, and Apprentices by trade.
      c. Equipment descriptions, quantities, unit costs and rates.
   5. Ensure all calculations performed by the form have been completed correctly. Contact the CPM directly if you suspect an error before hitting the save button.

D. When all data has been entered submit the COR form. This will kick off the COR Review and Approval process.

3.3. CHANGE ORDER REQUEST REVIEW, APPROVAL, AND PROCESSING

A. The A/E PROJ MGR and CPM shall review all CORs submitted by the GC.

1. Additional consulting staff and city staff having knowledge of the components of the COR shall review and advise the A/E PROJ MGR and CPM as to the accuracy of the items, quantities, and associated costs of the COR as directed by the CB.
2. The CPM shall review the COR with the Owner.

B. If required the A/E PROJ MGR and CPM, shall in good faith, further negotiate the COR with the GC as necessary. All amendments to any COR shall be documented within the Project Management Web Site software.

C. After final review of the COR the CPM and Owner may accept the COR.

D. The CPM shall prepare the COR in the form of an official Board of Public Works Change Order for final review and approval as outlined in Section 01 26 63 Change Order (CO).

E. The GC shall not act upon any accepted COR until it has received final approval through the Public Works process as an official CO to the Work unless instructed to do so by the CPM. Proceeding without the final approval of a fully authorized Change Order is at the GC's own risk.

3.4. EMERGENCY CHANGE ORDER REQUEST

A. In the event Work is required due to an emergency as described in the Contract Documents, the GC must request an equitable adjustment as soon as practicable, and in no case later than ten (10) working days of the commencement of such emergency.

B. The GC shall provide full documentation of all labor, materials and equipment used during the period of emergency as part of the COR submittal.

END OF SECTION

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SECTION 01 26 63
CHANGE ORDER (CO)

PART 1 – GENERAL 1
1.1. SUMMARY 1
1.2. RELATED SPECIFICATION SECTIONS 1
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2.1. CHANGE ORDER FORM 2
PART 3 - EXECUTION 2
3.1. PREPARATION OF THE CHANGE ORDER 2
3.2. EXECUTION OF THE CHANGE ORDER 2

PART 1 – GENERAL

1.1. SUMMARY

A. Except in cases of emergency, no changes in the Work required by the Contract Documents may be made by the General Contractor (GC) without having prior approval of the City Project Manager (CPM).

B. The City may at any time, without invalidating the Contract and without Notice to Sureties, order changes in the Work by written Change Order. Such changes may include additions and/or deletions.

C. The Change Order (CO) is a Board of Public Works (BPW) form that is reviewed and approved by a specific process.

D. The CO form is typically made up of multiple Change Order Requests (CORs) and/or Bid Items as appropriate depending on the type of project and how the contract was bid.

E. All CO documentation shall be processed through the Project Management Web Site (PMWS).

1.2. RELATED SPECIFICATION SECTIONS

A. Section 01 26 13 Request for Information (RFI)
B. Section 01 26 46 Construction Bulletin (CB)
C. Section 01 26 63 Change Order Request (COR)
D. Section 01 31 23 Project Management Web Site (PMWS)
E. Section 01 91 00 Commissioning

1.3. BOARD OF PUBLIC WORKS PROCEDURE

A. The Board of Public Works has a very explicit procedure for the review and approval of all change orders associated with any Public Works Contract as follows:
   1. The Supervisory Chain of the CPM shall review and approve any CO under $20,000 provided it does not include either of the following:
      a. The CO does not request a time extension to the contract.
      b. The CO does not cause the contract contingency sum to be exceeded.
   2. The Board of Public Works shall review and approve any CO that requires any of the following:
      a. Any CO over $20,000.
      b. Any CO requesting a time extension to the contract regardless of the monetary value of the CO.
      c. Any CO that that causes the contract contingency sum to be exceeded.

B. The Board of Public Works generally meets every other week and only once in August and December. The GC is cautioned that, under normal scheduling, a CO requiring a BPW review will take a minimum of two (2) weeks to achieve final approval.
   1. The City shall not be responsible for additional delays to the Work caused by the scheduling constraints of the Board of Public Works.

C. *SPECIAL NOTE:* The GC is cautioned to never proceed unless told to do so by the CPM. Only in rare instances may the CPM give a written notice to proceed on a COR without an approved CO. Proceeding without the written notice of the CPM or an approved CO is at the GC's own risk.

PART 2 – PRODUCTS

2.1. CHANGE ORDER FORM

A. The CO form is located on the Project Management Web Site. The CPM shall click the link in the left margin of the project web site opening a new form. Project information is pre-loaded, the CPM only needs to enter information and make attachments as needed to complete the form.

PART 3 - EXECUTION

3.1. PREPARATION OF THE CHANGE ORDER

A. The CPM shall prepare the required CO forms in the Project Management Web Site as follows:
   1. Provide information for all contract information.
   2. Provide a general description of the items described within the change order.
   3. Provide detailed information for each Item on the CO form. At the option of the CPM, they may include multiple Change Order Requests each as their own item.
   4. Provide required pricing and accounting information as needed for the item.
   5. Insert attachments of contractor/architect provided information that clarifies and quantifies the CO. Attachments may include but not be limited to material lists, estimated labor, revised details or specifications, and other documents that may be related to the requested change.
   6. Save the final version of the completed CO.

3.2. EXECUTION OF THE CHANGE ORDER

A. Upon saving the CO as described in section 3.1 above, the software associated with the Project Management Web Site shall notify the GC that the CO has been drafted and is ready for review. The GC shall do the following:
   1. Open the CO form using the link provided in the email notification and review all items on the form.
   2. The GC shall notify the CPM immediately of any errors or discrepancies on the form and shall not sign or save it.
      a. The CPM shall make any corrections as needed, re-save the form, and notify the GC.
   3. If/when the GC concurs with the CO form as drafted the GC shall digitally sign the form and click SAVE.

B. After the GC digitally signs/saves the CO it shall be routed through the Project Management Web Site for additional review and/or approvals. The CPM shall do the following:
   1. Monitor the review process to ensure the software is working properly at each review step.
   2. Ensure that proper BPW procedures are executed as needed by the CO approval process.
      a. Schedule the CO on the next available BPW agenda if required.
         i. Attend the BPW meeting to speak on the CO to board members and answer questions.
         ii. The GC and/or the Project Architect /Project Engineer (A/E PROJ MGR) may be required to attend the BPW meeting to address specific information as it relates to the Work and/or materials associated with the CO.
   3. Monitor final approval and distribution of the CO.
   4. Notify the GC that the CO has been completed.
   5. Ensure that the CO is posted to the next Public Works payment schedule.
   6. Verify that the GC's next Progress Payment-Schedule of Values show the CO as part of the contract sum.

C. Upon final approval of the CO the GC may proceed with executing the Work associated with the CO.

END OF SECTION

SECTION 01 29 73
SCHEDULE OF VALUES

PART 1 – GENERAL 1
1.1. SUMMARY 1
1.2. RELATED SPECIFICATIONS 1
1.3. RELATED DOCUMENTS 1
1.4. BASIS OF VALUES 1
PART 2 – PRODUCTS – THIS SECTION NOT USED 2
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3.1. APPLICATION FOR PAYMENT 2
3.2. PROJECT MANAGEMENT WEBSITE SOV SPREADSHEET 2
3.3. INITIAL SCHEDULE OF VALUES SUBMITTAL 2
3.4. SOV FOR PROGRESS PAYMENT REQUESTS 2

PART 1 – GENERAL

1.1. SUMMARY

A. The Schedule of Values (SOV) is a Contractor provided statement that allocates portions of the total contract sum to various portions of the contracted work and shall be the basis for reviewing the Contractors Progress Payment Requests.

B.

C. The General Contractor shall be responsible for filling out and updating the SOV in the Project Management website with each Progress Payment Request.

1.2. RELATED SPECIFICATIONS

A. Section 01 26 63 Change Order (CO)
B. Section 01 29 76 Progress Payment Procedures
C. Section 01 31 23 Project Management Web Site (PMWS)
D. Section 01 32 26 Construction Progress Reporting
E. Section 01 33 23 Submittals
F. Parts of this specification will reference articles within “The City of Madison FACILITIES MANAGEMENT SPECIFICATIONs for Public Works Construction”.
   1. Use the following link to access the FACILITIES MANAGEMENT SPECIFICATIONs web page:
      http://www.cityofmadison.com/business/pw/specs.cfm
      a. Click on the “Part” chapter identified in the specification text. For example, if the specification says “Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION **2**10.2” click the link for Part II, the Part II PDF will open.
      b. Scroll through the index of Part II for specification 210.2 and click the text link which will take you to the referenced text.

1.3. RELATED DOCUMENTS

A. The following documents shall be used as the basis for initiating and maintaining the SOV worksheets throughout the execution of this contract.
   1. Drawing documents and specifications (including general provisions) as provided with the bid set documents and any published addendums.
   2. Documents associated with revisions or clarifications to number 1 above after awarding of the contract, including but not limited to:
      a. Construction Bulletins
      b. Request for Information
      c. Approved Change Orders
   3. The latest daily/weekly Construction Progress Report
   4. Other specifications as identified in Section 1.2 above

1.4. BASIS OF VALUES

A. The Contractor shall provide a breakdown of the Contract Sum in sufficient detail to assist the Architect and City Project Manager in evaluating Progress Payment Requests. The breakdown detail may require a labor and material breakdown for each division of work or trade or as directed by the CPM.

B. The total sum of all items shall equal the Contract Sum.

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. APPLICATION FOR PAYMENT

A. The Contractor shall use the Project Management website or Payment with each Progress Payment Request.

B. Completely fill out the Pay Application per the tutorial provided for the PMWS

1. Fill out to reflect the current status of the contract through the payment date being requested.
2. The City of Madison calculates retainage on Public Works Contracts as follows:
   a. In general, across the duration of the contract, 2.5% of the total contract sum, including change orders, is withheld for retainage as referenced from the City of Madison FACILITIES MANAGEMENT SPECIFICATION 110.2:
      i. Beginning with Progress Payment 1, 5% retainage will be withheld until such time that 50% of the total contract sum has been paid out.
      ii. No additional retainage will be withheld after 50% of the total contract sum has been paid, unless additional change orders have been approved after the 50% milestone has been reached. Per City of Madison FACILITIES MANAGEMENT SPECIFICATION 110.2, additional retainage up to 10%, may be held in the event there are holds placed by Affirmative Action or liquidated damages by BPW.
      iii. Retainage for additional change orders after the 50% milestone will be withheld at the rate of 2.5% of the total cost of the change order.
      iv. Retainage is based on the change orders posted to the City's contract worksheet at the time the progress payment is processed.

C. Only change orders that have been finalized and posted to the City of Madison's Application for Partial Payment worksheet may be itemized into the SOV documents.

D. The Contractor shall sign and date the application.

3.2. PROJECT MANAGEMENT WEBSITE SOV SPREADSHEET

A. The Contractor shall use the PMWS spreadsheet provided by the City to itemize their SOV for this contract. Provide additional sheets as necessary.

B. Provide information by any method that allocates portions of the total contract sum to various portions of the contracted work. Possible methods include combinations of the following:

1. By division of work
2. By contractor, sub-contractor, sub sub-contractor
3. By specialty item or group
4. Other methods of breakdown as may be requested by the City Project Manager or City Construction Manager at the pre-construction meeting.

C. Provide total cost of the item/description of work including proportionate shares of profit and overhead related to the item.

3.3. INITIAL SCHEDULE OF VALUES SUBMITTAL

A. The Contractor shall upload their initial SOV to the Project Management Web Site, no later than five (5) working days after the Pre-construction Meeting.

1. The level of detail shall be as described in section 3.2 above.

B. The Project Architect /Project Engineer (A/E PROJ MGR) and the City Project Manager (CPM) shall review the SOV as any other submittal and may require modifications to reflect additional detail as necessary.

C. The Contractor shall resubmit the SOV as necessary until such time as the A/E PROJ MGR and CPM have sufficient detail for assessing and approving future Progress Payment Applications.

D. Progress Payment Application 1 will not be processed until such time as the Contractor has met this requirement regardless of the amount of work completed per the application.

3.4. SOV FOR PROGRESS PAYMENT REQUESTS

A. The Contractor shall update the initial SOV with each Progress Payment Application as follows:

1. Initial items and values as part of Section 3.3 above will not be adjusted once the original Schedule of Values submittal has been approved.

2. Change orders shall be added as additional items and values at the bottom of the SOV as they become approved and posted to the City's contract worksheet. The value for each change order shall be the value indicated on the SOV and shall stand alone. Values shall not be split out or combined with other existing items with similar work descriptions on the original SOV.
3. Fill out columns to properly reflect the work completed and materials received since the last Progress Payment Application.
4. Only materials delivered and stored on the project site may be reflected on SOV progress updates.

B. Provide an updated project schedule with each Progress Payment application.

C. See Specification 01 29 76 Progress Payment Procedures for additional information on submitting Progress Payment Applications.

END OF SECTION

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SECTION 01 29 76
PROGRESS PAYMENT PROCEDURES

PART 1 – GENERAL 1
1.1. SUMMARY 1
1.2. RELATED SPECIFICATIONS 1
1.3. RELATED DOCUMENTS 1
1.4. PROGRESS PAYMENT MILESTONES 1
1.5. PROGRESS PAYMENT SUBMITTAL 4
PART 2 - PRODUCTS - THIS SECTION NOT USED 4
PART 3 - EXECUTION 4
3.1. GENERAL CONTRACTOR PROCEDURE 4
3.3. CITY PROJECT MANAGER PROCEDURE 4

PART 1 – GENERAL

1.1. SUMMARY

A. The General Contractor (GC) shall review this and all related specifications prior to submitting progress payment requests.

B. Progress payment requests (Partial Payment-PP) for this contract shall be applied for by the GC in the Project Management Web Site (PMWS)

C. The City Project Manager (CPM) shall review and amend or approve the PP on the Project Management Web Site.

D. After approval of the PP by the CPM, they shall forward the PP to the appropriate agencies for BPW contractual review and payment processing.

1.2. RELATED SPECIFICATIONS

A.	Section 01 26 63	Change Order (CO)
B.	Section 01 29 73	Schedule of Values
C.	Section 01 31 19	Progress Meetings
D.	Section 01 31 23	Project Management Web Site (PMWS)
E.	Section 01 32 16	Construction Progress Schedules
F.	Section 01 32 26	Construction Progress Reporting
G.	Section 01 33 23	Submittals
H.	Section 01 45 16	Field Quality Control Procedures
I.	Section 01 77 00	Closeout Procedures
J.	Section 01 78 13	Completion and Correction List
K	Section 01 78 23	Operation and Maintenance Data
L.	Section 01 78 36	Warranties
M.	Section 01 78 39	As-Built Drawings
N.	Section 01 78 43	Spare Parts and Extra Materials
O.	Section 01 79 00	Demonstration and Training

1.3. RELATED DOCUMENTS

A. The following documents shall be used when evaluating PP requests.

1. Daily and weekly construction progress reports filed since the last payment request.
2. Contractors Schedule of Values as updated from the last payment request. See Specification 01 29 73.
3. Any document that may be required to be submitted for review and approval, as noted by the specifications listed in Section 1.2 above, or the Progress Payment Milestone Schedule in Section 1.4 below, to achieve a required bench mark of contract progression or contract requirement.

1.4. PROGRESS PAYMENT MILESTONES

A. City Engineering-Facility Management has developed the Project Payment Milestone Schedule (Section 1.4 below) to assist the GC in providing required construction specific documentation and general contractual documentation in a timely manner.

B. The Progress Payment Milestone Schedule is not an all inclusive list. Multiple agencies review progress payment requests and contract closeout requests. Missing, incomplete, or incorrect documentation for any agency may

be a cause for not processing progress payments. It shall be the sole responsibility of the Contractor for providing documentation as required or requested to the appropriate agencies.

C. The milestone schedule is based on the contract total sum and shall be valid for most contracts. Milestone submittals will be required with whatever progress payment hits the percentage of contract total indicated in the schedule.

D. The CPM shall review the milestone schedule with each progress payment request and at their option may elect to hold processing the progress payment until such time as the contractor has met the requirements for providing construction specific documentation.

E. It shall be the General Contractors responsibility to comply with all BPW Contract Administration requirements and related deadlines as outlined in the Award Letter, Award Checklist, and Start Work Letter.

Progress Payment (PP) Milestone Schedule		
Milestone Description	***Due Before***	***Remarks***
BPW Contract Administration Documentation • Workforce profiles • Best Value Contracting Documentation • Sub-contractors prequalification approval & Affirmative Action plans • Submittals Schedule • Other as may be required	PP-1, or start work as applicable	• For GC and Sub-contractors before PP-1 regardless of scheduling • Sub-contractors (if applicable), due 10 days before they may start work • Sub-contractors (if applicable), due 10 days before they may start work • Specification 01 32 19
Required Construction Submittals/Administrative Documents • Contractors Project Directory • Schedule of Values • Waste Management Plan • Closeout Requirement Checklist • Warranty Checklist • Time Lapse Construction Camera (camera installed and operational)	PP-1	References • Specification 01 31 23 • Specification 01 29 73 • Specification 01 74 19 • Specification 01 77 00 • Specification 01 78 36 • Specification 01 32 33
Construction Progress Milestones • Early submittals, per submittal schedule • Detailed Contract Schedules	PP-1	See specifications for specific requirements • Specification 01 32 19, Examples: concrete mix, structural steel, products with long lead times • See Specification 01 32 16
General Construction Progress Requirements are all up to date • Progress Schedules • Submittals/Re-submittals (ongoing) • Schedule of Values • Progress Reporting • LEED Documentation • Waste Management documentation • QMOs are being addressed and closed • Progress Cleaning • As-Built Drawings	Each future PP	Verified with each Progress Payment Request • Specification 01 32 16 • Specification 01 33 23 • Specification 01 29 73 • Specification 01 32 26 • All specifications with LEED documentation requirements • Specification 01 74 19 • Specification 01 45 16 • Specification 01 74 13 • Specification 01 78 39
*** All of the above are being updated on the Project Management Web Site as required**		
BPW Contract Administration Documentation	25% CT	See 1.4.E above. *This progress payment will be*

Progress Payment (PP) Milestone Schedule		
Milestone Description	***Due Before***	***Remarks***
• Weekly payroll reports • Best Value Contracting Reports • SBE Reports	or PP 2	*with held by BPW for any missing contractual documentation.*
Construction Progress Milestones • Construction/Contract Closeout Meeting #1 • Submittals/Re-submittals complete	50% CT	• Specification 01 31 19 • Specification 01 33 23
Operation and Maintenance (O & M) drafts	60% CT	• Specification 01 78 23
Construction/Contract Closeout Meeting #2 • Construction closeout checklist	70% CT	• Specification 01 31 19 • Specification 01 77 00
BPW Contract Administration Documentation • Request Finalization Review from BPW	80% CT	This is a recommendation to the GC and is not a requirement of this PP. • Specification 01 77 00
Construction Progress Milestones • Operation and Maintenance (O & M) finals, accepted • All major QMO issues resolved • As-Built Drawings, Division Trades ready for GC review	80% CT	• Specification 01 78 23 • Specification 01 45 16; Items that could prevent occupancy • Specification 01 78 39
All of the following shall be completed for this PP: • Regulatory Inspections completed • All QMO reports closed • Demonstration and Training completed • Attic Stock completed • Final Cleaning	90% CT	Contractor to determine the proper order of completion: • Governing ordinances and statutes • Specification 01 45 16 • Specification 01 79 00 • Specification 01 78 43 • Specification 01 74 13
Construction Closeout Procedures: • Letter of Substantial Compliance sent to BI and DHS as needed • Certificate of Occupancy issued • As-Built Drawings, finals, accepted • City Letter of Substantial Completion • Warranty letters dated and issued	100% CT	• Specification 01 77 00 • Generated/Signed by the Architect • Building Inspection • Specification 01 78 39 • Signed by the City Engineer • Specification 01 78 36
*** Completion of this begins the one year warranty.**		
BPW Contract Administration Documentation Contract Closeout Procedures • Construction Closeout has been completed • Contractor requests final payment of retainage upon receiving City Letter of Substantial Completion	Final	• Specification 01 77 00

Progress Payment (PP) Milestone Schedule		
Milestone Description	***Due Before***	***Remarks***
• All BPW contractual requirements are verified		• Contractor must provide any missing BPW Contractual Documentation
*** Completion of this closes the contract but not the warranty period/bond.**		
NOTE: **CT = Contract Total less held retainage**		

1.5. PROGRESS PAYMENT SUBMITTAL

A. Each progress payment submittal shall be completed in the Project Management Website. See guide on the Project Management Website for the procedure.

B. Submit all required construction progress documentation to the appropriate Project Management Web Site component as described in guides.

C. In general the following shall apply to all PP requests:

1. Materials or products:
   a. On order, being shipped, etc. may not be invoiced.
   b. Received and stored on the project site may be invoiced.
   c. Being manufactured off site at any location may not be invoiced (example: cabinetry, ductwork, etc.)
   d. Completed products stored off site locally waiting for delivery to the project site may be invoiced with prior approval by the CPM. All of the following conditions must be met to be allowed:
      i. Items must be visually inspected by CPM to verify product is complete.
      ii. Item must be stored inside a compatible structure and the structure and contents must be insured.
      iii. Contractor is responsible for condition until installation is completed.
2. All labor and equipment, including rental time for the current progress period may be invoiced.
3. Only completed installations may be invoiced to 100% based on the Schedule of Values.

D. DO NOT submit BPW Contract Administration Documentation for review with Progress Payment Requests, submit them directly to the correct agency and in the correct format as instructed from information in your BPW Contract Award Packet instructions.

PART 2 - PRODUCTS - THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. GENERAL CONTRACTOR PROCEDURE

A. The GC shall use the Project Management Website for each PP request.

1. The GC shall subtotal the work completed to date for all of the original Schedule of Value items.
2. Ensure that any newly posted change orders have been entered.
3. The GC shall submit the PP request in the Project Management Website. The username and date will be automatically recorded.
4. The GC shall provide the dates from and to for the PP being requested.
5. The GC shall provide the list of all contractors/sub-contractors that were actively working during the dates indicated above. The guide details the appropriate location for this list.
   a. All contractors/sub-contractors named must be in compliance with all City requirements (Pre-qualified, Affirmative Action Plan on file, etc). The PP will be held and not processed by the City of Madison until all contractors/sub-contractors are in compliance.
   b. Do not list the names of suppliers or manufacturers, doing so will slow down processing and require a re-submittal of the paperwork.
6. The GC shall attach a copy of the current Project Schedule.

3.3. CITY PROJECT MANAGER PROCEDURE

A. The CPM shall review all documents submitted by the GC to ensure the schedule of values accurately reflects the work completed to date.

B. The CPM may elect to hold processing of any progress payment pending submittal of required progress payment milestones.

C. When verified, the CPM shall send the PP and required documentation to the appropriate City agencies for further processing of the payment request.

D. The PP processing will be completed and available for view within the PMWS.

END OF SECTION

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SECTION 01 31 13
PROJECT COORDINATION

PART 1 – GENERAL 1
1.1. SUMMARY 1
1.2. RELATED SPECIFICATIONS 1
1.3. GENERAL REQUIREMENTS 1
1.4. GENERAL CONTRACTOR PERFORMANCE REQUIREMENTS 2
1.5. SUB-CONTRACTOR PERFORMANCE REQUIREMENTS 2
PART 2 – PRODUCTS – THIS SECTION NOT USED 3
PART 3 – EXECUTION – THIS SECTION NOT USED 3

PART 1 – GENERAL

1.1. SUMMARY

A. Project Coordination covers many areas within the execution of the Contract Documents and the requirements of proper coordination are the applicable to all contractors executing the Work of this contract.

B. This specification provides general information regarding project coordination for the General Contractor and all Sub-contractors. All contractors shall be familiar with project coordination requirements and responsibilities that may be defined in other specification within these Contract Documents.

C. The General Contractor shall at all times be responsible for the project, project site, and execution of the Contract Documents.

1.2. RELATED SPECIFICATIONS

A.	Section 01 29 76	Progress Payment Procedures
B.	Section 01 31 19	Progress Meetings
C.	Section 01 31 23	Project Management Web Site
D.	Section 01 32 16	Construction Progress Schedules
E.	Section 01 32 19	Submittals Schedule
F.	Section 01 33 23	Submittals
G.	Section 01 43 39	Mockups
H.	Section 01 45 16	Field Quality Control Procedures
I.	Section 01 60 00	Product Requirements
J.	Section 01 77 00	Closeout Procedures, including all specifications referenced therein
K.	Section 01 91 00	Commissioning

1.3. GENERAL REQUIREMENTS

A. The following general requirements shall applicable to all contractors:
   1. Cooperate with the Owner, all authorized Owner Representatives, Project Architect and all consultants of the Owner.
   2. Materials, products, and equipment shall be new, as specified and to industry standards except where otherwise noted.
   3. Labor and workmanship shall be of a high quality and to industry standards.

B. Existing conditions:
   1. Verify all existing conditions noted in the contract documents with actual filed locations. Verify dimensions, sizes and locations, of structural, equipment, mechanical and utility components.
   2. Report any inconsistencies, errors, omissions, or code violations in writing to the General Contractor (GC) immediately.
   3. Annotate any inconsistencies, errors, omissions on the GC As-Built record drawings immediately for future reference.

C. Contract Documents:
   1. The Contract Documents are intended to include everything necessary to perform the work. Every item required may not be specifically mentioned, shown, or detailed.
      a. Except where specifically stated all systems and equipment shall be complete, installed, and fully operable.
      b. If a conflict exists within the contract documents the contractor shall furnish the item, system, or workmanship of the highest quality, largest, largest quantity, or most closely fits the intent of the contract documents.

c. Manufacturers recommended installation details shall be verified and used prior to installation of products and equipment so as to not void warranties.

D. Errors and Omissions
1. No Contractor shall take any advantage of any apparent error or omission in the construction documents.
2. The City of Madison shall be permitted to make such corrections and interpretations as may be deemed necessary for the fulfillment of the intent of the construction documents.

E. Owners Representatives
1. All contractors shall be familiar with various Owner Representatives having Quality Management responsibilities for the duration of this project including but not limited to the following:
a. Project Architect, responsible for all decisions affecting the code compliance and design intent of the construction documents.
b. Consulting Architects and Engineers, responsible for providing consulting services to the Project Architect, Owner, and City Project Manager, also responsible for Quality Management of the construction documents.
c. Owner, the designated representative of the City Agency that will occupy the project upon completion.
d. City Project Manager, responsible for all day to day decisions regarding the execution and performance of this Public Works Contract.
e. Consulting City Staff, responsible for providing consulting services to the Project Architect, Owner, and City Project Manager, also responsible for Quality Management of the construction documents.
f. Commissioning Agent (CxA), responsible for ensuring that the project is meeting the Owner's Project Requirements and related quality assurance procedures.
2. Owner Representatives shall be attending progress meetings, pre-installation meetings, performing or being present for final testing and acceptance and quality management reporting during the execution of the contract documents as outlined in other specifications.

1.4. GENERAL CONTRACTOR PERFORMANCE REQUIREMENTS

A. Assume the responsibility for all Work specified in the Contract Documents except where specifically identified to be performed by the Owner or other contractor separately hired by the Owner.
1. Coordinate all work by Owner, equipment provided Owner, or contractor hired by the Owner into the project schedule.

B. Provide all construction management responsibilities as specified in other Division 1 specifications including but not limited to:
1. Scheduling of work
2. Coordination of work between other Trades and Sub-contractors
3. Construction administration and management
4. Site layout, cleanliness, and protection of completed work/stored materials
5. Waste Management
6. Quality Assurance and Quality Control

C. Use Diggers Hotline and private utility locating companies to accurately locate all public and private utilities on the property as needed. The GC is responsible for any repair or replacement to any public or private utility damaged during the execution of the Work

D. Report any inconsistencies, errors, omissions, or code violations in writing to the Project Architect immediately. Failure to report inconsistencies prior to beginning work shall indicate that the GC accepted all existing conditions.

E. The GC shall be responsible for assigning work and related responsibilities where the Contract Documents may not clearly state who is responsible for providing the work, material, or product.

F. Provide construction management oversight of all items described in Section 1.5 below.

G. Coordinate and assist CxA as outlined within 01 91 00 and as directed by Owner.

1.5. SUB-CONTRACTOR PERFORMANCE REQUIREMENTS

A. Be familiar with all of the contract documents as they pertain to your Work, adjacent work and the overall progress of the project.
1. All Sub-contractors shall be familiar with all Division 1 specifications as they may apply to progress, progress payments, quality control construction management, and closeout of the contract.

B. Coordinate your Work with all adjacent work and existing conditions.

1. Perform your work in proper sequence according to the GC's project schedule and in relation to the work of other trades.
2. Notify other sub-contractors and trades whose work may be connected to, combined with, or influenced by your work and allow them reasonable time and access to complete their work.
3. Join your work to the work of others in accordance with the intent of the Contract Documents.
4. Order materials and schedule deliveries to facilitate the general progress of the Work.

C. Cooperate with all other trades to facilitate the general progress of the work. This shall include providing every reasonable opportunity for the installation of work by others and the storage of their materials and equipment.
1. In no case shall any contractor exclude from the premises or work any Sub-contractor or their employees.
2. In no case shall any contractor interfere with the execution or installation of Work by any other Sub-contractor or their employees.

D. Arrange your work, equipment, and materials and dispose of your construction waste so as to not interfere with the work or storage of materials of others.

E. Coordinate all work as indicated during pre-installation meetings with Owner Representatives, the GC and other trades. Any work improperly coordinated shall be relocated as designated by the Owner Representative at no additional cost to the City.

F. Coordinate and assist CxA as outlined within 01 91 00 and as directed by Owner.

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 – EXECUTION – THIS SECTION NOT USED

END OF SECTION

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SECTION 01 31 19
PROJECT MEETINGS

PART 1 – GENERAL 1
1.1. SUMMARY 1
1.2. RELATED SPECIFICATIONS 1
1.3. PROJECT MEETING TYPES 1
1.4. GENERAL REQUIREMENTS 1
PART 2 – PRODUCTS – NOT USED IN THIS SECTION 1
PART 3 - EXECUTION 1
3.1. PRECONSTRUCTION MEETING 1
3.2. PROJECT MANAGEMENT WEB SITE – TUTORIAL MEETING 2
3.3. CONSTRUCTION PROGRESS MEETINGS 2
3.4. PRE-INSTALLATION MEETINGS 3
3.6 PRE-CONTRACT CLOSEOUT MEETINGS 3
3.7 OTHER SPECIAL MEETINGS 3

PART 1 – GENERAL

1.1. SUMMARY

A. The purpose of this specification is to identify various project related meetings and the responsible parties for scheduling, agendas, minutes, and required attendance.

B. This specification is not intended to be inclusive of all meeting types or a complete list of required meetings.

C. This specification is not intended to cover planning and execution meetings between the General Contractor (GC) and their sub-contractors.

1.2. RELATED SPECIFICATIONS

A. 01 31 23 Project Management Web Site

B. 01 32 16 Construction Progress Schedules

C. 01 43 39 Mockups

D. 01 91 00 Commissioning

1.3. PROJECT MEETING TYPES

A. The following project meeting types may be used but not limited to the following

1. Preconstruction Meeting
2. Project Management Web Site – Tutorial Meeting
3. Construction Progress Meetings
4. Pre-installation Meetings (including mock-up review meetings)
5. Weekly Trade Meetings
6. Special Meetings
7. Commissioning Meetings

1.4. GENERAL REQUIREMENTS

A. Representatives of Contractors, Subcontractors, and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.

PART 2 – PRODUCTS – NOT USED IN THIS SECTION

PART 3 - EXECUTION

3.1. PRECONSTRUCTION MEETING

A. After execution of the Contract the City Project Manager (CPM) shall schedule and conduct the Preconstruction Meeting at the Owner's facilities. The CPM shall coordinate the meeting agenda with the Project Architect and the GC Project Manager.

B. The CPM shall be responsible for the final agenda.

C. The CPM and Project Architect shall take notes on the meeting and post completed meeting minutes.

D. Attendance shall be required by all of the following:

1. Owner Representative(s)

2. Architect and applicable sub consultant(s)
3. General Contractor and applicable subcontractors and suppliers
4. City Quality Management Staff
5. Commissioning Agent
6. Others, as may be invited for particular agenda items.

E. Topics of the Preconstruction Meeting shall include but not be limited to the following:
1. Staff and contractor introductions
2. Completion Date
3. BPW Administrative requirements and due outs
   a. Small Business Enterprise (SBE) (if applicable)
   b. Certified payroll forms
   c. Workforce profiles
   d. Best Value Contracting (BVC)
4. General Facility Management Division 1 Specifications, including:
   a. Section 01 29 76 Progress Payment Procedures
   b. Section 01 31 23 Project Management Web Site (overview)
   c. Section 01 45 16 Field Quality Control Procedures
   d. Section 01 77 00 Closeout Procedures
   e. Section 01 91 00 Commissioning
5. Project Meeting scheduling
   a. Section 01 31 19 Project Meetings
6. Construction Schedule
7. Commissioning Process

3.2. PROJECT MANAGEMENT WEB SITE – TUTORIAL MEETING

A. The CPM shall schedule and conduct a virtual tutorial presentation of the PMWS prior to the beginning of construction.
B. The CPM shall be responsible for the final agenda, there will be no minutes.
C. The required attendance list in 3.1.D. above shall apply except for City Staff in items 1 and 4 who are already familiar with the PMWS system.

3.3. CONSTRUCTION PROGRESS MEETINGS

A. In general, all of the following shall apply:
1. Representatives of Contractors, Subcontractors, and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.
2. The attendance shall be from the required attendance list in 3.1.D. above.

B. The General Contractor Project Manager (GCPM) shall:
1. Schedule and conduct all construction progress meetings biweekly or more frequently as required.
2. Prepare agenda for meetings including, but not limited to the following:
   a. Safety
   b. Current Schedule, including review of the critical path and 6-week look ahead schedule
   c. Status of project related documentation (Submittals, RFIs, CBs, etc.)
   d. Quality Observation Log and status of correction of deficient items
   e. Project questions and issues from meeting attendees
   f. BPW Administration Check
   g. Other as needed
   h. Status of CORs and COs to be reviewed outside the standard progress meeting time.
3. Make physical arrangements for meetings.
4. GCPM to post meeting agendas to the appropriate libraries on the Project Management Web Site (PMWS) no less than two (2) working days prior to the scheduled meeting. Notify all required attendees, applicable parties to the contract, and others affected of the posted meeting agenda.
5. Preside at meetings.
6. Route a meeting attendance roster for attendees to sign-in on.
7. GCPM to record the minutes of the meeting; include significant proceedings and decisions. Post meeting minutes to the PMWS no more than two (2) working days after the completed meeting. Meeting minutes shall include a scanned copy of the attendance sign-in sheet. Notify all required meeting attendees, applicable parties to the contract, and others affected by decisions made at the meetings.
8. The above requirements do not apply to GC/sub-contractor meetings.

3.4. PRE-INSTALLATION MEETINGS

A. The GCPM shall schedule and conduct all pre-installation meetings, including mockup reviews, before each construction activity that requires coordination with other trades.
B. The GCPM shall be responsible for the final agenda and meeting minutes.
C. The GCPM will work with all concerned parties to resolve issues as needed and submit RFI's if necessary.
D. Required attendance shall be from the list in 3.1.D. above and shall be personnel having a stake in the outcome of the installation or knowledge of the system being installed.
E. In the event the Contractor installs equipment or materials without a pre-installation meeting the Contractor shall be solely responsible for removing, replacing, repositioning materials and equipment as instructed by the Project Architect or City Project Manager at no additional cost to the City.

3.6 PRE-CONTRACT CLOSEOUT MEETINGS

A. Two (2) Pre-contract Closeout Meetings shall be held to review the closeout procedures, requirements, and contract deliverables.
    1. Pre-contract Closeout Meeting #1 shall be scheduled prior to the 50% Progress Payment Request is being requested. This meeting shall discuss items such as closing out QMO reports, providing O&M drafts and finals, payroll and Affirmative Action documentation, and other contract deliverables.
    2. Pre-contract Closeout Meeting #2 shall be scheduled prior to the 80% Progress Payment Request is being requested. This meeting shall discuss, but not be limited to, the status of scheduling final regulatory inspections, cleaning up outstanding QMO's, demonstration and training, attic stock; and finalization review of payroll and other related documents.
B. The GCPM shall schedule, coordinate, and make physical arrangements for both meetings.
C. All of the following shall be required to attend both meetings:
    1. The GCPM and the GC Field superintendent
    2. All Subcontractor Project Managers regardless of the current status of their work.
        a. The GCPM may excuse a Subcontractor PM if they are confident that all contractual requirements for closeout by the subcontractor have been completed and/or delivered to the GCPM. The list of attendees shall be reviewed and agreed upon with CPM ahead of the meeting.
        b. At the option of these project managers the field supervisors may also attend.
    3. The Project Architect and at least one design consultant from each discipline represented by the plans and specifications to address open QMOs, final tests, reports, etc.
    4. The Owner
    5. The CPM
    6. Quality Management staff as needed to address open QMOs, final tests, reports, etc.
    7. The Commissioning Agent
D. The CPM shall publish an agenda and chair the meeting.

3.7 OTHER SPECIAL MEETINGS

A. The Contractor shall schedule special meetings per the requirements of the LEED Specification, the Project Quality Management Plan, the Commissioning Plan and as indicated by other specifications.
B. Special meetings include but are not limited to the following:
    1. Waste Management Conference
    2. Equipment start up meetings
    3. Testing and balancing meetings
    4. Commissioning meetings
    5. Other meetings as necessitated by the contract documents

END OF SECTION

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SECTION 01 31 23
PROJECT MANAGEMENT WEB SITE

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1.2. AUTODESK CONSTRUCTION CLOUD PROCEDURE OVERVIEW 1
1.3. RELATED SPECIFICATIONS 1
PART 2 - PRODUCTS 2
2.1. AUTODESK CONSTRUCTION CLOUD SYSTEM RELATED PRODUCTS 2
PART 3 - EXECUTION 2
3.1. POST BID-OPENING 2
3.2. POST PRE-CONSTRUCTION MEETING 2

PART 1 – GENERAL

1.1. GENERAL DESCRIPTION

A. The City of Madison (CoM) has established a cloud-based Project Management Tool (PMT) using an Autodesk product called Autodesk Construction Cloud (ACC).

B. The software is used throughout the design, construction and warranty process of major remodels and new construction projects.

C. Initially deployed in mid-2023, the PMT software will be deployed on all projects. The PMT software is cloud-based software and therefore will receive regular updates and enhancements.

1.2. AUTODESK CONSTRUCTION CLOUD PROCEDURE OVERVIEW

A. The CoM PMT is 3 main modules. The Autodesk Docs (https://help.autodesk.com/view/DOCS/ENU/) module is a document management file system that is the foundation of ACC. The Build https:/help.autodesk.com/view/BUILD/ENU/ module has many sections that assist in performing day to day functions of design/construction management while reducing the use of different software platforms, surface mail, email and email attachments. Finally, the Cost management (https://help.autodesk.com/view/BUILD/ENU/?guid=Cost_Overview) module is used to manage project finances.

1. Files within Autodesk Docs can store a wide variety file formats (https://help.autodesk.com/view/DOCS/ENU/?guid=Supported_Files_Docs) including but not limited to Word, Excel, PDF, photographs (all popular formats), etc.
2. The Issues section within the Build module is used for Punch Lists, Quality Control and Warranty issues.
3. File Folder and module section access are controlled by Permission Groups and Permission Level

B. A tutorial document on the web based PMT will be provided to the General Contractor (GC) who is awarded the contract. Additional training will be provided as needed for the GC and Sub-Contractors (SC) by the CoM.

C. The PMT has predefined work flows that channel automated alerts as documents are uploaded, reviewed, and completed. These workflows are designed for inbound information from the contractor as well as outbound information from the Architectural/Engineer consultant and the Owner.

D. The GC will be required to receive email notifications, access the internet to review related documentation and be able to upload/download documentation to the various project modules or folders.

E. The SC's will be required (at a minimum) to receive email notifications and access the internet to review related documentation. Prior to setting up the final PMT the GC and CPM shall meet to review all ACC workflows, the GC will determine to what level over the minimum requirements the SC's will be involved.

F. At final project closeout with the GC, the CoM will provide the Project Architect/Project Engineer (A/E PROJ MGR) and the GC, an exported version of the complete project in ACC.

1.3. RELATED SPECIFICATIONS

A. The following specification sections are directly related to the CoM PMT system.

1. 01 25 13 Product Substitution Procedures
2. 01 26 13 Request for Information (RFI)
3. 01 26 46 Construction Bulletins (CB)
4. 01 26 57 Change Order Request (COR)
5. 01 26 63 Change Order (CO)
6. 01 29 76 Progress Payment Procedures
7. 01 31 19 Project Meetings
8. 01 32 16 Construction Progress Schedules

9.	01 32 26	Construction Progress Reporting
10.	01 32 33	Photographic Documentation
11.	01 33 23	Submittals
12.	01 45 16	Field Quality Control Procedures (Owner)

PART 2 - PRODUCTS

2.1. AUTODESK CONSTRUCTION CLOUD SYSTEM RELATED PRODUCTS

A. Autodesk Construction Cloud is an Autodesk based software that requires no additional software installation, hardware or other special requirements/applications for the users. There are no costs associated with the use of this system.

B. Please consult Autodesk's web site for the latest system requirements (https://help.autodesk.com/view/BUILD/ENU/?guid=System_Requirements_ACC)

PART 3 - EXECUTION

3.1. POST BID-OPENING

A. After bids have been opened, a successful bidder has been determined, and bid acceptance procedures have been initiated the City Project Manager (CPM) will contact the GC to provide the following information.

1. Autodesk Construction Cloud Help (https://help.autodesk.com/view/BUILD/ENU/) and Learning Center (https://learnacc.autodesk.com/) are kept up to date with latest ACC features.
2. For more customized workflows, Project Management Software Tutorials have been developed. These tutorials are in a PDF printable format with screen shots and associated instructions on how to access and use the PMT.
3. A blank Project Directory in an Excel spread sheet format. The contractor shall provide the following information for GC and SC staffs as indicated on the spreadsheet. This will generally be the Project Manager for the GC as well as the Sub-contractors and the GC Site Supervisor.
   a. Last Name, First Name
   b. Company Name
   c. Email address (valid, work related)
4. Phone Contact number and professional name must be entered by each user themselves via https://profile.autodesk.com/
5. The GC shall provide the above information for all SC's where the GC is not self-performing the work.
6. The GC may provide project foreperson information for work being self-performed if he/she so desires.

3.2. POST PRE-CONSTRUCTION MEETING

A. The GCPM will return the completed Project Directory spread sheet to the CPM no later than the Pre-construction meeting.

B. The City Project Admin is responsible for uploading all project directory data into ACC, adding users to project and licenses to users for all non-city staff (GC/SC staffs).

C. All GC/SC staff will be notified through an automated email from Autodesk directing them to create an Autodesk account if they do not already have one. It is the responsibility of each GC/SC to follow the instructions to setup their own account

D. Once the GCPM has received his/her project invitation, uploading of contract related documents can begin. This would include but not be limited to project schedules, submittals, RFI's, and other documents as needed.

E. All workflows, review of documentation, and general archiving of construction related documentation will be conducted on the PMWS. These documents will generally not be emailed.

F. The following documents related to the execution of the contract will not be part of the PMT:

1. All documentation related to executing the contract, such as:
   a. Sub Contractors list
   b. Affirmative Action documentation
   c. Bonding documentation
   d. Documentation associated with payroll verification
   e. Final documentation associated with closing out the contract
2. Any documentation required/generated by ordinance, code or statute, such as;
   a. Erosion Control inspections
   b. Building Inspection Department inspections

1 **END OF SECTION**

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SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULES

PART 1 – GENERAL 1
1.1. SCOPE 1
1.2. RELATED SPECIFICATIONS 1
PART 2 – PRODUCTS – THIS SECTION NOT USED 1
PART 3 - EXECUTION 1
3.1. OVERALL PROJECT SCHEDULE (OPS) 1
3.2. 6 WEEK LOOK-OUT SCHEDULES (LOS) 1
3.3. PROJECT MANAGEMENT WEB SITE (PMWS) 2

PART 1 – GENERAL

1.1. SCOPE

A. This specification is to identify various project related schedules associated with indicating construction progress and outlook. The following schedules are the responsibility of the General Contractor (GC).
   1. Overall Project Schedule
   2. 6 Week Look-out Schedule

B. This specification is not intended to include internal schedules generated by the contractors during their planning and execution of the contract.

1.2. RELATED SPECIFICATIONS

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 31 23 Project Management Web Site
C. Section 01 31 19 Progress Meetings
D. Section 01 74 13 Progress Cleaning
E. Section 01 77 00 Closeout Procedures
F. Section 01 78 23 Operation and Maintenance Data
G. Section 01 78 36 Warranties
H. Section 01 78 39 As-Built Drawings
I. Section 01 78 43 Spare Parts and Extra Materials
J. Section 01 79 00 Demonstration and Training
K. Section 01 91 00 Commissioning
L. Other specification within the construction documents that may indicate the need for scheduling any event with Owner, Project Architect, Owner Representatives, including any owner provided equipment.

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. OVERALL PROJECT SCHEDULE (OPS)

A. The GC shall prepare an OPS that covers the duration of the contract from the pre-construction meeting through the end of construction to final contract closeout.
   1. The GC shall review Specification 01 77 00 Closeout Procedures to become familiar with definitions, differences, and requirements for closing out the construction and contract including the association with progress payments.

B. The GC shall provide copies and lead a discussion on the OPS during the pre-construction meeting.
C. The OPS shall indicate start and end dates of each task associated with the project.
D. The OPS shall clearly indicate the critical path of the project.
E. The GC shall update the OPS as often as necessary during the duration of the project. Updates will be briefed as needed during bi-weekly progress meetings.

3.2. 6 WEEK LOOK-OUT SCHEDULES (LOS)

A. The GC shall prepare the initial LOS to include detail of daily tasks for the first six (6) weeks of construction in depth for the Pre-construction meeting. The LOS shall be compatible and complimentary to the OPS.
B. The GC shall provide copies and lead a discussion on the LOS during the pre-construction meeting.

C. The LOS shall indicate start and end dates of each major task, associated related sub-tasks, and required parallel or pre-requisite tasks required to complete the major task on time.

D. The LOS shall also include identifying and scheduling such events as:
   1. Pre-installation meetings and mock-up review meetings.
   2. Quality management reviews of installations before they are covered.
   3. Owner provided equipment as designated by the contract documents.
   4. Work by others as designated by the contract documents.
   5. Critical submittal dates.

E. The GC shall update the LOS prior to each bi-weekly progress meeting to indicate the next 6 weeks of scheduled work. Updates will be briefed during each bi-weekly progress meeting.

3.3. PROJECT MANAGEMENT WEB SITE (PMWS)

A. The GC shall upload all project schedules and updates to the PMWS in an original PDF version of the scheduling document. Scans will not be permitted.

END OF SECTION

SECTION 01 32 19
SUBMITTALS SCHEDULE

PART 1 – GENERAL 1
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1.2. RELATED SPECIFICATIONS 1
1.3. RELATED DOCUMENTS 1
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1.5. SUBMITTAL REQUIREMENTS 2
1.6. ADMINISTRATIVE SUBMITTALS 2
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PART 3 - EXECUTION 2
3.1. OVERALL RESPONSIBILITIES OF ALL CONTRACTORS 2
3.2. GENERAL CONTRACTORS RESPONSIBILITIES 2
3.3. STAFF REVIEW RESPONSIBILITIES 3

PART 1 – GENERAL

1.1. SUMMARY

A. The General Contractor shall submit a complete and comprehensive list of all submittals anticipated during the execution of this contract.

B. The GC shall include the Administrative submittals identified in item 1.5 below and shall be required to up load them to the Project Management Web Site.

C. The initial Submittals Schedule shall be based on the original contract documents used at the time of bidding and any posted addenda through awarding of the contract.

D. The Submittal Schedule may be appended during the execution of the contract based on amendments to the contract in the form of Change Orders, Construction Bulletins, and other related documents that add, or change the scope of the work.

1.2. RELATED SPECIFICATIONS

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 31 23 Project Management Web Site (PMWS)
C. Section 01 33 23 Submittals
D. Section 01 91 00 Commissioning

1.3. RELATED DOCUMENTS

A. The following documents shall be used as the basis for initiating the original Submittals Schedule.
   1. Drawing documents and specifications (including general provisions) as provided with the bid set documents and any published addenda.

B. The following documents shall be used to amend the submittals schedule as needed during the execution of this contract.
   1. Documents associated with revisions or clarifications to number A.1 above after awarding of the contract, including but not limited to:
      a. Construction Bulletins
      b. Approved Change Orders

1.4. SUBMITTAL DEFINITIONS

A. Administrative Submittal: Any submittal that may be required by a Division 1 Specification and as noted in Section 1.5 below.

B. Critical Path Submittal: Any early submittal that needs a priority review due to early construction use or long lead times where a delay could affect the critical path of the construction schedule

C. Submittal: Any material, product, equipment, or general requirement as outlined in this and other specifications that require a favorable review or acceptance prior to proceeding with procuring the item or proceeding with the Work.

1.5. SUBMITTAL REQUIREMENTS

A. The GC and all Sub-contractors shall review the construction documents including the specifications of their individual Division or Trade to compile a complete list of all materials, products, or equipment that will require a positively reviewed submittal to be completed prior to procurement and installation.
   1. Submittals shall include but not be limited to any of the following that may apply:
      a. Shop Drawings
      b. Product Data
      c. Assembly Drawings
      d. Engineered Drawings
      e. Product Samples

B. The following items will require an approved submittal, verify with specifications for specific needs and requirements:
   1. Contractor certifications for specialized work such as asbestos removal, well drilling, controls, AV, etc.

1.6. ADMINISTRATIVE SUBMITTALS

A. The GC shall upload the following submittals within 15 working days of receipt of the City of Madison Start Work Letter. All Administrative Submittals shall be approved prior to requesting Progress Payment Number 1.
   1. Contractors Project Directory, see specification 01 31 23, discuss requirements with CPM
   2. Schedule of Values, see Specification 01 29 73
   3. Submittals Schedule, see Specification 01 32 19
   4. Waste Management Plan, see Specification 01 74 19
   5. Closeout Requirement Checklist, see Specification 01 77 00
   6. Warranty Checklist, see Specification 01 78 36

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. OVERALL RESPONSIBILITIES OF ALL CONTRACTORS

A. All contractors shall be responsible for reviewing the drawings and specifications within their Divisions of Work to provide a complete and comprehensive list of submittals to the General Contractor.

B. Each list shall indicate the title of the submittal, the associated specification of the submittal, whether the submittal can be considered an early/middle/late submittal, the anticipated date the submittal will be provided and the anticipated date the submittal needs to be approved.

C. Contractors shall be aware that the goals for submittal review by the Architect staff and City staff will be as follows:
   1. For items on the Critical Path as identified by the GC, five (5) working days
   2. For most other submittals ten (10) working days
   3. Additional time may be needed for complex submittals or if re-submittals are required.

D. The City will provide a spreadsheet to provide the format of the Submittal Schedule as part of the first administrative submittals.

3.2. GENERAL CONTRACTORS RESPONSIBILITIES

A. The General Contractor shall be responsible for all of the following:
   1. Consolidating all submittal lists from individual contractors into one master list with the provided spreadsheet on the Project Management Web Site
   2. Reviewing all submitted lists for completeness, timing with the overall contract, etc. The GC shall meet with individual contractors to make changes as necessary.
   3. Upload the completed Submittals Schedule to the Submittal Library on the Project Management Web Site See Specification 01 33 23 Submittals for more information on this procedure.
   4. Resubmit the schedule as needed after initial reviews have been completed.

B. The GC shall work with other contractors to amend the Submittals Schedule throughout the execution of the project based on changes and modifications as needed.

C. The GC and Project Architect shall be responsible for reviewing and briefing the submittal schedule and submittals status at each bi-weekly construction meeting.

3.3. STAFF REVIEW RESPONSIBILITIES

A. The Project Architect, consulting staff, Commissioning Agent (CxA), Owner, and city staff will review the Submittal Schedule for completeness per the plans and specifications within their divisions of work. The reviewing staff may provide comments as needed. Some examples might include the following:
   1. Submittal not required
   2. Provide photos of samples with digital submittal
   3. Insure one submittal for complete system
   4. Append the schedule to include…
   5. See Specification section for additional requirements

B. The Project Architect and City Project Manager will finalize review comments regarding the Submittal Schedule. Re-submittal of the submittal schedule may be required.

END OF SECTION

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SECTION 01 32 23
SURVEY AND LAYOUT DATA

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1.4. QUALITY ASSURANCE 1
1.5. SUBMITTALS 2
1.6. EXAMINATION 2
PART 2 – PRODUCTS – NOT USED 2
PART 3 - EXECUTION 2
3.1. PRE-CONSTRUCTION OWNER SUPPORT 2
3.2. UTILITY LOCATING 2
3.3. SURVEY CONTROL AND LAYOUT DATA 2
3.4. TOPOGRAPHIC SURVEYING 2
3.5. SITE SURVEY AS-BUILT 3

PART 1 – GENERAL

1.1. SUMMARY

A. The purpose of this specification is to set forth the minimal required guidelines to be followed by the General Contractor (GC) and the Land Surveyor (Surveyor) including but not limited to the following:
   1. Surveyor Professional Requirements
   2. Horizontal and Vertical Datum Control
   3. Local Control (if any)
   4. Electronic File and Data Requirements
   5. As-Built Documentation Requirements

B. When working on any City of Madison project, OSHA standards must be complied with. The Surveyor shall provide appropriate traffic control in accordance to the Manual on Uniform Traffic Control Devices (MUTCD).

C. The Surveyor shall be responsible for notifying Diggers Hotline in advance of beginning the field work for this contract.

1.2. RELATED SPECIFICATIONS

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 31 23 Project Management Web Site (PMWS)
C. Section 01 33 23 Submittals
D. Section 01 78 39 As-Built Drawings
E. Section 105.9, Survey Points and Instructions, of the City of Madison FACILITIES MANAGEMENT SPECIFICATIONS for Public Works

1.3. SURVEYOR QUALIFICATIONS

A. The General Contractors, Land Surveyor Sub-Contractor shall meet or exceed the following:
   1. The Principal Land Surveyor (PLS) shall be licensed to practice in the State of Wisconsin.
      a. The PLS's license shall be current at the beginning of the contract and the PLS shall maintain an active license throughout the execution of this contract.
   2. The PLS shall have a minimum of minimum of ten (10) years of field experience on similar projects of scope and size.
      a. Land Surveyors working under the direction of the PLS shall have a minimum of five (5) years of field experience on similar projects of scope and size.

B. The PLS shall be responsible for checking and verifying all work being performed under the PLS's direction during the execution of this contract. This shall include but not be limited to periodic field checks of equipment and survey data for accuracy and compliance with the contract documents.

1.4. QUALITY ASSURANCE

A. The PLS shall do all surveying in City of Madison Datum's as follows:
   1. All Horizontal Control shall be in the Dane County Coordinates (WISCRS), NAD 83(1997) datum, US Survey foot).

2. All Vertical Control shall be in NAVD88(1991).
3. Information on PLSS Section Corner Monuments and Tie Sheets can be found on the City Engineering Mapping website http://gis.cityofmadison.com/Madison_PLSS/PLSS_TieSheets.html.

1.5. SUBMITTALS

A. After initial project setup the PLS shall provide the following information as a Survey Data Submittal for review by the CPM/CCM, and Owner. See Specification 01 33 23 – Submittals for more information.
   1. Copy of the PLS (and any supporting staff) current State of Wisconsin registration certificate/licenses.
   2. Digital Survey Submittal shall be uploaded to the Project Management Web Site Submittal Survey shall be in Auto CAD format. Digital Submittal shall be of the project site setup showing all of the following:
      a. Key features not scheduled for demolition, including but not limited to building corners, roof overhangs, and door locations.
      b. Location of construction limits fencing.
      c. Locations of PLSS and/or project control points provided by the Owner.
      d. Locations of project based control points.
   3. Printed Survey Submittal shall be the same as item 1 above in PDF format. PDF file shall be formatted to print to scale on 24"x36" sheets as required to show all features with text neatly organized for each item identified. When multiple sheets are used a match line and sheet references shall be required.
   4. PDF file of the complete level/layer scheme. Scheme shall be in tabular form formatted to 8.5 by 11 paper and shall include all of the following:
      a. Level/layer designation (abbreviation).
      b. Level/layer designation (full title).
      c. Feature attribute characteristics (line weight, line style, font, etc.).
      d. Cell attribute information
      e. Samples of line styles and cells.

1.6. EXAMINATION

A. The PLS shall be responsible for verifying all site data including the owner provided local control points (see Section 3.1 below) prior to starting the Work.
B. Notify the Project Architect and CPM/CCM immediately if any discrepancies are discovered.

PART 2 – PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1. PRE-CONSTRUCTION OWNER SUPPORT

A. The CPM/CCM shall provide the GC/PLS with a digital CAD seed file on or before the Pre-construction meeting.
   1. Seed file shall be an Auto Cad seed file using the datum indicated above. Seed file shall be delivered as a Auto Cad format as requested by the PLS.
      a. Seed file shall be used as the PLS's initial base file for all future work on this contract.

3.2. UTILITY LOCATING

A. The GC and/or PLS shall be responsible for notifying Diggers Hotline for all utility locate requests.

3.3. SURVEY CONTROL AND LAYOUT DATA

A. The GC and PLS are responsible for all other survey control and layout data required to perform the work in this contract.

3.4. TOPOGRAPHIC SURVEYING

A. The Surveyor may perform the topographic survey with properly calibrated equipment as follows:
   1. Total station, achieving minimum accuracy for well-defined features of +/- 0.1 feet horizontal and +/-0.04 feet vertical at 95% confidence relative to control. "Well defined features" shall include but not be limited to property irons, pavements, trees, landscaping features, buildings, utility locations, and other permanent features.
   2. RTK GPS shall be permitted in large open areas, along tree lines, and in brushy areas.

3.5. SITE SURVEY AS-BUILT

A. See Specification 01 78 39 As-Built Drawings, Section 3.2 for more information on required record site information to be provided prior to contract closeout.

B. The GC shall be responsible for scheduling the PLS to capture locations and depths of all buried utilities prior to any contractor back filing trenches. The Owner may require missing information to be located and surveyed at the GC's expense.

END OF SECTION

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SECTION 01 32 26
CONSTRUCTION PROGRESS REPORTING

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1.2. RELATED SPECIFICATION SECTIONS 1
1.3. PERFORMANCE AND QUALITY ASSURANCE REQUIREMENTS 1
PART 2 – PRODUCTS - THIS SECTION NOT USED 1
PART 3 - EXECUTION 1
3.1. CONTRACTOR JOURNAL 1
3.2. CONSTRUCTION PROGRESS MEETINGS 2

PART 1 – GENERAL

1.1. SUMMARY

A. Daily records of project activities, resources used, weather conditions, and other information related to the ongoing progress of the project are extremely important at all levels of Construction Management.

B. Daily records provide the base for weekly progress reports and updating progress schedules.

1.2. RELATED SPECIFICATION SECTIONS

A. Section 01 31 19 Project Meetings

B. Section 01 31 23 Project Management Web Site

C. Section 01 32 23 Photographic Documentation

1.3. PERFORMANCE AND QUALITY ASSURANCE REQUIREMENTS

A. The General Contractor (GC) shall be responsible for all Construction Progress Reporting as outlined in this and other specifications as noted.

B. The GC shall maintain daily progress journals in a format of their choosing provided it is legible and contains the information as outlined in Section3.1 below.

C. The journal shall be located in the job trailer and shall be reviewable by the Project Architect or City Project Manager if so requested.

PART 2 – PRODUCTS - THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. CONTRACTOR JOURNAL

A. The GC shall maintain a journal of daily progress on which Work is performed by any employee or entity for which the GC is responsible. Such reports shall include all relevant data concerning the progress of Work activities the GC and Subcontractors are responsible for and the effect of that activity on the time of performance of the Contract.

1. Some projects may not require weekly journals be kept instead of daily journals. This is at the sole discretion of the City Project Manager. A daily journal will generally be required when the contract has a significant amount of site work. A weekly journal will generally be used when a contract is interior work only.

B. Journal entries shall be made in the Project Management Web Site. The form consists of the following areas:

1. Weather; include temperature, humidity, precipitation, wind and other related information such as significant storm events, times, and details.
2. Work completed by trade
3. Delays encountered
4. Deliveries received or delayed
5. Hot issues that need to be addressed
6. Safety issues
7. Photograph progress and upload to the Photo Library on the Project Management Web Site.
8. Other including inspections, testing, etc.
9. Space for attaching documents

C. Contractor Daily/Weekly Report Forms shall be completed and signed by the GC's Job Superintendent or other on-site representative authorized by the GC confirming each such report is current, accurate and complete.

D. If applicable the GC shall include schedules of quantities and costs, progress schedules, wage rates, reports, estimates, invoices, records and other data as requested by the CPM concerning Work performed or to be performed under this Contract if the CPM determines such information is needed to substantiate Change Order proposals, claims, or to resolve disputes.

3.2. CONSTRUCTION PROGRESS MEETINGS

A. The GC shall provide a verbal summary of the previous two (2) weeks progress reports at each bi-weekly construction progress meeting.

END OF SECTION

SECTION 01 32 33
PHOTOGRAPHIC DOCUMENTATION

PART 1 – GENERAL 1
1.1. SCOPE 1
1.2. RELATED SPECIFICATION SECTIONS 1
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PART 1 – GENERAL

1.1. SCOPE

A. The General Contractor (GC) shall be required to take weekly digital photographs of interior and exterior construction progress and upload the photos directly to the Project Management Web Site (PMWS).

B. The GC shall be required to provide digital time-lapse photo service of the project exterior -or interior when applicable- construction progress. Exterior or interior location determination to be confirmed with City Construction Manager.

1.2. RELATED SPECIFICATION SECTIONS

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 31 23 Project Management Web Site (PMWS)
C. Section 01 32 19 Submittals Schedule
D. Section 01 32 33 Submittals
E. Section 01 77 00 Closeout Procedures

1.3. SUBMITTALS

A. The GC shall provide general information on the type of camera being used for interior and exterior digital photographs.
   1. Information may be written on Contractor's transmittal sheet.
      a. Include camera name/type, aspect ratio setting, and average file size
      b. Provide sample project pictures as part of PDF submittal.

B. The GC shall provide sufficient information on the type of time lapse system being used that meets the requirements identified in section 2.2 below.

PART 2 – PRODUCTS

2.1. DIGITAL CAMERA

A. All digital photographs shall be taken with a good quality digital camera, cell phone, tablet, and other such digital device.

B. Digital photographs shall be formatted to achieve a good, clear, and detailed image where the final file size is between 600 KB and 3.0 MB (3000KB).

2.2. TIME LAPSE CONSTRUCTION CAMERA (TLCC)

A. The TLCC shall be a high quality weather proof camera owned and operated, or leased, by the GC for the duration of this contract with the following minimum capabilities:
   1. Pan-Tilt-Zoom (PTZ) capable.
   2. Wireless internet or built in cellular technology capable.
      a. The use of memory cards will not be permitted.
   3. Widescreen, high resolution (5-30 MP rating).
   4. Powered by 120V AC.
      a. The use of battery packs will not be permitted.
   5. Web/cloud hosted access to archived photos and video.
   6. Provides complete time lapse video capability.

7. 24/7 service and support for equipment, software, and hosting services.

B. Approved equipment/services include but are not limited to the following:
   1. OxBlue Corporation www.oxblue.com
   2. EarthCam www.earthcam.net
   3. TrueLook www.truelook.com
   4. Evercam www.evercam.com

PART 3 – EXECUTION

3.1. REQUIREMENTS FOR DIGITAL PHOTOGRAPHS

A. The GC shall take a minimum of two (2) exterior photographs each week. Exterior photographs will not be required on projects that do not include any exterior work.
   1. Exterior photos shall be taken from approximately the same location each week for the duration of the project.
   2. When applicable this requirement shall begin prior to commencing any site work.
   3. This requirement shall only be applicable when there is exterior work actively being conducted with the project. Periods of inactivity due to weather (winter conditions) do not require a photograph.
   4. This requirement shall end when the exterior work has been substantially completed.
   5. This requirement may be suspended due to weather conditions or substantial delays in exterior progress.

B. The GC shall take interior photographs each week that document interior construction progress.
   1. This requirement will begin when exterior wall framing begins.
      a. When an interior remodeling project includes demolition work interior photos shall be taken during the demolition process.
   2. Pictures do not need to be taken from the same location each week.
   3. This requirement shall end when the interior work has been substantially completed.

C. Digital photographs shall be properly zoomed in/out, and flash used as needed, to capture a level of detail required to properly show the progress being captured by the photograph.
   1. Blurry and dark pictures will not be accepted.

D. The camera default naming convention is acceptable. The GC does not need to rename or specifically identify pictures with a title.

E. All digital photographs shall be saved in a JPEG (.jpg) format and uploaded directly to the Project Management Web Site.

3.2. REQUIREMENTS FOR TIME LAPSE PHOTOGRAPHS

A. The GC shall be responsible for all of the following:
   1. Install an approved operation timelapse camera within 30 days after date fixed by Start Work Letter and/or Notice to Proceed
   2. Verify with the CPM/CCM a suitable place for mounting the camera and related equipment prior to installation.
   3. The complete installation, setup, maintenance, and removal of the camera and related equipment.
   4. The hosting and access of all photographs and videos taken by the camera during the project.
   5. Production of a final time lapse video (minimum of 3 minutes in length) of the project provided in a viewable format to the Owner on a thumb drive or CD.

B. Time lapse photos shall be taken from the same fixed position at approximately ten (10) minute intervals.
   1. Time lapse shall start before normal daily activities begin and end after normal daily activities have been completed.
      a. The GC shall adjust the camera time lapse schedule as needed to accommodate any periods of overtime or weekend work.
      b. Time lapse shall not be taken during major periods of no activity including night hours, holidays, weather related (winter) inactivity, etc.

C. All photos taken during the execution of this contract shall be accessible from a web-based service. Archived photos shall be organized by date and time so that they can be easily retrieved and viewed as needed.
   1. If necessary, the GC shall coordinate usernames and passwords for access to the photos. The City of Madison would prefer that the access be generic to accommodate a wide audience.

END OF SECTION

SECTION 01 33 23
SUBMITTALS

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3.3. PROJECT ARCHITECT'S REVIEW 3

PART 1 – GENERAL

1.1. SUMMARY

A. The General Contractor (GC) shall be responsible for providing submittals for review of all contractors and sub-contractors as designated in the construction documents. Submittals shall include but not be limited to all of the following:
   1. Equipment specified and pre-approved in the specification; to ensure quality, construction, and performance specifications have not changed since final design.
   2. Equipment specified by performance in the specification; to ensure that the intended quality, construction, and performance specified is met by the selected material or product.
   3. Shop, piece, erection, and other such drawings as indicated in the specifications to ensure all structural, dimensional, and assembly requirements are being met.
   4. Submittals indicating installation sequencing
   5. Submittals indicating control sequencing
   6. Contractor licensing, certification, and other such regulatory documentation when required by a specification.
   7. Other submittals as may be required by individual specifications.

B. The submittal process shall not be used to determine alternates to specified products or equipment. All considerations shall be reviewed during the bidding process and acceptable alternates shall be acknowledged by addendum prior to the closing of bidding. See bidding instructions for the information on submitting alternates for consideration.

D. In the event that a manufacturer has significantly changed a product (discontinued a model, changed dimension or performance data changed available colors, etc.) since bid opening the GC shall submit a Request for Information (RFI) to the Project Architect requesting other approved alternates prior to uploading a digital submittal.

E. Contractors and sub-contractors shall be responsible for knowing the submittal requirements of ALL sections within their scope of work under the contract. The Owner reserves the right to request documentation on any materials, equipment, or product being installed where a submittal is not on file. If the material, equipment, or product installed is determined not to meet the intent of the specification the contractor/sub-contractor shall be required to remove and replace the items involved. The GC shall be solely responsible for all costs associated with the removal and replacement.

F. Doors, Frames + Hardware Submittals - After submission of all door/frame/hardware submittals (and related low voltage door hardware submittals) Contractor will organize a meeting(s) with Owner, Architect, General Contractor, Electrician, Door/Frame/Hardware Supplier(s)/Installer(s), Low-Voltage Supplier/Installer, and others as applicable to comprehensively review and explain each door opening's submitted hardware package operation. Prior to this meeting the low voltage contractor shall have completed a review with the Madison Fire Department for all access control doors and be prepared to explain any conflicts or concerns with all parties. No procurement of door hardware (and related low voltage components) shall be procured until this meeting is completed; and until related submittals are returned to by the Owner/Architect team.

1.2. RELATED REFERENCES

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 31 23 Project Management Web Site (PMWS)
C. Section 01 32 19 Submittals Schedule
D. Section 01 32 26 Construction Progress Reporting
E. Section 01 91 00 Commissioning

F. All Technical Specifications, contract documents, construction drawings, and any published addendums during the bidding process.
G. All contract documents generated during the execution of the contract including but not limited to Requests for Information (RFI) and Construction Bulletins (CB).

1.3. SUBMITTAL REQUIREMENTS

A. A completed submittal shall meet the following requirements:
   1. Digital submittal shall be original PDF of manufacturer's data sheets or high quality color scan of the same.
      a. Submittals shall not include sales fliers or other similar documents that typically do not provide complete manufacturers data.
   2. Documents within the PDF submittal shall be printable to a sized sheet no less than 8-1/2 by 11 inches and no larger than 24 by 36 inches.
   3. At the beginning of each submittal the contractor shall identify the plan reference (WC-1, EF-3, etc.) in RED block letters that the submittal is for.
   4. Where multiple model numbers appear in a table the contractor shall identify the specific model being submitted by using a RED square, box, or other designation to distinguish the correct model from others on the page.
B. A complete submittal will include all information associated with the product or equipment as presented in plans, equipment tables, and specifications. Information shall include but not be limited to the following:
   1. Dimensional data
   2. Performance data
   3. Resource requirements, power, water, waste, etc.
   4. Clearance and maintenance requirements
   5. Finish information, colors, textures, etc.
   6. Warranty information
C. Where a submittal includes material samples (carpet, tile, paint draw downs, etc.) the contractor shall do the following:
   1. The Contractor shall submit the sample(s) as indicated in the specification.
   2. The Contractor shall include a quality photograph(s) of the product with the digital submittal. Photographs shall meet the following requirements:
      a. Formatted to be between 500Kb and 1.0 Mb in file size
      b. Have no glare or flash reflection on the sample
      c. Sample fills the frame of the photo and shows detail as needed. Include multiple photos from other angles as needed.
      d. Scanned copies of products or photos are not acceptable.
D. Uploaded submittals should be relative and related to a specific written specification.
   1. Do not upload submittals under a broad category or division (I.E. HVAC 23 00 00). Always upload by the specific specification that identifies a required product or performance to be met.
   2. Group related items together if the specification is written that way. (I.E. all of the plumbing fixtures and trim relative to one specific specification should be submitted together).
   3. Submittals shall be grouped and adhere to the divisions in the submittal schedule. Submittals that do not conform to the submittal schedule and/or specification divisions will be rejected for re-submittal.

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. GENERAL CONTRACTOR'S PROCEDURES

A. All required submittals will be uploaded to the Project Management Web Site (PMWS) by the GC.
   1. Fill in required information on the form that will be used for routing the review and comments.
   2. Attach all documentation as described in Section 1.3 above.
      a. Submit samples under separate cover to the Project Architect when necessary.
B. Uploading the submittal indicates that the GC has reviewed and approved the submittal against the contract document requirements.
C. The GC shall discuss submittal status at all progress meetings and shall monitor submittal review/approval/re-submittal so as to not incur delays in the project schedule.
D. A completed upload of the submittal to the PMWS initiates the review process workflow.

E. The GC and sub-contractors shall provide re-submittals as required.

3.2. SUBMITTAL REVIEW

A. Upon completion of the submittal upload by the GC the PMWS automatically notifies the appropriate Architect/Engineer and Owner Representative, including CxA, by Division/Specification number that there is a submittal for review.

B. The submittal shall be reviewed internally by the required Architect/Engineer and Owner Representative and CxA in a timely fashion and provide commentary on missing items, incorrect information, or incomplete shop drawings, etc as needed.

C. When the internal review is completed the PMWS will notify the Project Architect the submittal is ready for final review.

3.3. PROJECT ARCHITECT'S REVIEW

A. Upon completion of the internal review the Project Architect shall review all internal review comments, confer with the CPM and CxA as needed and determine the appropriate disposition status for the submittal (approved or resubmit).

B. The Project Architect shall summarize final internal review comments onto the submittal cover sheet, provide a final disposition of the submittal and update the review status of the submittal to "Complete…" (with or w/o comments) or "Rejected".

C. A completed Final Review status will be completed by the City Project or City Construction Manager and initiates the PMWS to notify the GC and appropriate sub-contractor(s) that the review of the submittal has been completed.

END OF SECTION

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SECTION 01 43 39
MOCKUPS

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PART 1 – GENERAL

1.1. SUMMARY

A. Definition
   1. Mockups are field samples constructed, applied, or assembled at the project site for review by the Owner, Owners Representative, Architect and Consultants.
   2. Mockups are three dimensional, true scale models that illustrate materials and methods, equipment, workmanship, or location; based on plans, details, and assemblies.

B. Approved mockups establish the standard of quality by which the final work will be judged.

C. Approved mockups shall be properly documented and entered Into the Submittal Library on the Project Management Web Site like any other required submittal. See section 3.4 below for more information.

1.2. RELATED SPECIFICATIONS

A.	Section 01 26 13	Request for Information (RFI)
B.	Section 01 26 46	Change Bulletin (CB)
C.	Section 01 26 63	Change Order (CO)
D.	Section 01 31 19	Project Meetings
E.	Section 01 32 16	Construction Progress Schedules
F.	Section 01 33 23	Submittals
G.	Section 01 45 00	Quality Control

1.3. RELATED DOCUMENTS

A. The following documents shall be used for preparing mockups.
   1. All plans, specifications, and details including those derived as revisions (RFI, CB, CO).
   2. Construction Progress Schedules. Mockups shall be done and completed in a timely fashion for review and approval so as to not impact the Contractors project schedule.
   3. Any Manufacturers installation/assembly instructions.

1.4. PERFORMANCE REQUIREMENTS

A. All Contractors shall be responsible for providing and constructing mockups as specified in their Division of Work in the plans and specifications.

B. Materials to be used shall be as specified in the construction documents, full sized and properly assembled.

C. Completed mockups shall be of sufficient size to provide visible detail of all components as needed for the sample.

1.5. QUALITY ASSURANCE

A. The General Contractor (GC) shall be responsible for coordinating all of the following as needed:
   1. Designating the location for the mockup construction
   2. Coordinating the work of all contractors and materials required to complete the mockup
   3. Ensuring that the mockup meets the intent of the construction documents before scheduling the mockup review meeting.

PART 2 - PRODUCTS

2.1. MATERIALS

A. The materials used in mockups shall be only those materials indicated in the plans, specifications, and favorably reviewed submittals.

B. Mockups shall be made of full scale materials as delivered to the project site.

C. All materials associated with a particular detail, construction method, manufacturer's installation instructions shall be properly represented and visible in the mockup. This includes but is not limited to finished mortar joints, sealants, backer rods, tie bars, rebar, etc.

PART 3 - EXECUTION

3.1. REVIEW THE PLANS AND SPECIFICATIONS

A. The GC shall review the plans and specifications with all required contractors prior to constructing the mockup.

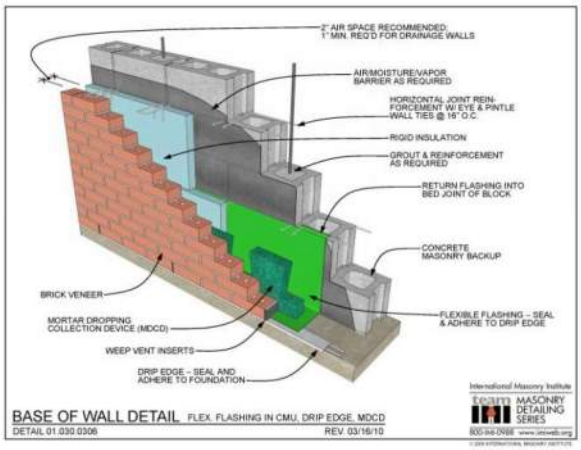
1. Mockups that will be built and remain in place, if favorably reviewed, will be installed in an area easily accessible for review.
2. Mockups that will not be built in place or will not remain will be constructed in a space on the project site protected from weather, construction traffic, and other such disturbances until such time as the associated work has been completed.
3. Insure all products being represented in the mockup meet the plans, specifications, and any published changes.

3.2. MOCKUP CONSTRUCTION

A. Mockups shall be of sufficient size to show various material adjacencies, connectivity, patterns, and other such related features.

B. Mockups shall be constructed in a layered fashion so that all products being used can be seen and evaluated.

C. The construction detail below is an example of a properly layered mockup.



D. REQUIRED MOCK UPS INCLUDE:

WALL AT METAL PANEL
WALL AT MASONRY

3.3. MOCKUP REVIEW

A. The General Contractor and all associated Sub-contractors (Contracting Team) shall meet with the Owner, Owners Representative, Architect and Consultants (Design Team) as necessary to review the mock-up. Contractors shall be prepared to answer questions on materials and methods as necessary.

B. The Contracting and Design Teams shall review the mockup in detail for materials, methods, and workmanship with respect to the intent of the contract documents. Improvements or adjustments shall be discussed as needed.

C. If the mockup is incomplete or does not show sufficient detail of products and workmanship the General Contractor shall resubmit a new mockup.

D. Re-submittal of mockups to meet the intent of the contract documents shall be the responsibility of the General Contractor. No Change Orders will be processed for additional time or materials associated with re-submitting a mockup for approval.
   1. In the event that a submitted mockup meets the criteria of the contract documents but does not meet the expectations of the design team and alternative methods or materials are discussed the following procedure shall be used:
      a. Project Architect shall publish a Construction Bulletin (CB) to detail the required/recommended changes.
      b. The GC shall prepare and submit a new mockup.

3.4. FINAL SUBMITTAL

A. The field approved mockup shall be submitted by the General Contractor as any other submittal for project documentation purposes. The mockup submittal shall consist of the following:
   1. Digitally photograph the field approved mockup. Take as many detailed photos as necessary to capture the complexity of the mockup.
   2. Provide a written summary of the approved mockup. Include all recommended adjustments, level of expected workmanship, and other such detail as discussed during the mockup review.
   3. Submit the mockup to the Project Management Web Site. See Specification 01 33 23 Submittals for additional information.

END OF SECTION

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SECTION 01 43 50
AIR BARRIER SYSTEMS

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3.1. FIELD QUALITY CONTROL 3
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PART 1 – HEADING 1

1.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, Division 07 Specification Sections, apply to this Section.

1.2. SUMMARY

A. Contractor will engage a qualified consultant(s) to perform tests and inspections prior to the installation of air barrier components.

B. This section includes administrative and procedural requirements for accomplishing an airtight building enclosure that controls infiltration or exfiltration of air.

C. Related Sections:

1. Section 07 25 00: Weather Barriers.
2. Requirements of this section relate to the coordination between subcontractors required to provide an airtight building enclosure, customized fabrication and installation procedures, not production of standard products.

1.3. DEFINITIONS

A. Air Barrier System: The airtight components of the building enclosure and the joints, junctures and transitions between materials, products, and assemblies forming the air-tightness of the building enclosure.

B. Services: Include coordination between the trades, the proper scheduling and sequencing of the work, pre-construction meetings, inspections, tests, and related actions, including reports performed by Contractor, by independent agencies, and by governing authorities. They do not include contract enforcement activities performed by Architect.

1.4. PERFORMANCE REQUIREMENTS

A. General Performance: The Contractor shall ensure that the intent of constructing the building enclosure with a continuous air barrier system to control air leakage into, or out of the conditioned space is achieved. The air barrier system shall have the following characteristics:

1. It shall be continuous, with all joints sealed.
2. It shall be structurally supported to withstand positive and negative air pressures applied to the building enclosure.
3. Continuity of the air barrier materials and products with joints to provide complete assemblies.
4. Continuity of all the enclosure assemblies with joints and transition materials to provide a whole building air barrier system.

B. Connection shall be made between:

1. Foundation and walls.
2. Walls and windows or doors.
3. Different wall systems.
4. Wall and roof.
5. Wall and roof over unconditioned space.
6. Walls, floor and roof across construction, control and expansion joints.

7. Walls, floors and roof to utility, pipe and duct penetrations.

C. Air Barrier Penetrations: All penetrations of the air barrier and paths of air infiltration / exfiltration shall be made air-tight.

D. Compliance Requirements:

1. Assemblies: an air permeance not to exceed 0.03 cfm/ft2p under a pressure differential of 0.3 in. water (1.57psf) (0.15 L/s.m2 @ 75 Pa) when tested in accordance with ASTM E 1677.
2. Materials: Materials used for the air barrier system in the opaque envelope shall have an air permeance not to exceed 0.004 cfm/ft2 under a pressure differential of 0.3 in. water (1.57psf) (0.02 L/s.m2 @ 75 Pa) when tested in accordance with ASTM E 2178. Or,
3. Entire Building: The air leakage of the entire building shall not exceed 0.15 cfm/sf under a pressure differential of 0.3 in. water (1.57psf) (0.75 L/s.m2 @ 75 Pa) when tested according to ASTM E 779.

1.5. SUBMITTALS

A. Field quality-control reports.

B. Testing agency shall submit a certified written report, in duplicate, of each inspection, test, or similar service to the Architect. If the Contractor is responsible for the service, submit a certified written report, in duplicate, of each inspection, test, or similar service through the Contractor.

1. Submit additional copies of each written report directly to the governing authority, when the authority so directs.

C. Report Data: Written reports of each inspection, test, or similar service include, but are not limited to, the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making the inspection or test.
6. Designation of the Work and test method.
7. Identification of product and Specification Section.
8. Complete inspection or test data.
9. Test results and an interpretation of test results.
10. Ambient conditions at the time of sample taking and testing.
11. Comments or professional opinion on whether inspected or tested Work complies with Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting.

1.6. QUALITY ASSURANCE

A. General Performance: The Contractor shall ensure that the intent of constructing the building enclosure with a continuous air barrier system to control air leakage into, or out of the conditioned space is achieved. The air barrier system shall have the following characteristics:

B. Inspection and testing services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with Contract Document requirements.

1. Qualifications for Air Barrier Testing and Inspection Agencies: Engage Air Barrier inspection and testing service agencies, including independent testing laboratories, that are prequalified and that specialize in the types of air barrier system inspections and tests to be performed.

C. Specific quality-control requirements for individual construction activities are specified in the sections of the specifications. Requirements in those sections may also cover production of standard products. It is the Contractor’s responsibility to ensure that each subcontractor is adequately and satisfactorily performing the quality assurance documentation, tests and procedures required by each section.

D Specified inspections, tests, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with Contract Document requirements.

1.7. PROJECT CONDITIONS

A. Contractor Responsibilities: Unless otherwise indicated as the responsibility of another identified entity, Contractor shall provide coordination of the trades, and the sequence of construction to ensure continuity of the air barrier system joints, junctures and transitions between materials and assemblies of materials and products, from substructure to walls to roof. Provide quality assurance procedures, testing and verification as specified herein. Facilitate inspections, tests, and other quality-control services specified elsewhere in the Contract

Documents and required by authorities having jurisdiction or by the Owner. Costs for these services are included in the Contract Sum.

B. Organize preconstruction meetings between the trades involved in the whole building's air barrier system to discuss where each trade begins and ends and the responsibility and sequence of installation of all the air-tight joints, junctures, and transitions between materials, products and assemblies of products specified in the different sections, to be installed by the different trades.

C. Build a mock-up before proceeding with the work, satisfactory to the Architect, of each airtight joint type, juncture, and transition between products, materials and assemblies.

D. Associated Services: Cooperate with agencies performing required inspections, tests, and similar services, and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required include, but are not limited to, the following:
   1. Provide access to the Work.
   2. Furnish incidental labor and facilities necessary to facilitate inspections and tests.
   3. Take adequate quantities of representative samples of materials that require testing or assist the agency in taking samples.
   4. Deliver samples to testing laboratories.
   5. Provide security and protection of samples and test equipment at the Project Site.

E. Duties of the Testing and Inspection Agency: The independent agency engaged to perform inspections, sampling, and testing of air barrier materials, components and assemblies specified in individual Sections shall cooperate with the Architect and the Contractor in performance of the agency's duties. The testing agency shall provide qualified personnel to perform required inspections and tests.
   1. The agency shall notify the Architect and the Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   2. The agency is not authorized to release, revoke, alter, or enlarge requirements of the Contract Documents or approve or accept any portion of the Work.
   3. The agency shall not perform any duties of the Contractor.

F. Coordination: Coordinate the sequence of activities to accommodate required services with a minimum of delay. Coordinate activities to avoid the necessity of removing and replacing construction to accommodate inspections and tests.
   1. The Contractor is responsible for scheduling times for inspections, tests, taking samples, and similar activities.

PART 2 – PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1. FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
   1. Qualitative Testing and Inspection:
      a. Daily reports of observations, with copies to the Owner, Contractor and Architect.
      b. Continuity of the air barrier system throughout the building enclosure with no gaps, holes.
      c. Structural support of the air barrier system to withstand design air pressures.
      d. Masonry and concrete surfaces are smooth, clean and free of cavities, protrusions and mortar droppings, with mortar joints struck flush, or as required by the manufacturer of the air barrier material.
      e. Site conditions for application temperature and dryness of substrates.
      f. Maximum length of exposure time of materials to ultra-violet deterioration.
      g. Surfaces are properly primed.
      h. Laps in material are 2" minimum, shingled in the correct direction (or mastic applied on exposed edges), with no fishmouths.
      i. Mastic applied on cut edges.
      j. Roller has been used to enhance adhesion.
      k. Measure application thickness of liquid-applied materials to manufacturer's specifications for the specific substrate.
      l. Materials used for compatibility.
      m. Transitions at changes in direction, and structural support at gaps.

n. Connections between assemblies (membrane and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.
o. All penetrations sealed.

2. ASTM E 1186/98 “Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Retarder Systems.”
   a. Infrared scanning with pressurization/depressurization.
   b. Smoke pencil with pressurization/depressurization.
   c. Pressurization/depressurization with use of anemometer.
   d. Generated sound with sound detection.
   e. Tracer gas measurement of decay rate.
   f. Chamber pressurization/depressurization in conjunction with smoke tracers.
   g. Chamber depressurization using detection liquids.

3. Quantitative Tests: Provide written test reports of all tests performed, with copies to the Owner, Contractor and Architect.
   a. Material compliance for maximum air permeance, ASTM E 2178.
   b. ASTM E 283, Determining rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen.
   c. Assemblies, ASTM E 1677, test pressure and allowable air leakage rate to be determined by design professional for interior design conditions and location of project.
   d. CAN/CGSB 1986 Standard 149.10, Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method.
   e. CAN/CGSB 1996 Standard 149.15 Determination of the Overall Envelope Airtightness of Office Buildings by the Fan Depressurization Method Using the Building’s Air Handling System.
   f. Canadian National Master Specification Sections 07272 Air Barrier Systems for Exterior Walls of Low-Rise Buildings.
   g. Canadian National Master Specification 07272.1 : Durability Assessment of Bead-Applied Urethane-Based Sealant Foam for Air Barriers.
   h. Whole building, floors, or suites, ASTM E779, Determining Airtightness of Buildings Air Leakage Rate by Single Zone Air Pressurization.
   i. Windows and connections to adjacent opaque assemblies, ASTM E783.
   j. Tracer gas testing, ASTM E741.
   k. Pressure test, ASTM E330.
   l. Bond to substrate, ASTM D4541-95.
   m. Minimum dry or wet film thickness for liquid-applied materials are per the manufacturer’s requirements.

3.2. REPAIR AND PROTECTION

A. Upon completion of inspection, testing, sample taking and similar services, repair damaged construction and restore substrates and finishes. Comply with Contract Document requirements for Division 1 Section "Cutting and Patching."
B. Protect construction exposed by or for quality-control service activities, and protect repaired construction.
C. Repair and protection is Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing, or similar services.

END OF SECTION

SECTION 01 45 16
FIELD QUALITY CONTROL PROCEDURES

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PART 1 – GENERAL

1.1. SUMMARY

A. The City of Madison has developed a multi-faceted Quality Management Program that begins with contract signing and runs through contract closeout to ensure the best quality materials, workmanship, and product are delivered for the contracted Work.
   1. The Project Management Web Site is a Construction Management tool that provides contractors and staff a single on-line location for the daily operations and progression of the Work.
   2. The Quality Management Observation (QMO) is an ongoing observation of the construction process as it progresses. The City of Madison does not use a “Punch List” or “Corrections List” as it is typically known throughout the construction industry. The QMO process acts as an “in progress punch list”.
      a. By using the QMO process the City of Madison’s goal is to have a zero item punch list prior to the 90% progress payment and owner occupancy.

B. All contractors shall be required to review the specifications identified in Section 1.2 below, and other related specifications identified therein to become familiar with the terminology and expectations of this City of Madison Public Works contract.

C. It is the intent of this specification to outline the requirements, expectations, and responsibilities of the General Contractor (GC), Project Architect, and other representatives of the Owner for items of Quality Assurance and Quality Control.
   1. This specification is not intended to conflict with Specification 01 40 00 Quality Requirements or other specifications requiring testing and inspecting services.
   2. This specification does not relieve the GC from any requirements associated with regulatory inspections performed by the City of Madison Building Inspection Unit, or inspectors from other agencies as required by code.
   3. Any testing performed by an Owner’s Representative does not relieve the GC from performing any testing that may required by the construction documents.

1.2. RELATED SPECIFICATION SECTIONS

A. Section 01 26 13 Request for Information (RFI)
B. Section 01 29 76 Progress Payment Procedures
C. Section 01 31 13 Project Coordination
D. Section 01 31 23 Project Management Web Site (PMWS)
E. Section 01 40 00 Quality Requirements
F. Section 01 77 00 Closeout Procedures
G. Section 01 78 13 Completion and Correction List
H. Section 01 91 00 Commissioning

1.3. PERFORMANCE REQUIREMENTS

A. All contractors shall be responsible for a proper quality assurance/quality control (QA/QC) program throughout the execution of the Work defined within the construction documents, including all recognized construction industry standards and all applicable regulatory codes.

B. The GC shall be responsible for all of the following:
   1. Monitor the quality of all workmanship, supplies, materials, and products being installed by all contractors and installers to ensure they meet or exceed the minimum requirements set forth by the construction documents.
   2. Submit a Request for Information (RFI) whenever manufacturers' instructions or referenced standards conflict with the construction documents before proceeding with the Work.
   3. Ensure that Work requiring special certifications or licensing is being performed by is being performed and supervised by personnel that meet the appropriate requirements.
      a. Ensure that all certificates and licenses are current throughout the execution of the project.

C. The CoM and its representatives shall perform quality assurance and quality control activities throughout the execution of this project. This in no way relieves the GC of maintaining an acceptable QA/QC program. =

1.4. QUALITY ASSURANCE

A. The GC shall be responsible for the following:
   1. All materials, equipment, and products shall be new, clean, undamaged, and meet the performance specifications defined within the construction documents including favorably reviewed submittals.
      a. Any material, equipment, or product that does not meet the requirements of the construction documents shall be removed and replaced, including any adjacent and related work, at the GCs expense.
   2. All Work shall be performed by persons properly trained and/or qualified to produce workmanship of the quality specified in the construction documents.
   3. Providing access to updated as-builts, addenda, submittals, bulletins and other related construction documents at the project site.

B. The CoM and its representatives may be responsible for any of the following:
   1. Attend pre-installation meetings
   2. Attend construction progress meetings
   3. Review all submittals
   4. Conduct field visits for QA/QC purposes, provide feedback to the GC and sub-contractors using Quality Management Observation (QMO) reports.
   5. Review delivered equipment
   6. Witness equipment installations, startups, testing as specified in other specifications

1.5. QUALITY MANAGEMENT OBSERVATION REPORT

A. The Quality Management Observation report or QMO is used as a QA/QC tool by those entities responsible for QA/QC activities, including but not limited to, the GC, CoM, Project Architect /Project Engineer(A/E PROJ MGR), CX agent, etc.

B. QMOs are designed to be an early observation of non-conforming construction work before it becomes buried by follow on work. As such it is most often used as an "in progress punch list".

C. QMO forms are part of the Quality Control Library on the Project Management Web Site.

PART 2 – PRODUCTS - THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. QUALITY MANAGEMENT RESPONSIBILITIES

A. While making routine progress visits to the construction project the GC, CPM, CxA and A/E PROJ MGR, and applicable others shall observe the details of the construction and installations to ensure that the intent of the construction documents is being followed.

B. If during the progress visit there is a determination of contract non-conformance a QMO report shall be initiated to begin the documentation process.
   1. The GC field superintendent shall be informed immediately of any issue that may cause harm, damage to finished work, or be buried prior to properly filing a QMO report.

C. The following information when filing a QMO report:
   1. Open a QMO report in the Project Management Web Site
   2. Enter the date and time of the field visit
   3. Provide references to construction documents if any (examples; specification, drawing page, details, approved submittals, RFI, CB, etc)
   4. Provide a short title for the observation being made

5. Provide a detailed description of the observation being made
6. Select all categories (Sitework, Structure, Enclosure, Interior, etc) from the given list that may apply to the observation being reported.
    a. For each category selected additional boxes shall open with contractor names associated with each category.
7. Select all contractors from the lists provided that may need to be aware of the observation.
8. Provide any attachments that may help provide reference to the observation.

D. The software for the Project Management Website will email notifications that a QMO report has been initiated.

3.2. RESPONDING TO A QMO

A. The GC shall be responsible for determining the course of action required to remedy the non-conforming issue and shall coordinate and direct the contractor(s) responsible for any work related to the observation.

B. All contractors assigned to remedy the observation by the GC shall provide follow-up responses
1. Open the QMO report in the Project Management Web Site.
2. Enter a description of your follow-up response in the box provided.
3. Add attachments (pictures) if needed to show the work has been completed.

3.3. GENERAL CONTRACTORS FOLLOW-UP

A. The GC shall inspect the work to ensure that all assigned contractors have remedied the observation to the intent of the construction documents.

B. The GC shall respond with any additional comments in their response box.

3.4. QMO CLOSEOUT PROCEDURE

A. The person who initiated the QMO shall review the remedied work and if properly corrected shall close and date the QMO form.
1. In the event there are still issues the Quality Manager can add additional comments in the response area, and re-issue the QMO for additional review as needed.

B. Once the person who initiated the QMO has closed the item the CPM shall review and verify with the A/E PROJ MGR that the Observation has been properly remedied and provide final closure on the QMO.

3.5. CONSTRUCTION CLOSEOUT

A. The GC shall note that successful close out QMOs are required for construction closeout as follows:
1. Certain progress payments as identified in Specification 01 29 76 are contingent QMO reports being properly closed out.
2. Specification 01 77 00 defines all construction closeout requirements.

END OF SECTION

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SECTION 01 45 29
TESTING LABORATORY SERVICES

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PART 1 – GENERAL

1.1. REQUIREMENTS INCLUDED

A. The Contractor shall employ and pay for the services of an independent testing laboratory to perform specified services and testing.

B. Testing Laboratory inspection, sampling and testing is required for:

1. Section 03 30 00: Cast-In-Place Concrete
2. Section 05 12 00: Structural Steel Framing
3. Section 05 40 00: Cold-Formed Steel Framing
4. Section 31 20 00: Earthwork

1.2. RELATED REQUIREMENTS

A. Conditions of the Contract: Inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities.

B. Related Requirements Specified in Other Sections:

1. Division 22 and 23: Testing of Mechanical Systems
2. Division 26: Testing of Electrical Systems

1.3. QUALIFICATION OF LABORATORY

A. Meet "Recommended Requirements of Independent Laboratory Qualification" published by American Council of Independent Laboratories.

B. Meet basic requirements of ASTM E 329, "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction."

C. Authorized to operate in State in which the Project is located.

1.4. LABORATORY DUTIES

A. Cooperate with Owner, A/E and Contractor; provide qualified personnel after due notice.

B. Perform specified inspections, sampling and testing of materials and methods of construction:

1. Comply with specified standards.
2. Ascertain compliance of materials with requirements of Contract Documents.

C. Promptly notify the Owner, A/E and Contractor of observed irregularities or deficiencies of work or products.

D. Promptly submit written report of each test and inspection; one copy each to A/E, Consulting Engineer, Owner and Contractor. Each report shall include:

1. Date issued.
2. Project Title and number.
3. Testing laboratory name, address and telephone number.
4. Name and signature of laboratory inspector.
5. Date and time of sampling or inspection.
6. Record of temperature and weather conditions.
7. Date of test.
8. Identification of product and specification section.
9. Location of sample or test in the Project.
10. Type of inspection or test.
11. Results of tests and compliance with Contract Documents.

12. Interpretation of test results, when requested by A/E or the Contractor.

E. Perform additional tests as required by Owner, A/E or the Contractor.

1.5. LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory is not authorized to:
1. Release, revoke, alter, or enlarge on requirements of Contract Documents.
2. Approve or accept any portions of the Work other than those portions of the Work scheduled for testing.
3. Perform any duties of the Contractor.

1.6. CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel, provide access to Work and to manufacturer's operations.

B. Secure and deliver to the laboratory, adequate quantities of representative samples of materials proposed to be used and which require testing. Submit concrete mix designs to A/E for approval prior to pouring concrete.

C. Provide to the laboratory the preliminary design mix proposed to be used for concrete, and other material mixes that require control by the testing laboratory.

D. Furnish copies of Product test reports as required.

E. Furnish incidental labor and facilities:
1. To provide access to Work to be tested.
2. To obtain and handle samples at the Project site or at the source of the product to be tested.
3. To facilitate inspections and tests.
4. For storage and curing of test samples.

F. Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.

G. Make arrangements with laboratory and pay for additional samples and tests required for Contractor's convenience.

H. Employ and pay for the services of a separate, equally qualified independent testing laboratory to perform additional inspections, sampling and testing required when initial tests indicate work does not comply with Contract Documents.

I. Temporarily halt the progress of the Work when tested materials do not comply with Contract Documents and promptly notify the Owner or their designated representative and A/E.

J. Remove and replace at no cost to the Owner, all defective materials discovered upon testing not to comply with Contract Documents, including cost for retesting and re-inspecting replaced Work that failed to comply with the Contract Documents.

1.7. SPECIFIC TEST, INSPECTIONS, AND METHODS REQUIRED

A. **Section 03 30 00: Cast-In-Place Concrete**
1. Secure sample of aggregates Contractor proposes to use and test for compliance with Specifications.
2. Certify compliance with Specifications of cement proposed for use by the Contractor.
3. Review and approve the Contractor's proposed concrete mix proportions for the required concrete strengths using materials Contractor proposed to use on the project. Incorporate specified admixtures and not less than amounts of cement specified.
4. Perform appropriate laboratory tests, including compression tests of cylinders and slump test to substantiate mix designs.
5. Inspect and test materials during concrete work to substantiate compliance with Specifications and mix requirements.
a. Testing:
i. Sample and test concrete in accordance with ASTM C 31, ASTM C 143, ASTM C 172, and ASTM C 231.
ii. Perform slump tests in accord with ASTM C 143 from same concrete batch used for test cylinders and record results and comments on compression test reports.
iii. Perform compression tests in accordance with ASTM C39.
iv. When air-entrained concrete is used, a minimum of one (1) air content test shall be performed in accordance with ASTM C 231 for each set of test cylinders taken.
v. Identify all test cylinders with symbols to indicate location on the job where concrete test was made. Record on project record drawings.
vi. Strength tests shall be made for: each day's pour; each class of concrete; each change of supplies or sources; and for each 100 cubic yards of concrete or fraction thereof.

vii. One slump test shall be made for each set of test cylinders taken following the procedure in ASTM C 143.

b. Test Cylinders for all Concrete

i. Each test shall consist of a minimum of four cylinders.

ii. Make test cylinders in conformity with ASTM C 31.

iii. After 24 hours three cylinders to be carefully transported to the testing laboratory for moisture curing and one cylinder to be field cured.

iv. One field cured cylinder to be tested at 7 days and two laboratory cured cylinders to be tested at 28 days. Reserve one cylinder for further testing.

v. The average of all strength tests representing each class of concrete, as well as the average of any three consecutive strength tests for each class of concrete, shall be equal to or greater than the specified strength.

vi. If the A/E has reason to believe that cylinder strength tests are not representative of the strength of concrete in place, A/E shall require drilled cores to be cut and tested at the Contractor's expense. Coring and testing shall be in accordance with ASTM C 42 Standard Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

B. **Section 05 12 00: Structural Steel Framing**

1. Welding:

a. Provide inspection of shop and field welding in accordance with Section 6 of AWS D1.1.

b. Visually inspect all welds, perform appropriate non-destructive tests on apparent defective welds. Verify conformance with Specifications.

c. Non-destructive testing shall be performed on 20 percent of the total length of all full penetration welds. If a sufficient number of welds are deficient, additional testing may be performed at the discretion of the testing lab, at no cost to Owner.

2. Bolting:

a. Visually inspect all connections for proper number, size and type of bolt.

b. Review all bolted connections for compliance with "snug tight" requirements of AISC.

c. No Slip-critical (SC) connections/bolts are required for this project.

d. Shear Connectors, Headed/Deformed Bar Concrete Anchors:

i. Verify pre-production test records for installation of shear connectors, concrete anchors and threaded studs.

ii. Shear connectors shall be struck with a hammer. Those not producing a "clean" pinging sound indicative of a fully attached shear connector shall be bent 15 degrees off vertical towards the nearest support by striking with a hammer. If shear connector does not become loose and weld is not broken, it shall be considered acceptable, and shall be left in the bent position. Replace failing shear connectors and test as before.

iii. A visual inspection shall be made of shear connectors and headed/deformed bar concrete anchors after installation. If visual inspection reveals that a sound weld and a 360 degree flash has not been obtained, the connector/anchor shall also be tested by bending a minimum of 15 degrees off vertical opposite to the missing weld/flash, irrespective of the results of the "ping" test required for shear connectors. If the connector/anchor does not become loose it shall be considered acceptable and shall be left in this position. Replace failing connector/anchors and inspect as before.

C. **Section 05 40 00: Cold Formed Steel Framing**

1. As directed by A/E, Contractor's testing agency may inspect the maintenance of a quality control program including spot checking weldments and welding procedures in accordance with AWS standards.

D. **Section 31 20 00: Soil Compaction Control and Trenching and Backfilling**

1. Soils Engineer to be onsite during excavation operation.

2. Visually inspect, test, and certify that exposed undisturbed underlying soil is suitable for required footing bearing capacity and placement of fills.

3. Maximum and minimum density of fill soil for compaction percentage of relative density and moisture density shall be determined in accordance with ASTM Designation D 1557. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.

4. Number of tests as follows:

a. Subgrade, Undisturbed and Demolition Surfaces: Visual inspection and probe; test if required.

b. Interior Fills: One test per 2,500 sq. ft for each two foot or less lift.

c. Exterior Fills: One test per 2,500 sq. ft for each two foot or less lift.

d. Utility Trenches: One test per 50 lineal feet for each two foot or less lift.

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 – EXECUTION – THIS SECTION NOT USED

END OF SECTION

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

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PART 1 – GENERAL

1.1. SUMMARY

A. This Section includes general procedural requirements for temporary facilities and controls including, but not limited to the following:
   1. Temporary Utilities
   2. Telecommunications Services
   3. Temporary Sanitary Facilities
   4. Barriers
   5. Fencing
   6. Exterior Enclosures
   7. Security
   8. Vehicular Access and Parking
   6. Waste Removal
   7. Project Identification
   8. Field Offices

1.2. RELATED SPECIFICATION SECTIONS

A. Section 01 31 19 Progress Meetings
B. Section 01 31 23 Project Management Web Site
C. Section 01 74 19 Construction Waste Management and Disposal

1.3. QUALITY ASSURANCE

A. Regulations: Comply with industry standards and applicable laws and regulations if authorities having jurisdiction, including but not limited to:
   1. Building Code requirements
   2. Health and safety regulations
   3. Utility company regulations
   4. Police, Fire Department and Rescue Squad rules
   5. Environmental protection regulations
   6. Joint Commission - Hospital Accreditation Standards

B. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library "Temporary Electrical Facilities".
C. Electrical Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70 "National Electric Code".

1.4. TEMPORARY UTILITIES

A. Contractor will provide the following:
1. Electrical power and metering, consisting of existing facilities.
2. Water supply, consisting of existing facilities.
B. General:
1. Existing facilities may be used.
2. New permanent facilities may be used.
C. Water Service: water is available from existing building services.
1. Use trigger-operated nozzles for water hoses, to avoid waste of water.
D. Temporary Electric Power Service: Electrical Contractor shall extend temporary power from existing building services.
E. Temporary Lighting: Electrical Contractor shall provide temporary lighting with local switching
1. Install and operate temporary lighting, minimum of 30 fc, to fulfill security and protection requirements, without operating the entire system, and will provide adequate illumination for all areas of work, including construction operations and traffic conditions.
F. Temporary Heat: General Contractor shall provide temporary heat required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.
1. Heating Facilities: Except where use of the permanent system is authorized, provide vented self-contained LP gas or fuel oil heaters with individual space thermostatic control.
a. Use of gasoline-burning space heaters, open flame, or salamander type heating units is prohibited.

1.5. TELECOMMUNICATIONS SERVICES AND WI-FI

A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization through construction closeout.
B. Telecommunications services shall include:
1. Windows-based personal computer dedicated to project telecommunications.
2. Shared access to the internet via WIFI or similar wireless connection.
a. Access must be capable to support minimum of 10 wireless devices.
3. Email Account/address dedicated for GC Project Manager of GC Supervisor on site.

1.6. TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
B. Temporary toilets: Comply with regulations and health codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best serve the Project's needs.
1. Provide toilet tissue, paper towels, paper cups, and similar disposable materials foreach facility. Provide covered waste containers for used material.
2. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy.
C. Maintain daily in clean and sanitary condition
D. Water: Provide potable water approved by local health authorities

1.7. BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

1.8. FENCING

A. Construction: Refer to Plan Documents and Specification Section 01 76 00: Fencing Materials and Barricades

1.9. EXTERIOR ENCLOSURES

A. Provide temporary weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.10. SECURITY

A. Provide security and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

1.11. VEHICULAR ACCESS AND PARKING

A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.

B. Coordinate access and haul routes with governing authorities and Owner.

C. Provide and maintain access to fire hydrants, free of obstructions.

D. Existing parking areas located in the lower area of the Warner Park Community Recreation Center as shown in the Lands for Work may be used for construction parking for the duration of the construction work. Under no circumstances shall construction vehicles be parked in the parking lot outside of the Lands for Work or in the construction area.

1.12. WASTE REMOVAL

A. See Section 01 74 19 - Waste Management, for additional requirements.

B. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.

C. Provide containers with lids. Remove trash from site periodically.

D. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.

E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.13. PROJECT IDENTIFICATION

A. Provide project identification sign of design and construction indicated in Section 01 58 13.

B. Erect on site at location determined by Owner .

C. No other signs are allowed without Owner permission except those required by law.

1.14. FIELD OFFICES

A. Office: Weather tight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack and drawing display table.

B. Field Office shall be located in the Lands for Work.

C. Provide space for Project Meetings with table and chairs to accommodate a minimum of ten (10) persons.

D. Provide a minimum of a 40” LCD monitor or other digital projection device to be connected to the computer identified in Section 1.4 Telecommunications Services (above), for use during progress meetings in connection with reviewing construction progress information posted to the Project Management Web Site (Specification 01 31 23) hosted by the Owner.

PART 2 - PRODUCTS

2.1. TEMPORARY PARTITIONS

A. Provide dustproof partitions to limit dust and dirt migration and to separate occupied areas from fumes and noise.

1. Non-fire rated partitions, standard

a. Wood stud framing, 6-mil polyethylene

2.2. EQUIPMENT

A. Temporary Lifts and Hoists: Contractors requiring temporary lifts and hoists shall provide facilities for hoisting materials and employees.

B. Electrical Outlets: Electrical Contractor shall provide properly configured NEMA polarized outlets to prevent insertion of 110-120 volt plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button and pilot light, for connection of power tools and equipment.

C. Electrical Power Cords: Contractors requiring power cords shall provide grounded extension cords; use "hard-service" cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.

D. Lamps and Light Fixtures: Electrical Contractor shall provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered glass enclosures, where exposed to breakage. Provide exterior fixtures where exposed to moisture.

E. Heating Units: General Contractor shall provide temporary heating units that have been tested and labeled by UL, FM or another recognized trade association related to the type of fuel being consumed.

F. First Aid Supplies: General Contractor shall provide first aid supplies complying with governing regulations.

G. Fire Extinguishers: General Contractor shall provide hand-carried, portable UL-rated, fire extinguishers of NFPA recommended classes for the exposures, extinguishing agent and size required by location and class of fire exposure.

PART 3 - EXECUTION

3.1. TEMPORARY FIRE PROTECTION

A. Until fire protection needs are supplied by permanent facilities, General Contractor shall install and maintain temporary fire protection facilities of the types needed to protect against reasonably predictable and controllable fire losses.

B. Comply with NFPA 10 "Standard for Portable Fire Extinguishers," and NFPA 241 "Standard for Safeguarding Construction, Alterations and Demolition Operations".

C. Locate fire extinguishers where convenient and effective for their intended purpose.

D. Store combustible materials in containers in fire-safe locations.

E. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways and other access routes for fighting fires.

F. Prohibit smoking on the premises.

G. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.

H. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site

I. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

3.2. COLLECTION AND DISPOSAL OF WASTE

A. Collect waste from construction areas and elsewhere daily

B. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly.

C. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 deg F.

D. Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material in a lawful manner.

3.3. ENVIRONMENTAL PROTECTION

A. Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result.

B. Avoid use of tools and equipment which produce harmful noise.

C. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

3.4. REMOVAL OF TEMPORARY UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, and materials prior to Substantial Completion inspection.

B. Remove underground installations to a minimum depth of 2 feet (600 mm). Grade site as indicated.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing facilities used during construction to original condition.

E. Restore new permanent facilities used during construction to specified condition.

END OF SECTION

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SECTION 01 58 13
TEMPORARY PROJECT SIGNAGE

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2.2. PROJECT IDENTIFICATION SIGN 1
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PART 1 – GENERAL

1.1. SECTION INCLUDES
A. Project identification sign.

1.2. QUALITY ASSURANCE
A. Design sign and structure to withstand 50 miles/hr wind velocity.
B. Sign Painter: Experienced as a professional sign painter for minimum three years.
C. Finishes, Painting: Adequate to withstand weathering, fading, and chipping for duration of construction.

1.3. SUBMITTALS
A. See Section 01 30 00 – Administrative Requirements for submittal procedures.
B. Shop Drawing: Show content, layout, lettering, color, structure, sizes.

PART 2 - PRODUCTS

2.1. SIGN MATERIALS
A. Structure and Framing: New, wood, structurally adequate.
B. Sign Surfaces: Exterior grade plywood with medium density overlay, minimum ¾" thick, standard large sizes to minimize joints.
C. Rough Hardware: Galvanized

2.2. PROJECT IDENTIFICATION SIGN
A. One painted sign, 32 sq ft area, bottom 6 feet above ground.
B. Content:
1. Project title, City of Madison, and Parks Division logo
2. Names and title of Architect.
3. Name of Prime Contractor.
4. Full color project rendering from high resolution image as furnished by Architect.

PART 3 - EXECUTION

3.1. INSTALLATION
A. Install project identification sign within 30 days after date fixed by Notice to Proceed.
B. Erect at designated location.
C. Install sign surface plumb and level, with butt joints. Anchor securely.

3.2. REMOVAL
A. Remove sign, framing supports, and foundations at completion of Project and restore the area.

END OF SECTION

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SECTION 01 60 00
PRODUCT REQUIREMENTS

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3.6. FINISH PRODUCTS 3
3.7. DUCTWORK, PIPING, AND CONDUIT 3
3.8. OWNER PROVIDED, CONTRACTOR INSTALLED EQUIPMENT 4

PART 1 – GENERAL

1.1. SUMMARY

A. The purpose of this specification is to provide general guidelines and responsibilities related to the receiving, handling, and storage of all materials and products from arrival on the job site through installation.
   1. Immediate inspection of delivered goods means a timely replacement if damaged.
   2. Proper storage helps prevent damage and loss by weather, vandalism, theft, and job site accidents.
   3. Proper storage helps with job site performance and safety.
   2. Proper handling helps prevent damage and job site accidents.

B. Each Contractor shall be directly responsible for the receiving, handling, and storage of all materials and products associated with the Work of their Division or Trade.

C. Each Contractor responsible for Work associated with Owner provided materials or products shall be responsible for the receiving, handling and storage of the material/product as outlined in Section 3.8 below..

1.2. RELATED SPECIFICATIONS

A. Parts of this specification will reference articles within “The City of Madison FACILITIES MANAGEMENT SPECIFICATIONs for Public Works Construction”.
   1. Use the following link to access the FACILITIES MANAGEMENT SPECIFICATIONs web page:
      http://www.cityofmadison.com/business/pw/specs.cfm
      a. Click on the “Part” chapter identified in the specification text. For example if the specification says “Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION **2**10.2” click the link for Part II, the Part II PDF will open.
      b. Scroll through the index of Part II for specification 210.2 and click the text link which will take you to the referenced text.
      c. City Standard Detail Drawings (SDD) may be located from the index in Part VIII.

B. Section 01 57 21 Indoor Air Quality

C. Section 01 74 13 Progress Cleaning

D. Section 01 76 00 Protecting Installed Construction

E. Other Divisions and Specifications that may address more specifically the requirements for the storage and handling of materials and products associated Work of other Divisions or Trades.

1.3. QUALITY ASSURANCE

A. The GC shall be responsible for ensuring that these minimum storage and handling requirements are met by all contractors on the project site including but not limited to the following:
   1. Receiving deliveries of materials, products, and equipment.
      a. Inspect all deliveries upon arrival for damage, completeness, and compliance with the construction documents.
         i. Deliveries shall remain in original packaging or crates, shipping manifest shall be kept with the delivery and the packaging shall have visible identification of the items within the packaging.

b. Immediately report any damaged products or equipment to the GC, begin arrangements for immediate replacement.
c. Materials or equipment that have been damaged, are incomplete, or do not comply with the construction documents shall not be permitted to be installed.

2. All materials and products shall be stored within the designated limits of the project site. Only store the amount of material necessary for upcoming operations so as not to interfere with other construction activities and access to Work by the Owner and Architect. Any offsite storage shall be at the expense of the contractor storing the material or product. All offsite storage requirements shall comply with this specification. All offsite storage of materials is subject to Owner Representative Quality Management review at any time.
3. Large storage containers may be used but shall be weather tight, securable, placed on concrete blocks, timbers, or jack stands and shall be level.
4. When lifting equipment is required the equipment rating shall be greater than the loading requirements of the item being lifted. In addition all of the following shall apply as necessary:
   a. Only designated and/or designed lift points shall be used.
   b. Large items shall have tag lines and handlers at all times during lifting operations.
   c. Lift at multiple points as needed to prevent bending.
5. Materials and products stored inside of the structure shall comply with all of the following:
   a. Storage shall not be allowed to impede the flow of work in progress.
   b. Storage shall not be allowed to hide completed work from review and inspections.
   c. Storage shall not exceed the design loads of the structural components it is being stored upon.
6. All materials and products shall be stored according the manufacturers minimum recommended requirements. All of the following shall be considered before storing any product or material:
   a. Dust and dirt
   b. Moisture and humidity, including rain and snow
   c. Excessive temperatures, direct sun, etc
   d. Product or material weight and size
   e. Potential for breakage
   f. Product incompatibility with other products such as corrosiveness, chemical reactions, flammability, etc.
   g. Product or material value and replacement cost
7. The Contractor shall be responsible for providing fully functional tarps or plastic wrap, to protect materials and products from the weather. All coverings shall be free of large holes and tears, and shall be tied, strapped, or weighted down to resist blowing.
8. The Contractor shall be responsible for any temporary heating, cooling, or other utility requirement that may be associated with the storage of a material or product.
9. The Contractor shall be responsible for securing materials and products of value such as copper, A/V equipment, etc. Such items shall be stored in securable shipping containers, job trailers or other such storage devices. Container shall be kept secured when not in use.

B. The GC shall inspect the job site daily to ensure that all products and materials stay weather tight and are secured against vandalism or theft as required by this specification.
C. The Owners Representative may at any time request improvements regarding storage of any material or product being provided under these construction documents.

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. GENERAL CONTRACTOR REQUIREMENTS

A. Designate material storage and handling areas as needed including all of the following:
   1. Designate specific areas of the site for delivery and storage of materials to be used during the execution of the Work.
   2. Designated areas shall not be located so as to interfere with the installation of any Work including Work by others such as the installation of utilities or the maintenance of existing utilities. This shall include not storing items in active utility easements as designated by the site plan.
B. Arrange for openings in the building as needed to allow delivery and installation of large items. Openings shall be appropriately sized to include the use of booms, slings, and other such lifting devices that may be larger than the item being installed.

1. When openings are required in completed Work (new or existing) the GC shall be responsible for providing an appropriate opening and for restoring the opening to the original or better condition upon completion. Restoration shall be weather tight and complete.

C. Repeated moving and handling of items being stored shall not be allowed. The GC shall be responsible for any damage and replacement because of mishandling or excessive handling.

3.2. BULK MATERIAL

A. Bulk material such as sand, gravel, top soil and other types of fill shall be stored away from the construction area and shall be stock piled as follows:
1. All bulk material shall be piled safely and efficiently in as small an area as practical. Only store the amount of material necessary for upcoming operations so as not to interfere with other construction activities and access to Work by the Owner and Architect.
2. All stock piles shall have silt fence/sock properly installed around the perimeter to prevent erosion and loss of material. Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION Section 210.1(f) and other related specification or details.
3. Fine grained material shall be protected with tarps to prevent blowing. Tarps shall be weighted or staked to stay in place.

B. Bulk material such as brick, concrete block, stone, and other palletized materials shall be stored on original shipping pallets until ready for use.

3.3. DRY PACKAGED MATERIAL

A. Dry packaged material such as cement, mortar, etc shall be stored on pallets, on slightly elevated ground or clear stone pad to keep water away from the base of the material being stored. Protect from moisture.

3.4. STRUCTURAL AND FRAMING MATERIAL

A. All structural and framing material shall be stored in an organized manner arranged by type, size and dimension. Materials shall be stored on pallets or timbers as necessary and shall not be allowed to lie directly on the ground.

B. Long and heavy items shall be supported at several points to prevent bending and warping.

3.5. EQUIPMENT

A. Equipment delivered to the site shall be stored away from all construction activities until the item can either be moved inside or properly installed.

B. Equipment shall be stored on slightly elevated ground or clear stone pad to keep water away from the base of the equipment.

3.6. FINISH PRODUCTS

A. Finish products such as flooring, tile, counters, lockers, toilets, partitions, lighting, and other similar items should not be delivered and stored until the structure has been enclosed, is weather tight, temperature controlled and the contractor is ready for such items to be installed.
1. Storage of finished products outside for any length of time shall not be allowed.

B. Products that cannot be stored inside the structure shall be stored in secured containers or job trailers until such time as they are ready to be installed.

C. Products with a high potential for breakage such as glass, mirrors, tiles, toilet fixtures, etc. shall be stored with additional protection as necessary such as but not limited to the following:
1. Store in original shipping containers until ready for installation.
2. Do not store in high traffic areas.
3. Shield with other materials such as cardboard, plywood, or similar products.

3.7. DUCTWORK, PIPING, AND CONDUIT

A. All piping and conduit shall be stored horizontally unless otherwise specified by the manufacturer or Division and Trade Specifications.
1. Do not store directly on grade.
2. Cover metal pipes and tubes to prevent rust and corrosion, allow ventilation to prevent condensation.
3. Whenever possible use pipe stands for storing pipe and conduit to prevent tripping and rolling hazards.

B. All ductwork shall be stored horizontally or vertically as necessary unless otherwise specified by the manufacturer or Division and Trade Specifications.
1. During storage, both ends of each duct shall be protected with plastic sheathing to prevent dust and dirt from getting inside the duct. Sheathing shall be sufficiently taped to the duct.

2. After installation, free/open ends shall remain protected with taped plastic sheathing and or temporary filters as specified by division or Trade specifications.

3.8. OWNER PROVIDED, CONTRACTOR INSTALLED EQUIPMENT

A. Section 3.8.A. shall apply to all equipment being provided to any contractor directly from the Owner for installation under the contract.
   1. The Owner or Owners Representative shall do the following:
      a. Inspect all deliveries upon receipt and notify manufacturer of any issues directly.
      b. Review the received shipment with the contractor.
         i. Only provide products or materials to the contractor that were not damaged through shipping or handling.
         ii. Confirm missing products or materials and anticipated delivery schedule if known.
   2. The Contractor responsible for the installation of Work associated with Owner provided materials or products shall "take ownership" and provide safe and secure storage and handling as previously described within this specification.
      i. The Contractor shall be liable for the repair or replacement of any material or product damaged after taking ownership of the product from receipt through final acceptance.

B. Section 3.8.B. shall apply to all equipment being provided by the Owner but shipped directly to any sub-contractor or the project site for installation under the contract.
   1. The GC and/or Contractor responsible for the Work associated with the Owner provided materials or products shall do the following:
      a. Inspect all deliveries upon receipt and notify the Owner or Owners Representative of any issues directly.
         i. Owner or Owners Representative shall notify manufacturer of any issues directly.
      b. Review the received shipment with the Owner or Owners Representative
         i. Confirm missing products or materials and anticipated delivery schedule if known.
   2. The Contractor shall "take ownership" and provide safe and secure storage and handling as previously described within this specification.
      i. The Contractor shall be liable for the repair or replacement of any material or product damaged after taking ownership of the product from receipt through final acceptance.

END OF SECTION

SECTION 01 71 23
FIELD ENGINEERING

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PART 1 – GENERAL

1.1. REQUIREMENTS INCLUDED

A. The Contractor shall provide and pay for field engineering services required for the Project:
   1. Land surveying services required to execute the Work, to include building addition location and layout, and location and layout of pavements and all proposed site improvements.
   2. Verification of existing building dimensions, elevations, and relationship to proposed additions.
   3. Professional Engineering services to execute Contractor's construction methods.
   4. Registered Professional Engineer in the State of Wisconsin to determine the load capacity of the existing structure for use of Contractors temporary facilities, equipment, lifts, machinery, material storage, etc.

1.2. RELATED REQUIREMENTS

A. Conditions of the Contract

1.3. PROCEDURES

A. A property survey has been prepared for the Owner and has been bound with Contract Drawings. Surveys shall describe physical characteristics, legal limitations and utility locations for the site of the Project, and a legal description of the site. If information is incomplete, notify Owner to furnish additional information. Verify easement locations, front, side, and rear yard restrictions, if any; and property line locations. Verify control points, and establish bench marks. Locate and layout roads, walks, parking areas and all civil structures and all proposed site improvements.

B. Verify locations of underground services, utilities, structures, etc. which may be encountered or affected by the Work.

1.4. PROJECT SURVEY REQUIREMENTS

A. Using datum, the lot lines and present levels have been established as indicated on the Drawings. Other grades, lines, levels and benchmarks, shall be established and maintained by the Contractor, who shall be responsible for them. As work progresses, the Contractor shall layout on forms and floor, the locations of all partitions, walls and fix column centerlines as a guide to all trades. The Contractor shall make provision to preserve property line stakes, benchmarks, or datum point. If any are lost, displaced or disturbed through neglect of any Contractor, Contractor's agents or employee, the Contractor responsible shall pay the cost of restoration.

B. Establish lines and levels, locate and layout, by instrumentation and similar appropriate means, additions, column locations, floor levels, stakes for walks, etc.

C. Provide data to all Subcontractors for their use as applicable.

D. From time to time, verify layouts by same methods.

1.5. RECORDS

A. Maintain a complete, accurate log of all control and survey work as it progresses.

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 – EXECUTION – THIS SECTION NOT USED

END OF SECTION

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SECTION 01 73 29
CUTTING AND PATCHING

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3.2. PREPARATION 2
3.3. PERFORMANCE 2
3.4. CLEANUP AND RESTORATION 3

PART 1 – GENERAL

1.1. SUMMARY

A. This Section includes general procedural requirements for cutting and patching including, but not limited to the following:
   1. Examination
   2. Preparation
   3. Performance
   4. Cleanup and Restoration

1.2. RELATED SPECIFICATION SECTIONS

A. Divisions 02 through 32 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.
B. Division 07 Section "Penetration Fire Stopping" for patching fire-rated construction.

1.3. DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.
C. Level Alpha

1.4. QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
B. Operational Elements: Do not cut and patch operating elements and related components ina manner that results in reducing their capacity to perform as intended or that may result in increased maintenance or decreased operational life or safety.
C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity that results in reducing their capacity to perform as intended, or that may result in increased maintenance or decreased operational life or safety. Some miscellaneous elements include the following:
   1. Water, moisture, or vapor barriers
   2. Membranes and flashings
   3. Exterior curtain-wall construction
   4. Equipment supports
   5. Piping, ductwork, vessels, and equipment
   6. Noise and vibration control elements and systems
D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

1.5. WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

B. All cutting and patching work performed under this contract shall be warranted like new work as defined by the Specification governing the work.

PART 2 - MATERIALS

2.1. GENERAL

A. Comply with requirements specified within other sections of the Specifications.

B. In-Place Materials: Use materials identical to existing in-place materials. For exposed surfaces use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1. EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2. PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect in-place construction and existing conditions during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations. If the failure to protect, or the lack of protection, of in-place construction and/or existing conditions results in damage, the contractor shall be responsible for repair to previous condition.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to eliminate interruption to occupied areas.

3.3. PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete or Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Division 3l Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.

D. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

3.4. CLEANUP AND RESTORATION

A. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
   1. Clean piping, conduit, and similar features before applying paint or other finishing materials.
   2. Restore damaged pipe covering to its original condition.
   3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
   4. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
   5. Ceilings: Patch, repair, or re-hang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
   6. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather tight condition.
   7. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
   8. Any smoke and fire caulking that has been disturbed must be replaced by the Contractor as required by code.

END OF SECTION

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SECTION 01 74 13
PROGRESS CLEANING

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3.2. PROJECT SITE CLEANING 2
3.3. PROGRESS CLEANING 2
3.4. FINAL CLEANING 3
3.5. CALL BACK WORK 4

PART 1 – GENERAL

1.1. SUMMARY

A. Throughout the execution of this contract all contractors shall be responsible for maintaining the project site in a standard of cleanliness as described in this specification.

B. All contractors shall also comply with the requirements for cleaning as described in other specifications.

C. Work included in this specification shall include but not be limited to:

1. Safety Cleaning
2. Project Site Cleaning
3. Progress Cleaning
4. Final Cleaning

1.2. RELATED SPECIFICAITONS

A. Section 01 35 00 Special Procedures
B. Section 01 60 00 Product Requirements
C. Section 01 74 19 Construction Waste Management and Disposal
D. Section 01 76 00 Protecting Installed Construction

1.3. QUALITY ASSURANCE

A. The General Contractor (GC) shall conduct daily inspections, more often if necessary, of the entire project site to ensure the requirements of cleanliness are being met as described within these specifications.

B. All contractors shall comply with other regulatory requirements as they apply to waste recycling, reuse, hauling, and disposal requirements of any governmental authority having jurisdiction.

C. The Owner reserves the right to have work done by others in the event any contractor fails to perform cleaning as described within these specifications. The cost of any Owner provided cleaning shall be charged to the contractor through a deduct change order.

PART 2 - PRODUCTS

2.1. CLEANING MATERIALS AND EQUIPMENT

A. The Contractor shall provide all required personnel, equipment, and materials necessary to maintain the required level of cleanliness as described in this specification.

B. Use only cleaning materials and equipment that are compatible with the surface being cleaned, as recommended by the manufacturer, or as approved by the A/E.

C. Use only cleaning materials, equipment, and methods as recommended in the manufacturers care and use guide of the material, finish or equipment being cleaned.

PART 3 - EXECUTION

3.1. SAFETY CLEANING

A. All Contractors shall be responsible for safety cleaning as required by OSHA and other regulatory requirements as applicable.

B. Safety Cleaning shall include but not be limited to the following:
   1. All work areas, passageways, ramps, and stairs shall be kept free of debris, scrap materials, pallets, and other large items that would obstruct exiting routes. Small items such as tools, electrical cords, etc are picked up when not in use.
   2. Form and scrap lumber shall have nails/screws removed or bent over. Lumber shall be neatly stacked in an area designated by the GC.
   3. Spills of oil, grease, and other such liquids shall be cleaned immediately or sprinkled with sand/oil-dry first, then cleaned.
   4. Oily, flammable, or hazardous items shall be stored in appropriate covered containers and storage devices unless actively being used.
   5. Oily, or flammable rags, and other such waste shall only be disposed of in authorized covered containers.
   6. Disposal by burning shall not be allowed at any time.

3.2. PROJECT SITE CLEANING

A. This section applies to the general cleanliness of the project site as a whole for the duration of the execution of this contract.

B. Exterior Project Site Areas
   1. The GC and other Contractors as appropriate shall ensure the following levels of cleanliness are applied to the exterior project site areas.
      a. The overall appearance of the project site is neat and orderly. Defined areas for material storage, material waste, job trailers, and the project area are clean and well maintained.
      b. The construction fence is maintained, erect with no gaps, and properly posted per all regulatory requirements.
      c. All erosion control measures are properly maintained, cleaned, and repaired as necessary.
      d. All loose materials (construction or waste) are properly tied or weighted down to resist blowing.
      e. All construction materials are properly covered with fully functional tarps or plastic wrap, protected from the weather, coverings are tied, strapped, or weighted down to resist blowing.
      f. Dust control is applied as necessary or as required by any regulatory requirement.

C. Interior Project Site Areas
   1. All Contractors shall ensure the following levels of cleanliness are applied to the interior project site areas.
      a. The overall appearance of the project site is neat and orderly. Defined areas for material storage, material waste, and project area are clean and well maintained.
      b. Stored materials are kept in original shipping containers whenever possible. Stored materials not in shipping containers are properly stored and protected according to other applicable specifications.
      c. All scraps and debris shall be properly disposed of as often as necessary to keep work areas, passageways, stairs, and ramps free of debris and clear for emergency exiting.
      d. Boxes, pallets, and other such shipping containers, are broken down, stored in a consolidated area or, disposed of as often as is necessary.
      e. Hand tools, supplies, materials, electrical cords not being used are picked up and sptored in gang boxes, not left as walking hazards in work areas, passageways, etc.

D. Job Trailer
   1. The interior of the job trailer shall be kept clean and available as a work space at all times. The GC shall ensure that the following is provided for within the job trailer:
      a. Meeting space including tables and chairs.
      b. Sufficient space for all contractors to access the official construction documents, provide updates, etc.

3.3. PROGRESS CLEANING

A. This sub-section shall apply to all Progress Cleaning prior to the installation of finishes, fixtures, and trim (IE rough-in).
   1. For the purposes of this section “clean” shall be defined as a level of cleanliness free of dust and other material capable of being removed by use of reasonable effort using a good quality janitor broom and shop-vac.
   2. Daily cleanings shall be conducted by all contractors at the end of the work day as follows:
      a. Debris in excavated areas shall be removed prior to backfill and compaction.
      b. Debris in wall cavities, chase spaces, etc shall be removed prior to enclosing the spaces.

c. Large items shall be properly stored, returned to designated areas, or disposed of as necessary.
d. Loose materials shall be properly secured.
e. Flammable or hazardous materials are properly stored or disposed of.

3. Weekly cleaning shall be conducted by all contractors as designated by the GC. Weekly cleanings shall include all the above for a daily cleaning and other necessary cleaning as designated by the GC.

B. This sub-section shall apply to Progress Cleaning in preparation for the installation of finishes, fixtures, and trim.
a. Surfaces receiving finishes shall be thoroughly cleaned prior to contractors applying finish materials. The GC shall be responsible for inspecting the area and surfaces being cleaned for finish prior to the sub-contractor applying the finish. This shall include but not be limited to the following:
i. Wall surfaces shall be wiped clean of dirt and oily residues, vacuumed free of dust, and shall be free of surface imperfections prior to painting or installing wall coverings.
ii. Metal surfaces shall be wiped clean of dirt and oily residues, and be free of surface imperfections prior to painting.
iii. Flooring shall be broom swept of large and loose items then vacuumed clean of dust and small particles, and damp mopped clean and dried prior to installing any flooring finish. Additional cleaning may be required depending on the preparation requirements recommended by the flooring material manufacturer.

C. This sub-section shall apply to Progress Cleaning after the installation of finishes, fixtures, and trim.
1. For the purposes of this section “clean” shall be defined as a level of cleanliness free of dust and other material capable of damaging or visually disfiguring finished work, finishes, fixtures, and trim.
2. Progress Cleaning at this point in the contract shall be conducted immediately as follows:
a. Dust, dirt, etc shall be swept and vacuumed off of finish flooring and trim.
b. Liquid spills shall be cleaned up according to the spill type. This shall include drips and spills caused by paint, stain, sealants, and other such items.
3. The Contractor(s) at no additional cost to the Owner shall be responsible for replacing any finished work, finishes, fixtures, and trim damaged or disfigured because of inadequate or improper cleaning.

3.4. FINAL CLEANING

A. As noted in Specification 01 29 76 Progress Payment Procedures, Progress Payment Milestone Schedule, Final Cleaning shall not be conducted prior to requesting the 90% contract total progress payment and all of the following shall be complete:
1. All final regulatory inspections including but not limited to Building Inspection Department and Madison Fire Department inspections have been successfully completed.
2. All Quality Management Observation (QMO) reports have been closed out.
3. All Demonstration and Training has been completed.
4. All Attic Stock has been consolidated and located to its designated area
5. All protection for installed construction shall be removed prior to final cleaning by the contractor responsible for providing the protections. This shall include the removal of any adhesive residues left behind from tapes. Contractors shall only use manufacturer authorized cleaning materials for removing adhesives, etc.

B. For the purposes of this section “clean” shall be defined as a level of cleanliness generally provided by skilled cleaners using commercial quality building maintenance equipment and materials.

C. The GC shall be responsible for ensuring that all requirements under this section are being met.

D. General Requirements
1. Employ experienced personnel or professional cleaners for final cleaning as necessary for the areas or equipment being cleaned.
2. Cleaning equipment used shall be commercial grade equipment commonly used by professional cleaners.
3. Cleaning equipment and materials shall be cleaned, rinsed, or replaced to ensure a uniform level of cleanliness is being maintained during the final cleaning. This shall include but not be limited to the following:
a. Vacuum cleaner bags and/or filters are changed and/or cleaned as often as necessary.
b. Dust & wipe down rags are washed, rinsed, or replaced before starting each room.
c. Mopping equipment
i. Mop water for washing shall have cleaning solution added to the amount and temperature per manufacturer’s recommendations. Mop washing water shall be replaced often to maintain the levels of the cleaning solution and temperature required.
ii. Mop water for rinsing shall remain clean, clear, and be replaced as often as necessary.

iii. Mop heads shall be rinsed often and replaced as necessary.
iv. Mop heads and buckets shall be thoroughly rinsed with each change of water.
v. Only new mop heads shall be used for rinsing.

E. Refer to all other specifications in this contract for specific requirements regarding final cleaning of finishes, fixtures, equipment, etc.

F. Exterior Cleaning shall include but not be limited to the following:
1. All exterior glazing surfaces have been professionally cleaned and are free of dust and streaking.
2. Metal roofs, siding, and other surfaces shall be clean of dirt and free of splashed or excess materials such as sealants, mortar, paint, etc.
3. All exterior furnishings shall be clean, waste receptacles shall be empty.
4. Paved areas shall be clean, free of dirt, oily stains and other such blemishes
5. Exterior lights and diffusers are clean and free of dust.

G. Interior Cleaning shall include but not be limited to the following:
1. Remove all labels, stickers, tags, and other such items which are not required by code as permanent labels.
2. All interior glazing surfaces, including mirrors, have been professionally cleaned and are free of dust and streaking.
3. All interior surfaces have been cleaned of excess materials such as paint, sealants, etc and have been wiped free of dust.
4. Interior metals, fixtures, and trim have been cleaned free of dust and oily residues
5. Carpet flooring has been thoroughly cleaned; vacuumed free of dust, excess glues and other stains removed per manufacturers use and care instructions.
6. Resilient flooring has been thoroughly cleaned; vacuumed free of dust, excess glues and other stains removed, mopped and buffed per manufacturers use and care instructions.
7. Interior non-occupied concrete floors shall be broom cleaned, vacuumed free of dust, excess glues and other stains removed per manufacturers use and care instructions.
8. Light fixtures, lamps, diffusers and other such items have been dusted and cleaned as necessary.

3.5. CALL BACK WORK

A. The GC shall be responsible for ensuring that any contractor returning to the project site for completion or correction work has re-cleaned and restored the area to the levels described in section 3.4 above upon completion of the work. This shall include but not be limited to the following:
1. The immediate area(s) where work was completed.
2. Adjacent areas where dust or debris may have traveled.
3. Other areas occupied during the completion of the call back work.
4. Path of entrance/exit, to/from the area(s) of work.

END OF SECTION

SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

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PART 1 – GENERAL

1.1. SUMMARY

A. This specification includes administrative and procedural requirements for the recycling, re-use, salvaging, and disposal of non-hazardous construction and demolition waste.

B. The General Contractor (GC) shall be fully responsible for complying with all applicable ordinances and other such regulatory requirements during the execution of this contract.

1.2. RELATED SPECIFICAITONS

A. 01 29 76 Progress Payment Procedures
B. 01 31 23 Project Management Web site
C. 01 32 19 Submittals Schedule
D. 01 33 23 Submittals
E. 01 77 00 Closeout Procedures
F. Other Divisions and Specifications that may address the proper disposal of construction or demolition waste as it pertains to work being conducted under that particular specification.

1.3. CITY ORDINANCES

A. There are two (2) Madison General Ordinances (MGO) that the City of Madison has regarding construction and demolition waste.
   1. MGO 10.185, Recycling and Reuse of Construction and Demolition Debris, describes the requirements associated with this ordinance including definitions, documentation requirements, and penalties.
   2. MGO 28.185, Approval of Demolition (Razing, Wrecking) and Removal, describes the requirements associated with applying for and receiving a demolition permit.

B. All City of Madison, Board of Public Works, contracts being conducted by City Engineering, Facility Management, for construction, remodeling, or demolition shall comply with the above ordinances regardless of project type or size.

1.4. DEFINITIONS

A. Clean: Untreated and unpainted material, free of contamination caused by oils, solvents, caulks, and other chemicals.

B. Construction and Demolition Debris: Materials resulting from the construction, remodeling, repair, and demolition of utilities, structures, buildings, and roads.

C. Disposal: Off-site removal of construction and demolition debris and the subsequent sale, recycling, reuse, or deposit in authorized landfill or incinerator.

D. Hazardous: Exhibiting the characteristics of hazardous substance, i.e. ignitability, corrosiveness, toxicity, or reactivity and including but not limited to asbestos containing materials, lead, mercury and PCBs.

E. Non-hazardous: Exhibiting none of the characteristics of a hazardous substance.

F. Nontoxic: Not immediately poisonous to humans or poisonous after a long period of exposure.
G. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product.
H. Recycle: Any process by which construction or demolition debris is diverted from final disposal as solid waste at a permitted landfill and instead is collected, separated, and/or processed into raw materials for new, reused, or reconstituted products; or for the recovery of materials for energy production processes.
I. Recycler: Any recycling facility, transfer station, or other waste handling facility which accepts construction and demolition debris for recycling, or for other transferring to a recycling facility.
J. Recycling: The process of sorting, cleaning, treating, or reconstituting solid waste and other discarded materials for the purpose of preparing the material to be recyclable. Recycling does not include burning, incinerating or thermally destroying waste.
K. Return: To give back reusable items or unused products to vendors for credit.
L. Reuse: Shall mean any of the following:
    1. The on-site use of reprocessed construction and demolitions debris.
    2. The off-site redistribution of a material, for use in the same manner or similar manner at another location.
    3. The use of non-toxic, clean wood as an alternative fuel source.
M. Salvage: To remove a waste material from the project site for resale or reuse by the Owner or others.
N. Toxic: Poisonous to humans either immediately or after a long period of exposure.
O. Trash: Any product or material unable to be re-used, returned, recycled, or salvaged.
P. Waste: Extra materials or products that have reached the end of its useful life or its intended use. Waste includes salvageable, returnable, recyclable and re-useable construction and demolition materials, and trash.

1.5. PERFORMANCE REQUIREMENTS

A. The GC shall develop a Waste Management Plan that results in end-of-project rates for salvage/recycling/reuse of 95 percent (minimum) by weight of the total waste generated by the Work. Percentages may be adjusted on a project by project basis depending on selected LEED goals associated with the project.
B. The GC shall salvage or recycle 100 percent of all uncontaminated packaging materials including but not limited to the following:
    1. Paper
    2. Cardboard
    3. Beverage containers
    4. Boxes
    5. Plastic Sheet and film
    6. Polystyrene packaging
    7. Wood crates and pallets
    8. Plastic pails and buckets
C. Promote a resourceful use of supplies and materials through proper planning and handling. Generate the least amount of waste possible by minimizing errors, poor planning, breakage, mishandling, contamination or other similar factors.
D. Use all reasonable means to divert construction waste from landfills and incinerators through recycling, reuse, or salvage as appropriate.

1.6. SUBMITTALS AND DELIVERABLES

A. The GC shall provide their completed Waste Management Plan to the Project Management Web Site as a submittal for review by the Project Architect and City Project Manager.
    1. See item 1.8 below for Waste Management Plan submittal requirements.
    2. The Waste Management Plan shall be completed, submitted, and approved as a pre-requisite for Progress Payment number 1.
    3. Copies of all documentation required by this specification shall be submitted to the appropriate Project Management Web Site Library. Documentation shall be reviewed by the City Project Manager during all Progress Payment reviews for compliance and accuracy.
B. The Waste Management Coordinator shall provide copies of items 1 through 5 below to the appropriate Project Management Web Site Library and shall update the Waste Management Summary Log to reflect the records being submitted.
    1. Records of Donations: Indicate receipt and acceptance of itemized salvageable waste donated to individuals or organizations. Indicate if the organization is tax exempt.

2. Records of Sales: Indicate receipt and acceptance of itemized salvageable waste sold to individuals or organizations. Indicate if the organization is tax exempt.
3. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts and invoices.
4. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts and invoices.
5. Statement of Refrigerant Recovery: The Refrigerant Recovery Technician responsible for recovering refrigerant shall provide the GC with a statement indicating all of the following:
    a. All recovery was performed according to EPA Regulations.
    b. All refrigerant present was recovered; indicate the total quantity recovered by unit.
    c. Date of Recovery.
    d. Name, address, company name, and phone number of technician performing the recovery.
    e. Technician shall sign and date the statement.

C. LEED Submittal: The GC shall provide the following information using the appropriate LEED letter template upon project completion: indicating that the requirements of the credit have been met. *NOTE: This requirement shall only apply to projects having a LEED certification goal.*
1. Total waste material generated.
2. Total waste material diverted by diversion method; recycling, salvage, re-use, etc.
3. Which waste streams have been diverted; minimum four different streams required to achieve LEED credit
4. Statement that the credit requirements have been met.
5. GC shall sign the letter.

1.7. QUALITY ASSURANCE

A. Waste Management Coordinator: The GC shall be responsible for designating a Waste Management Coordinator. Coordinator may be the GC Supervisor, GC Project Manager or other member of the GC staff having knowledge of proper waste management procedures and all applicable regulations.
B. Regulatory Requirements: comply with all hauling and disposal regulations of authorities having jurisdiction.
C. The Waste Management Coordinator shall comply with Specification 01 31 19 Project Meetings, Section 3.7.B.1 and conduct a Waste Management Conference at the job site. This conference shall be repeated as necessary as additional trades are added to the Work. The conference shall include but not be limited to the following:
1. Identify the Waste Management Coordinator; provide trade contractors with name, phone, and email information.
2. Review and discuss the Waste Management Plan and the roles of the Coordinator.
3. Review the requirements for documenting and reporting procedures of each type of waste and its disposition.
4. Review procedures for material separation; indicate availability and locations of containers and bins.
5. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
6. Review waste management procedures specific to each trade.

D. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

1.8. WASTE MANAGEMENT PLAN

A. Develop a plan consisting of waste identification, a waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume. Use the same units of measure throughout the waste management plan.
1. Waste Identification: Indicate anticipated types and quantities of site clearing, demolition waste, and construction waste that will be generated during the execution of this contract. Include assumptions for the estimates.
2. Waste Reduction Work Plan: The work plan shall consist of but not be limited to all of the following:
    a. Identify methods for reducing construction waste. Re-using, framing and forming materials, re-planning material cuts to minimize waste, etc.
    b. Identify what types of materials will be recycled. Provide lists of local companies that receive and/or process the materials. Include names, addresses, and phone numbers.
    c. Identify what types of materials will be disposed of and whether it will be disposed of in a landfill facility or by incineration facility. Provide lists of local companies that receive and/or process the materials. Include names, addresses, and phone numbers.
    d. Identify methods to be used on site for separating waste including all of the following:

i. Sizes of containers to be used.
ii. Labels to be used on the containers to identify the type of waste allowed in the container.
iii. Designated locations on the project site for waste material containers.

B. If project requires demolition incorporate the ordinance required (MGO 28.185) Recycling and Reuse Plan into the Waste Management Plan.

C. Provide all of the following for the Waste Management Coordinator:
1. Name, employer, employer address, phone number, and email address of the designated coordinator.
a. The GC shall also provide this information with the required Project Directory Submittal at the beginning of the project.

D. If at the option of the GC, they choose to contract with a Waste Management Disposal Company that allows comingled and unsorted waste materials, the GC shall include with their Waste Management Plan the following:
1. Name, address, phone number, state permitting information, and other pertinent information about the disposal company.
2. Documentation from the disposal company indicating company policies and procedures regarding comingled and unsorted waste materials to include:
a. GC responsibilities on the project site.
b. Disposal company procedures for receiving, sorting, recycling, and disposing of comingled and unsorted waste material.

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. PLAN IMPLEMENTATION

A. Implement the approved waste management plan. Provide adequate containers, storage space, signage, transportation and other items required to implement the plan during the execution of this contract.

B. The GC and Waste Management Coordinator shall be responsible for monitoring and reporting the status of the Waste Management Plan and shall monitor the waste management practices on site as frequently as needed.

C. Train all workers, sub-contractors, and suppliers on proper waste management procedures as appropriate for the work being conducted on the project site.
1. Distribute the waste management plan to everyone concerned within seven (7) days of submittal approval.
2. Distribute the waste management plan to new workers, sub-contractors, and suppliers when they first appear on the project site.
3. Conduct additional training as needed during the execution of the contract to keep a positive focus on the waste management plan.

D. Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent and used facilities.
1. Designate and label specific areas on the project site necessary for separating materials to be salvaged, recycled, reused, donated, and sold.
2. Comply with any specification or regulatory requirements pertaining to dust, dirt, environmental protection, and noise control.

3.2. HAZARDOUS AND TOXIC WASTE

A. The Owner shall be responsible under separate contract for the removal of any asbestos related materials. All other materials shall be removed by the GC.

B. All hazardous and toxic waste shall be separated, stored, and disposed of according to all applicable regulations.

C. All hazardous and toxic materials on site shall have a Material Safety and Data Sheet (MSDS) available that indicates storage requirements, emergency information, and disposal requirements as necessary.

3.3. GENERAL GUIDELINES FOR ALL WASTES

A. Recycle all paper and beverage containers used by workers, sub-contractors, suppliers and visitors to the project site.

B. All revenues, savings, rebates, tax credits, and other such incentives received from recycling, reusing, or salvaging waste materials shall accrue to the GC unless specified otherwise in the contract documents.

C. Separate recyclable, reusable, and salvageable waste from other waste materials, trash, and debris except where Waste Management Disposal Company allows comingled waste materials, see section 1.8.D above.

1. Separate by type in appropriate containers or designated areas according to the approved waste management plan away from the construction area. Do not store within the drip lines of existing trees.
2. Inspect containers and bins frequently for contamination and inappropriately sorted materials. Remove contaminated materials and resort as necessary.
3. Stockpile bulk materials such as sand, topsoil, stone, etc., on site away from the construction area and without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water, and cover to prevent windblown dust. Do not store within the drip lines of existing trees.
4. Whenever possible store items off the ground and/or protect them from the weather.

3.4. GUIDELINES FOR RECYCLABLE, RE-USABLE, AND SALVAGEABLE WASTE

A. The following guidelines is not a complete or all inclusive list and shall be adjusted as needed by the methods and procedures identified in the Waste Management Plan.

B. Asphalt Paving: Break-up into transportable pieces or grind, transport to an authorized recycling facility.

C. Carpet and Pad: Separate carpet and pad scraps, containerize and transport to an authorized recycling facility.

D. Ceiling System Components: Suspended ceiling system components shall be sorted by material type as follows:
   1. Broken, cut, or damaged tiles shall be containerized, transport to an authorized recycling facility.
   2. Damaged, or cut tracks, trim and other metal grid system components shall be sorted with other metals of similar types, palletize, transport to an authorized recycling facility.

E. Clean Fill: When allowed by Division 31 Specifications; concrete, masonry, stone, asphalt pavement, sand and other such materials may be used as clean fill on this project site. The GC shall verify with the Project Architect, Structural Engineer, or Civil Engineer as necessary prior to using any materials as clean fill. Materials shall be processed, placed, and compacted as specified. If not being re-used on site, transport to an authorized recycling facility.

F. Clean Wood Materials: Including but not limited framing cutoffs, wood sheathing or paneling materials, structural or engineered wood products, and pallets or crates. Clean Wood shall be free of paints, stains, oils, preservatives and other such contaminates.
   1. Useable pieces shall be sorted by type and dimension, bundled and transported off site by the GC or returned to the supplier.
   2. Non-useable pieces shall be palletized or containerized, transport to an authorized recycling facility.
   3. Clean, uncontaminated sawdust and wood shavings shall be bagged, transport to an authorized recycling facility.

G. Concrete: Break-up into transportable pieces, remove all reinforcing and other metals, transport to an authorized recycling facility.

H. Glass Products: Shall be sorted by types, do not include light fixture lamps and bulbs. Products broken in shipment shall be returned to the supplier. Broken or cracked items still in frames shall be taped to prevent further breakage and injury to workers. Transport to an authorized recycling facility.

I. Gypsum Board: Stack large clean pieces on wooden pallets or container, store in a dry location, transport to an authorized recycling facility.

J. Light Fixture Lamps and Bulbs: Fluorescent tubes shall be containerized, transport to an authorized recycling facility.

K. Masonry and CMU: Remove all metal reinforcing, anchors, and ties, clean undamaged pieces and neatly stack on pallets, transport damaged pieces to an authorized recycling facility.

L. Metals: Sort metals by type as follows, this does not include piping:
   1. Architectural metals including but not limited to siding, soffit, and roofing panels shall be sorted by material, palletize or bundle as needed and transport to an authorized recycling facility.
   2. Structural steel, sort by size and type; palletize and transport to an authorized recycling facility.
   3. Miscellaneous metals such as aluminum, brass, bronze, etc shall be sorted by type, containerized or palletized as necessary, transport to an authorized recycling facility.

M. Packaging and shipping materials
   1. Cardboard boxes and containers: Breakdown all cardboard boxes and containers into flat sheets. Bundle and store in a dry location until transported for recycling.
   2. Pallets:
      a. Whenever possible require deliveries using pallets to remove them from the project site.
      b. Neatly stack pallets in preparation for reusing them or providing them to other companies for salvage or re-use.
      c. Break down pallets into component wood pieces that comply with the requirements for recycling clean wood materials. Neatly stack or palletize pieces in preparation for transportation.

3. Crates: Break down crates into component wood pieces that comply with the requirements for recycling clean wood materials. Neatly stack or palletize pieces in preparation for transportation.
4. Polystyrene Packaging: Separate and bag materials.

N. Piping and conduit: Reduce all piping and conduit to straight lengths, sort and store by size, material and type. Remove supports, hangers, valves, boxes, sprinkler heads, and other such components, sort and store by size, material and type. Transport to authorized recycling facilities according to material types.

O. Roofing: Roofing materials shall be sorted and containerized by type, transport to authorized recycling facilities according to material types.

P. Site-Clearing Waste: Sort all site waste by type.
1. Only stockpile soils types and quantities required for re-use on the project site. All remaining quantities shall be transported off site to an authorized facility that receives such materials.
2. Brush, branches, and trees with no marketable re-use shall be transported to facilities for chipping into mulch.
3. Trees with a marketable re-use shall be salvaged and transported to facilities that specialize in processing trees for future use as wood products.

3.5. GUIDELINES FOR DISPOSAL OF WASTES

A. The following guidelines shall be adjusted as needed by the methods and procedures identified in the Waste Management Plan.

B. Any waste that is contaminated, organic, or cannot be recycled, re-used, or salvaged shall be legally disposed of in an authorized landfill or incinerator. Disposal methods shall follow all applicable regulatory requirements.

C. No waste material of any kind, except those types designated as clean fill in section 3.4 above, shall be allowed to be buried on the project site at any time.

D. No burning of any kind of waste material shall be permitted on this project site at any time.

E. Paint and Stain: Paints, stains, and their containers shall be disposed of as follows:
1. Whenever possible containers should be thoroughly cleaned immediately after emptying and sorted with as appropriate (metal or plastic) for recycling
2. Empty containers, regardless of type or base material, may be disposed of with lids off with general garbage.
3. Latex paint may be placed with general garbage if properly solidified as follows:
a. Small amounts (an inch or less in can): Remove lids and allow paint to dry out in the can and harden. Protect cans from rain and freezing.
b. Large amounts (more than one inch): Mix paint with equal amounts of cat litter, stir and allow to completely dry. Alternate method: mix with commercial paint hardener.
4. Oil-based or combustible paints and stains, regardless of liquid or solid, shall be transported to an approved facility that takes such items such as Dane County Clean Sweep Sites.

F. Treated Wood Materials: Treated wood materials including but not limited to wood that has been painted, stained, or chemically treated shall not be recycled or incinerated.

END OF SECTION

SECTION 01 76 00
PROTECTING INSTALLED CONSTRUCTION

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PART 1 – GENERAL

1.1. SUMMARY

A. The purpose of this specification is to provide clear responsibilities, guide lines, and requirements related to providing protection to already installed construction.

B. Already installed construction shall include but not be limited to the following:

1. Any existing site feature such as pavement, curbs, drainage features, utilities, landscaping features (trees, shrubbery, plantings, flagpoles, etc) and other such exterior items not associated with the building whether on or adjacent to the project site.
2. Any existing structure on or adjacent to the project site.
3. Any existing interior work that may be adjacent to the new work including all paths of ingress/egress to areas associated with accessing the Work.
4. Any existing feature of any kind within the public right-of-way that may be on the project site property, adjacent to the project site or across the street from the project site.

C. All contractors shall be familiar with the specifications of their Division of Work for specific requirements on protection of the Work.

D. The requirements noted within this specification do not relieve any contractor of the responsibility for compliance with any code, statute, ordinance, or other such regulatory requirement having jurisdictional authority over these contract documents.

1.2. QUALITY ASSURANCE

A. It shall be the responsibility of every contractor and worker assigned to the project to be diligent in protecting all existing work, and newly installed construction.

B. It shall be the General Contractors' (GC) responsibility under the contract to provide all reasonable protection methods, materials, or precautionary measures required to protect new or existing construction as described in within this specification to the project as a whole.

1. The GC shall be responsible to ensure any damaged new or existing construction is repaired or replaced at no additional cost to the Contract.
2. The GC at their discretion may direct other contractors to provide and maintain protection of completed work associated with their Division of Work. I.E.: The carpet installer may be required by the GC to provide carpet protection along traveled paths, ingress/egress, etc after installation.

C. It shall be the responsibility of the GC to ensure that all materials being used to protect installed construction are compatible with, and/or adjacent to, the materials being protected. This shall include but not be limited to the material used as covering, tapes used to fasten protective materials, etc.

1.3. RELATED SPECIFICATIONS

A. Parts of this specification will reference articles within "The City of Madison FACILITIES MANAGEMENT SPECIFICATIONs for Public Works Construction".
   1. Use the following link to access the FACILITIES MANAGEMENT SPECIFICATIONs web page:
      http://www.cityofmadison.com/business/pw/specs.cfm
      a. Click on the "Part" chapter identified in the specification text. For example if the specification says "Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION **2**10.2" click the link for Part II, the Part II PDF will open.
      b. Scroll through the index of Part II for specification 210.2 and click the text link which will take you to the referenced text.
      c. City Standard Detail Drawings (SDD) may be located from the index in Part VIII.

B. Section 01 60 00 Product Requirements

C. Section 01 74 13 Progress Cleaning

PART 2 - PRODUCTS

2.1. FENCING MATERIALS AND BARRICADES

A. Except where noted in other areas of the construction documents, the responsible contractor shall provide a six foot galvanized chain link fence including full height mesh screen at the project lines as shown on the Civil Drawings. For temporary barricade situations, the responsible contractor may provide one of the following that sufficiently provide a sturdy physical barrier and/or visual barrier as necessary for the intended application.
   1. Standard orange construction barrels each with a standard rubber base ring and reflective tape
      a. Provide flashing amber lights as needed to increase night time visibility
   2. Steel "T" style fence posts
   3. 4'0" high standard orange construction fence
   4. Traffic barricades
   5. Jersey barriers
   6. Other types of fencing or barricades typically used in the construction industry

B. The contractor responsible for providing the fencing materials and barricades shall also be responsible for maintaining them. This shall include but not limited to fixing damaged fencing, standing up barrels that have been knocked over, realigning barrels, and ensuring flashing lights are fully operational at all times.

C. The following fencing and barricade designations, and their use descriptions shall be used throughout this specification to provide uniformity in describing protection requirements.
   1. Type A, Jersey Barriers, to be used as permanent blocking devices to deny access to alternate project site entrances or exits.
   2. Type B, Traffic Barricades, to be used as temporary blocking devices to deny access to alternate project site entrances or exits.
   3. Type C, Construction Barrels without construction fencing shall be used for lane closures, temporary blocking devices to deny access and the protection of single locations (I.E. identify the location of an access structure) that do not require fencing.
   4. Type D, Construction Barrels with construction fencing where it becomes necessary to surround an object with a complete visual barricade and it is impractical or unacceptable to install fence posts. The surround shall be constructed in such a manner as to provide a buffer zone around and access to the item being protected.
   5. Type E, Steel "T" Fence Posts shall be used at the project lines, as indicated on the Civil Drawings, with six foot galvanized chain link fencing to surround an object with a complete visual barricade and it is practical to install fence posts. The surround shall be constructed in such a manner as to provide a buffer zone around and access to the item being protected. All posts shall be driven installed. Surface mounted posts to only be used for temporary barricades.
   6. Type X, Other fencing or barricade types that may be designated and detailed within the construction documents shall use additional alpha numeric designations.

2.2. EROSION CONTROL PROTECTION

A. Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION 210.2 for authorized materials associated with erosion control materials.

2.3. INTERIOR FINISH PROTECTION MATERIALS

A. Except where noted in other areas of the construction documents or this specification the responsible contractor:
   1. Shall not provide the cheapest or least effective method as an effort to meet any protection requirement.
   2. Shall provide materials of sufficient quality, and durability to provide adequate protection based on the seasonal conditions and the anticipated duration at the time the protection will be needed.
   3. Shall provide sufficient quantity of protection material to protect the construction as needed.

B. Prior to installing protective measures the responsible contractor shall propose to the GC, Project Architect (PA)/Project Engineer (PE) and City Project Manager (CPM) the proposed plan for protection, materials to be used and samples as necessary.
   1. The PA/PE and CPM reserve the right to disapprove any proposed method and/or material and/or make alternate proposals.

PART 3 - EXECUTION

3.1. GENERAL EXECUTION REQUIREMENTS

A. The GC shall be responsible for ensuring all of the following procedures and requirements are implemented as needed for the duration of the Work performed under this contract.

B. The GC shall also be responsible for the following:
   1. Reporting any incident of damage to existing property, right-of-way, or utility to the CPM immediately upon rendering the incident safe, and notifying emergency response teams, and emergency utility crews as needed.
   2. Conduct a site walk through prior to leaving at the end of each day to assess:
      a. Protection measures are properly in place, provide correction actions as necessary.
      b. Note damage to existing completed work and schedule repair/replacement as needed.
   3. Ensure all contractors and workers are being diligent in protecting existing work, and newly installed construction.

3.2. PROTECT ADJACENT PROPERTIES

A. Whenever possible through the design process the City of Madison shall have previously provided notice to adjacent property owners that work will be occurring on or near their property. The City of Madison shall also have obtained any permanent or temporary easements that may be necessary to complete any Work on adjacent properties.

B. It shall be the responsibility of the GC to do the following for all Work under this contract being performed on or adjacent to the property line:
   1. Contact the adjacent property owner and provide them with information on the work to be done, equipment to be used, and estimated duration of the work. Information to be updated and communicated to property owner(s) as construction progresses and site conditions change.
      a. If any adjacent property is a rented or leased space the GC shall also make contact and provide the same information to the tenants.
      b. Determine from the owner and/or tenants if there are any concerns for children, pets, special plantings, or other concerns.
   2. Discuss the following with all contractors performing work on or near the property line.
      a. Work to be completed and timeline.
      b. Concerns of adjacent property owners/tenants from item 1 above.
      c. Which protective measures will be necessary to protect adjacent properties and address the concerns of adjacent property owners/tenants.
   3. Ensure all protective measures are placed and maintained during the execution of Work on or adjacent to the property line. Interact with the adjacent property owners/tenants as needed.

C. Any contractor doing work on or adjacent to the property line shall install and maintain any protective measure identified in the contract documents, this specification, or as directed by the GC.

D. The GC shall be responsible for restoring any damage to structure and property located on or adjacent to the property line.
   1. Restoration shall include but not be limited to repair or replacement using like materials and finishes to its original condition or better.
   2. Restoration of landscaping materials shall include watering of any seed, sod, or other planting of any kind for a reasonable period of time to encourage germination and root development.

E. The GC shall keep the CPM informed directly to any issues pertaining to adjacent property owners and tenants.

3.3. PROTECT LANDSCAPING FEATURES

A. Except where specifically stated in other areas of the construction documents the following minimal protection requirements shall apply under this section.

1. Whenever possible do not install new landscape features until exterior building construction has been completed, equipment such as scaffolding and lifts are no longer needed and have been removed, and heavy equipment operation is no longer required.
2. Whenever possible remove and temporarily store all existing landscape features such as benches, waste receptacles, signage, and other such features that will be within the area of Work that can be removed.
3. Landscape features that cannot be removed such as flag poles, light poles, light bollards, etc. shall be protected with Type D fencing for areas on pavement or Type E fencing for areas on soil.
4. Planting beds shall be protected using Type E fencing around the exposed perimeter of the planting bed as needed.
5. The City of Madison FACILITIES MANAGEMENT SPECIFICATION 107.13 shall apply to all tree protection in and around the project site at all times.

3.4. PROTECT UTILITIES

A. The contractor shall be responsible for notifying all utilities to determine emergency response procedures and protection requirements prior to installing any construction protection.

1. This includes requesting utility marking through Diggers Hotline.
   a. Call 811 or 1-800-242-8511 to request a public utility locate
   b. For emergency locate call (262) 432-7910 or (877) 500-9592
2. Contact the Owner and CPM for any available private utility information on the property that may be available prior to calling a private utility locating company.

B. Except where specifically stated in other areas of the construction documents the following minimal protection requirements shall apply under this section.

1. Hydrants, lamp posts, electrical transformers, and other utility pedestals shall be protected with Type D fencing for areas on pavement or Type E fencing for areas on soil. Fence posts shall be located so as to not be directly over the utility main.
2. Storm sewer structures in pavement shall have proper inlet protection according to City of Madison FACILITIES MANAGEMENT SPECIFICATION 210.1(g) and Type C Construction Barrels when necessary.
3. Storm sewer structures in turf and other landscaped areas shall have proper inlet protection according to City of Madison FACILITIES MANAGEMENT SPECIFICATION 210.1(g) and Type E fencing for areas on soil.
4. Stormwater management features such as greenways, retention/detention ponds, bio-filtration ponds and other such features shall be properly protected according to the appropriate erosion control measure specified on the Erosion Control Plan. See multiple sections of City of Madison FACILITIES MANAGEMENT SPECIFICATION 210.1
   a. For the protection of hard to see items such as structures, castings, inlets, etc. in grassy areas provide Type E fencing for areas on soil.
   c. For the protection of storm water management features having special soils and plants such as bio-filtration ponds provide Type E fencing for areas on soil.
5. Other structures and covers including but not limited to cleanouts, wiring hand holes, valve boxes, access structures, grease trap structures, etc shall be protected as follows:
   a. Provide Type E fencing for areas on soil.
   b. When paving operations are complete provide a construction barrel or cone near structures as necessary depending on required heavy construction traffic.

3.5. PROTECT PUBLIC RIGHT OF WAY

A. Except where specifically stated in other areas of the construction documents the following minimal protection requirements shall apply under this section.

1. All public right-of-way (area from behind the sidewalk to the centerline of the street) shall remain open and accessible except during periods of active work. At such times the public right of way shall be properly closed and signed as referenced in City of Madison FACILITIES MANAGEMENT SPECIFICATION 107.9.
2. Bus stops and bus stop structures shall remain accessible at all times.
3. Traffic signage and traffic signals, traffic control boxes shall be protected with Type D fencing for areas on pavement or Type E fencing for areas on soil.

a. Protection at traffic signage/signals shall not obstruct the viewing of the sign/signal for its intended purpose at any time.

B. When additional protection for traffic control is required, the use of barricades, guardrails, lane closures and other such procedures will be detailed within the construction documents.

C. When additional protection for overhead sidewalk cover is required the contract documents shall indicate the specific location and structural requirements of the protective structure.

3.6. PROTECT STORED MATERIALS

A. All contractors shall refer to Specification 01 60 00 Product Requirements for all storage and protection requirements of building materials and products delivered to the site.

3.7. PROTECT WORK - EXTERIOR

A. Provide all temporary services that may be required to protect the installed material from heat, cold, humidity, etc, while materials such as concrete, mortar, sealants, paints, etc, are drying and/or curing.

B. Open trenches, pits, and other such excavations shall be properly covered, lined, or shored as needed during periods of inclement weather to prevent the caving of soils onto existing work in progress. Refer to the appropriate specifications and/or regulatory requirements governing this type of work as necessary.

C. Provide adequate protection at all openings with heavy duty tarps, plastic sheathing, or wood framing and sheathing as needed to protect interior work in progress from inclement weather as needed.

D. Protect exterior finishes of all kinds with heavy duty tarps or plastic sheathing as needed while landscaping is being installed through full germination of seeded areas or installation of filter fabric and mulches to keep dust, dirt, and mud off of finished exterior surfaces.

E. Designate specific curb mounting points and provide wood blocking where small vehicles, skid loaders and other such equipment may need access to areas being landscaped.

F. Provide plywood turning pads for skid loaders to turn on to prevent tire marking on new pavement.

G. Do not permit the parking of vehicles with any kind of fluid leaks to park on new pavement.

H. The contractor shall be responsible for cleaning, repairing, or replacing any completed work or work in progress under this specification as deemed necessary by the CPM without additional cost to the contract.

3.8. PROTECT WORK - INTERIOR

A. The GC shall do all of the following:

1. Provide all temporary services that may be required to protect the installed material from heat, cold, humidity, etc, while materials such as concrete, mortar, sealants, paints, etc, are drying and/or curing.
2. Provide adequate visual and/or physical protection as needed to protect newly completed interior work such as paint, flooring material, sealants, grouts, etc that may be drying and/or curing.
3. Provide adequate space and materials for cleaning boots, tool boxes, supplies, and other items coming into the project site once finish work has begun.
4. Clean dirtied areas and repair/replace damaged areas immediately.

B. The contractors responsible for interior work shall be responsible for protecting their work and finishes from dirt, mud, snow, spills, splatters, and physical damage after installation as follows:

1. Protect vinyl composite, rubber composite, painted/stained concrete, and tiled flooring as follows:
   a. Define foot traffic areas and protect with Ramboard Temporary Floor Protection products as a minimum basis of design or other protection product(s) compatible with installed flooring product if Ramboard is not compatible. Products to be used shall be new.
      i. Tape all edges, seams, etc with a good quality tape that does not leave sticky residue. Do not allow any debris or other material between the installed flooring and the protection material.
      ii. Repair tears immediately, replace worn areas with like material as necessary.
2. Protect carpeted areas as follows:
   a. Define foot traffic areas and protect with a minimum of 6mil, clear, polyethylene sheeting 3 feet wide. Products to be used shall be new.
      i. Tape all edges, seams, etc with a good quality tape that does not leave sticky residue. Do not allow any debris or other material between the installed flooring and the protection material.
      ii. Repair tears immediately, replace worn areas with like materials as necessary.
3. Protect all finished walls in high traffic areas with Ramboard Temporary Wall protection products or approved equal.

i. Tape all edges, seams, etc with a good quality tape that does not leave sticky residue. Do not allow any debris or other material between the installed flooring and the protection material.
ii. Repair tears immediately, replace worn areas with like materials as necessary.

3. Protect counter tops, cabinets, and other finished surfaces with large sheets of thick cardboard or Ramboard products. Do not allow toolboxes, finish materials, parts and other such items to be placed on finished materials.

C. All protection shall stay in place until the CPM, PA/PE, and GC mutually deem the project is ready for Final Cleaning. The contractors responsible for protecting the work shall be responsible for removing the protection and removing any adhesive residue at that time. Contractors shall only use manufacturer authorized cleaning materials for removing adhesives, etc.

D. Contractors doing work in un-protected areas of finished work shall be required to provide drop cloths and other protection as noted within this specification for the duration of their work.

1. Finished areas shall be sufficiently covered to accommodate all equipment, and materials being used to complete the work being done.
2. Finished areas shall be sufficiently covered to prevent splatters, over spray, etc when doing touch-up work.
3. Contractors who do not provide sufficient protection under this sub-section shall be responsible for any costs associated with cleaning, repairing or replacing already finished construction at no additional cost to the contract.

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES

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PART 1 – GENERAL

1.1. SUMMARY

A. The purpose of this specification is to clearly define and quantify the requirements associated with closing a City of Madison Public Works Contract for facility related work.

B. All contracts have two distinct but related paths. Each path needs to be properly closed independently in order to close the contract as a whole.

1. Construction closeout is related to closing out all of the Work associated with the construction documents.
    a. It shall be the responsibility of all contractors to be fully aware of the required Work and closeout requirements involved in their individual trades.
2. Contract closeout is related to closing out all of the administrative aspects of the contract in general.
    a. It shall be the responsibility of all contractors to be fully aware of the administrative requirements required by the contract and to provide the supporting documentation required.
3. Construction Closeout must be completed before Contract Closeout can begin.

C. This specification will provide general knowledge associated with the following areas:

1. Construction Closeout Requirements
2. Construction Closeout Procedure
3. Contract Closeout Requirements
4. Contract Closeout Procedure
5. Final Payment and Certificate of Completion

1.2. RELATED SPECIFICATIONS

A. Contractors shall review all references to other specifications including specifications relating to the execution of the Work associated with their Division or Trade.

B. Section 01 29 76 Progress Payment Procedures
C. Section 01 31 23 Project Management Web Site (PMWS)
D. Section 01 32 26 Construction Progress Reporting
E. Section 01 45 16 Field Quality Control Procedures
F. Section 01 74 13 Progress Cleaning
G. Section 01 45 16 Construction Waste Management and Disposal
H. Section 01 76 00 Protecting Installed Construction
I. Section 01 78 13 Completion and Correction List
J Section 01 78 23 Operation and Maintenance Data
K. Section 01 78 36 Warranties
L. Section 01 78 39 As-Built Drawings
M. Section 01 78 43 Spare Parts and Extra Materials
N. Section 01 79 00 Demonstration and Training
O Section 01 91 00 Commissioning
P. Other requirements as noted in the contract documents signed by the General Contractor

1.3. DEFINITIONS

A. ***Substantial Compliance***: A letter provided to the City of Madison Building Inspection and signed by the Project Architect indicating that all Work has been completed to a level that would allow Owner Occupancy and that all construction is in compliance with the construction documents. A copy of this letter is also provided to the State of Wisconsin Department of Health and Safety as necessary to clear plan review requirements. This letter does not represent construction closeout.

B. ***Certificate of Occupancy***: The Regulatory letter from the City of Madison Building Inspection Department indicating that all regulatory requirements and inspections have been completed and the building may now be occupied for its intended use. This letter does not represent construction closeout.

C. ***Certificate of Substantial Completion***: A letter provided by the Department of Public Works, signed by the City Engineer indicating that Construction activities are substantially complete. This letter does represent construction closeout and the date of this letter begins the date of the Warranty Period.

D. ***Construction Closeout***: The point in the contract where all contractual requirements associated the execution of the Work as described in the plans, specifications, and other documents have been successfully met and the items described in 1.3.A, .B, and .C above have been completed.

E. ***Final Progress Payment***: The progress payment associated with achieving Construction closeout as described in 1.3.D above. At this point the contractor may request all monies associated with the contract be paid with the exception of held retainage.

F. ***Contract Closeout***: The point in the contract where all contractual requirements associated with the City of Madison, Board of Public Works contract has been successfully met.

G. ***Final Payment***: The final contract payment submittal that may be approved by the City of Madison after all contractual requirements of the Public Works Contract have been met and any remaining monies (retainage) due to the contractor may be released for the Final Payment.

1.4. QUALITY ASSURANCE – CONSTRUCTION CLOSEOUT

A. All contractors shall be responsible for properly executing the construction closeout requirements associated with their Work as described in the specifications governing their Work.

B. The GC shall be responsible for all of the following:

1. Ensuring that all contractors have met the construction closeout requirements associated with their Work.
2. Coordinate the collection of all construction closeout deliverables from all contractors, provide the deliverables to the Project Architect and City Project Manager for review as necessary, and ensure all contractors correct deficiencies of deliverables and resubmit as needed for final acceptance.
3. Ensure all closeout requirements identified in the Construction Closeout Checklist below have been completed as intended by the construction documents.

1.5. QUALITY ASSURANCE – CONTRACT CLOSEOUT

A. The City of Madison, Department of Civil Rights (DCR) monitors contract compliance for construction and procurement contracts to ensure that local, state and federal regulations are followed by contractors working on City of Madison Public Works (PW) projects. DCR will monitor all PW projects from contract award through the final payment at the close of the project. Contractors will be required to submit reporting paperwork throughout the PW project process.

1. Contractors are encouraged to visit the web site identified below for additional information, checklists, forms, and other information provided by DCR as it relates to Contract Compliance.
   http://www.cityofmadison.com/Business/PW/contractCompliance.cfm
2. Questions regarding the process should be directed to parties and offices as identified on the various forms, documents, and instructions or contact:
   City of Madison, Department of Civil Rights
   210 Martin Luther King Jr. Blvd., Room 523
   Madison, WI 53703
   (608) 266-4910

B. All Sub-Contractors have submitted the applicable required documents described in item 1.5.D below to the General Contractor (GC) for Contract Closeout.

C. The GC has submitted the required applicable documents described in item 1.5.D below for all contractors to the appropriate City of Madison Agency per instructions associated with each submittal.

D. The documents required for submittal to the City of Madison for Contract Closeout may include any/all of the items listed below depending on contract type. It is the sole responsibility of all contractors to know and submit the required and complete documentation in a timely fashion.

1. Weekly Payroll Reports
2. Employee Utilization Reports
3. Documentation required for Small Business Enterprise (SBE) goals
4. Other documents as maybe required or requested through the Finalization Review Process

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. CONSTRUCTION CLOSEOUT CHECKLIST

A. All contractors shall be responsible for reviewing the drawings and specifications within their Divisions of Work to provide a complete and comprehensive list of all Construction Closeout Requirements to the GC.
   1. The checklist shall include all items identified within the construction documents that require any of the following (and examples) prior to moving into Contract Closeout Procedures:
      a. Documents indicating a specified level of performance has been achieved, such as:
         i. Test reports of all types
         ii. Startup reports
      b. Required documentation, such as:
         i. As-builts and record drawings
         ii. Operation and maintenance data
      c. Physical items to be turned over to the owner, such as:
         i. Attic stock
         ii. Keys
      d. Required maintenance completed, such as:
         i. Ducts cleaned
         ii. Filters replaced
      e. Commissioning and LEED related items and submittals
      f. Owner and Maintenance Training

B. Each list shall indicate the title of the closeout requirement, the associated specification of the requirement, the required result or deliverable, the responsible contractor(s), and a column to verify the item has been turned in and completed.

C. The GC shall be responsible for all of the following:
   1. Consolidating all the closeout lists into one master Construction Closeout Checklist.
      a. The checklist shall be in a tabular data format similar to the sample below
   2. Upload the completed checklist to the Project Management Web Site for review.
   3. Resubmit the checklist as needed after initial reviews have been completed.

D. The GC shall work with all contractors to amend the Construction Closeout Checklist throughout the execution of the project based on changes and modifications as necessary.

Title	Specification	Description	Responsibility	Completed
Quality Management Observation Reports	01 45 16	All QMO reports have been properly responded to, reviewed and closed by the CPM.	All, GC	
As-Built Drawings	01 78 39	As-Built drawings have been reviewed and accepted per the specification	All, GC	
Testing and Balancing of HVAC	23 09 23	Provide final TnB reports indicating design performance has been achieved	HVAC	

3.2. CONSTRUCTION CLOSEOUT REQUIREMENTS

A. The timely submittal or completion of closeout requirements shall go hand in hand with the Progress Payment Milestone Schedule that can be found in Specification 01 29 76 Progress Payments. No payments shall be made until all requirements for that payment have been met.
   1. The GC and all major Subcontractors, Project Architect /Project EngineerA/E PROJ MGR, and CPM, shall review all requirements for Construction/Contract Closeout during two (2) special meetings.
      a. The first meeting shall be held at the 50% Contract Total Payment milestone. This meeting shall discuss the requirements associated with various construction/contract closeout documentation and events when they are due with respect to progress payments.

b. The second meeting shall be held at the 70% Contract Total Payment milestone. This meeting shall review the contractors progress regarding the closeout checklist, begin making plans for upcoming deadlines such as scheduling training, where to put attic stock, and when they are due with respect to progress payments.

2. The GC, A/E PROJ MGR, and CPM, shall utilize the Construction Closeout checklist to ensure that all construction closeout requirements have been met.

3.3. CONSTRUCTION CLOSEOUT PROCEDURE

A. Upon successful completion and final acceptance of all Construction Closeout Requirements the GC may submit to the CPM and A/E PROJ MGR the request for Final Progress Payment (100% contract total, less retainage).

B. The A/E PROJ MGR will confirm with the design consultants, CPM, and other City of Madison staff that all requirements of the Work have been completed and will do the following:
   1. Approve the final progress payment application
   2. Provide the required signed payment documents to the CPM
   3. Provide the required Letter of Substantial Compliance to the following as required:
      a. State Safety and Building Division
      b. Local Building Inspection office
      c. GC
      d. CPM

C. The CPM shall draft the City Letter of Substantial Completion for signature by the City Engineer. This letter shall state any of the following that may still be tied to the contract and/or warranty:
   1. Indicate that the date of the letter shall also be the beginning of the Warranty period.
   2. Indicate any allowed due outs, reasons for them, and anticipated dates of finalization.
      a. QMO issues such as off season testing of equipment
      b. Off season training of equipment

D. The GC and all subcontractors shall finalize all warranty letters associated with their Work using the date noted on the City Letter of Substantial Completion, and provide the CPM with all warranties as described in Specification 01 78 36 Warranties. Upon receipt and final approval of the Warranties the CPM may initiate final processing of the Final Progress Payment (100% contract total, less retainage).

3.4. CONTRACT CLOSEOUT REQUIREMENTS

A. The GC and all sub-contractors shall follow all requirements associated with documenting contract compliance and provide documentation as required or requested by DCR or PW staff. All contractors are encouraged to stay current with submissions of the following documentation:
   1. Weekly Payroll Reports no later than the Progress Payment equal to 50% of the contract total.
   2. Employee Utilization Reports
   3. Agent or Subcontractor Affidavit of Compliance with Prevailing Wage Rate Determination
   4. Prime Contractor Affidavit of Compliance with Prevailing Wage Rate Determination
   5. Documentation required for Small Business Enterprise (SBE) goals
   6. Other documents as maybe required or requested through the Finalization Review Process

B. Near the Progress Payment equal to 80% of the contract total the GC shall request in writing a Finalization Review. At that time DCR or PW staff shall prepare a report of all contract documentation submitted to date. A list of missing items or outstanding issues will be emailed to the GC. <u>No additional follow-up will be generated by DCR or PW Staff</u>.

3.5. CONTRACT CLOSEOUT PROCEDURE

A. The Contract Closeout Procedure will not begin until the Construction Closeout Procedure has been completed.

B. When the GC feels they have successfully met all of the Contract Closeout Requirements associated with Section 3.3 above the GC may submit to the request for Final Payment to the CPM.

C. The CPM shall sign and submit the Final Payment request for processing.

D. DCR and PW staff shall do a complete review of all documentation associated with item 3.3.A above.

E. The GC shall be notified directly by DCR or PW Staff of any documentation that may still be missing, have incomplete information, or other outstanding issues. It shall be the responsibility of the GC to continue follow-up with DCR and PW staff until all documentation has been successfully submitted and accepted.

F. When all required documentation associated with Contract Closeout has been successfully submitted and accepted by DCR and PW Staff the City of Madison shall process the Final Payment of any remaining monies including retainage.

END OF SECTION

SECTION 01 78 13
COMPLETION AND CORRECTION LIST

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PART 1 – GENERAL

1.1. SUMMARY

A. The City of Madison has developed a multi-faceted Quality Management Program that begins with contract signing and runs through contract closeout to ensure the best quality materials, workmanship, and product are delivered for the contracted Work.

1. The Project Management Web Site is a Construction Management tool that provides contractors, consultants, and staff a single on-line location for the daily operations and progression of the Work.
2. The Quality Management Observation (QMO) is an ongoing observation of the construction process as it progresses. The City of Madison does not use a "Punch List" or "Corrections List" as it is typically known throughout the construction industry. The QMO process acts as an "in progress punch list". Work identified as not in compliance with the contract documents by the Owner, Owner Representatives, Owner Consultants, etc. shall be resolved immediately at the Contractor's expense. Unresolved issues will be subject to withholding of progress payment(s) until completed.
3. Very stringent expectations are tied to Construction Closeout and Contract Closeout procedures. Specific milestones throughout the project need to be met and the milestones are tied to the Progress Payment Schedule.

B. All contractors shall be required to review the specifications identified in Section 1.2 below, and other related specifications identified therein to become familiar with the terminology and expectations of this City of Madison Public Works contract.

1.2. RELATED SPECIFICATIONS

A.	Section 01 29 76	Progress Payment Procedures
B.	Section 01 31 23	Project Management Web Site (PMWS)
C.	Section 01 45 16	Field Quality Control Procedures
D.	Section 01 77 00	Closeout Procedures

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 – EXECUTION – THIS SECTION NOT USED

END OF SECTION

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SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

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PART 1 – GENERAL

1.1. SUMMARY

A. The purpose of this specification is to provide clear responsibilities and guide lines related to providing well documented and complete Operation and Maintenance (O&M) Data related to general facility use, equipment, systems, finishes, and materials to City of Madison Staff (Owner, Owner Representatives, Maintenance, and Custodial Personnel) as needed.

B. Operation and Maintenance Data shall apply to both of the following categories except where specific requirements are noted under their separate titles as follows:

1. Operation and Maintenance Data: Generally shall mean the owner manual that provides information on start-up, shut-down, operation, troubleshooting, maintenance, parts, and other such documentation as it pertains to all equipment and systems installed under the Work.
2. Use and Care instructions: Where applicable use and care instructions shall also be considered O&M for such things as flooring, tile, partitions, and other such finishes and trim related items, installed under the Work.

1.2. RELATED SPECIFICATIONS

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 31 23 Project Management Web Site
C. Section 01 77 00 Closeout Procedures
D. Section 01 78 13 Completion and Correction List
E. Section 01 78 19 Maintenance Contracts
F. Section 01 78 36 Warranties
G. Section 01 79 00 Demonstration and Training
H. Section 01 91 00 Commissioning
I. Other Divisions and Specifications that may address more specifically the requirements for O&M Data.

1.3. QUALITY ASSURANCE

A. All O&M Data shall meet the requirements identified in Section 1.4 below.

B. All contractors shall provide O&M Data for each piece of equipment, system, or finish installed during the installation of the Work. O&M Data shall be provided to the General Contractor (GC) for verification and submittal.

C. The GC shall be responsible for receiving all required O&M Data files from all contractors for verifying that all files submitted meet the requirements in Section 1.4 below.

1.4. O&M DATA REQUIREMENTS

A. O&M Data shall be provided in digital PDF format as follows:

1. PDF files shall be complete first generation consumer useable editions of PDF documents as provided by any of the following:
   a. Product manufacturer
   b. Supplier of product
   c. Product manufacturer internet site

2. Acceptable PDF files shall have the following functionality:
    a. Word searchable
    b. Key areas are bookmarked
    c. Table of Contents and/or Index linked to content is preferred whenever possible.
3. Scanned printed material, with word searchable capabilities, saved as a PDF, is not acceptable and will be rejected without further review.

B. O&M Data shall include but not be limited to the following manufacturers' published information as appropriate for the equipment, system, material, or finish:
1. Installation instructions
2. Parts lists, assembly diagrams, explosion diagrams
3. Wiring diagrams
4. Start-up, shut-down, troubleshooting and other related operation procedures
5. Lubrication, testing, parts replacement, and other such maintenance procedures
6. General use, care, and cleaning instructions
7. Special precautions and safety requirements
8. A list of certified equipment vendors, service companies, parts suppliers including company name, address, and phone number
9. A list of the recommended spare parts to have on hand at all times
10. A list by type of all recommended lubes, oils, packing material, and other maintenance supplies
11. Copies of final test reports, balance reports, and other related documentation
12. Warranty information for equipment and systems

1.5. O&M DATA SUBMITTALS

A. O&M Data shall be prepared as identified in this specification and shall be submitted for review as per the schedule identified in Specification Section 01 29 76, Progress Payment Procedures.

B. O&M Data Draft submittals will be reviewed for content, procedure, and compliance only. A general critique with recommendations for improvement will be made but re-submittals will not be required.

C. O&M Data Final submittals will be reviewed for content, procedure, and compliance. Re-submittals will be required until such time as each submittal is accepted.

NOTE: Acceptance of O&M Data Final submittals is required to be complete prior to scheduling and conducting owner related training and construction closeout.

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. O&M DATA PREPARATION - GENERAL

A. All contractors shall prepare O&M Data for draft and final submission as follows:
1. Obtain digital PDF files for each piece of equipment, system, material or finish as described in Sections 1.4.A.1 and 1.4.A.2 above.
2. Verify that all information as described in Section 1.4.B above is included with the PDF file. Obtain missing information as necessary for a complete submittal.

B. Rename each individual PDF file as follows.
1. Do not use special characters such as #, %, &, /, etc. These characters are reserved by the Project Management Web Site software the City of Madison uses; however the under-score (or under-bar) '_' is an allowed character.
2. Use the following format and examples for renaming your file:
    a. Format: ***Equipment name_What_WARNER PARK COMMUNITY RECREATION CENTER EXPANSION_Contract number_Year***
        i. *Equipment Name* represents the name of any equipment, system, material or finish as designated in the Contract Documents.
        ii. *What* represents what the file is about
        iii. *WARNER PARK COMMUNITY RECREATION CENTER EXPANSION* represents the title of the project or contract. A shortened version of the title may be identified by the City Project Manager to be used by all contractors.
        iv. *Contract number* is the specific identification number the Work was bid under and appears on the plan set title sheet and in each sheet title block

v. *Year* represents the year the contract will be closed out

b. Examples of file names

i. AHU 2_Operation Manual_Fire Admin_1234_2015

ii. CPT 2_Use and Care_MPD West_9876_2011

C. All contractors shall submit the completed digital PDF files to the GC in sufficient time for the GC to meet the O&M Data submission deadlines as described in Specification Section 01 29 76, Progress Payment Procedures.

D. O&M Data shall be submitted and reviewed as described in sections 3.2 and 3.3 below.

3.2. O&M DATA DRAFT SUBMITTAL

A. All contractors shall prepare and submit the following for an O&M Data Draft review submittal:

1. Prepare three (3) complete O&M Data file samples as described in section 3.1 above.
2. Review all specifications within their Division of Work and prepare a complete O&M Data checklist listing all equipment, systems, materials, or finishes. Checklist shall be in tabular form similar to the example below and shall indicate the title (and plan identifier when applicable) of the O&M Data, the associated specification, and a column to verify the item has been turned in and completed.

B. The GC shall be required to review all contractors' samples and checklists for compliance with this specification and shall return any to the originating contractor that are insufficient for re-submittal.

1. When acceptable to the GC, they shall upload each O&M Data draft submittal file to the O&M Draft library on the Project Management Web Site.

C. The Project Architect, City Project Manager, CxA, Consulting Staffs and Owner Representatives shall review the O&M Data draft submittals and checklist within fifteen 15 working days as follows:

1. Provide general critique comments by Division on O&M Data samples submitted. Critique is intended to provide all contractors with information on strengths and weaknesses of their submittals.
   a. Re-submittal of the O&M Data samples will not be required.
2. Review in detail the O&M Data Checklist for completeness. Provide comments as needed.
   a. Re-submittal of the O&M Checklist will be required until accepted.

Title	Specification	Completed
Overhead Door Operator	08 36 00	
Air Handling Unit (AHU-3)	23 00 00	
Water Heater (WH-1)	22 30 00	

3.3. O&M DATA FINAL SUBMITTAL

A. All contractors shall prepare and submit the following for an O&M Data Final review submittal:

1. Prepare complete O&M Data files as described in Section 3.1 above according to their approved checklist as described in Section 3.2 above.
2. Submit completed checklist and all final O&M Data files to the GC for final submittal review.

B. The GC shall be required to spot check all contractors' submittals for completeness against their checklists and for compliance with this specification and shall return any to the originating contractor that are insufficient for re-submittal.

1. When acceptable to the GC, they shall upload each O&M Data final submittal file to the O&M Final library on the Project Management Web Site.

C. The Project Architect, City Project Manager, CxA, Consulting Staffs and Owner Representatives shall review the O&M Data final submittals and checklist within fifteen (15) working days as follows:

1. Review the files submitted against the checklist and request any missing files through the GC.
2. Review in detail all of the O&M Data files for completeness.
   a. Submittals shall be accepted or rejected as individual PDF files.
   b. Contractors shall re-submit entire O&M submittal if any portion is rejected or incomplete.

3.4. CONSTRUCTION CLOSEOUT

A. All contractors shall review Specification 01 77 00, Closeout Procedures and Specification 01 79 00 Demonstration and Training.

1. Acceptance of all final O&M Data submittals is required prior to scheduling Demonstration and Training Sessions.
2. Completion of all Demonstration and Training Sessions is required to receive the Substantial Compliance for Occupancy Certificate, and to begin Construction Closeout procedures.

END OF SECTION

SECTION 01 78 36
WARRANTIES

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PART 1 – GENERAL

1.1. SUMMARY

A. The purpose of this specification is to provide clear responsibilities and guide lines related to providing all Warranties and Guarantees related to the Work, workmanship, materials, equipment, and other such items required by the Construction Documents.

B. Manufacturers' disclaimers and limitations on product warranties do not relieve any contractor of the warranty on the Work that includes the product.

C. Manufacturers' disclaimers and limitations on product warranties do not relieve suppliers, manufacturers and any contractor required to provide special warranties under the contract documents.

1.2. RELATED SPECIFICATIONS

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 31 23 Project Management Web Site
C. Section 01 77 00 Closeout Procedures
D. Section 01 78 23 Operation and Maintenance Data
E. Section 01 91 00 Commissioning
F. Other Divisions and Specifications that may address more specifically the requirements for Warranties related to the installation of all items and equipment installed under the execution of the Work.

1.3. DEFINITIONS

A. See specification 01 77 00 for the definitions of the following terms that may also be used in this specification:
1. Substantial Compliance
2. Certificate of Occupancy
3. Certificate of Substantial Completion
4. Construction Closeout
5. Contract Closeout

B. Emergency Repair: The Owner or Owner Representative reserves the right to make emergency repairs as required to keep equipment or materials in operation or to prevent damage to property and injury to persons without voiding the contractors warranty or bond or relieving the contractor of their responsibilities during the warranty period.

C. Installer: The company or contractor hired to install a finished product that was manufactured and supplied specifically for the Work within this contract. The Installer may or may not be the same company that supplied the product. See the definition for supplier.

D. Supplier: Any company that makes a specific finished product for the Work from information within the Contract Documents. Examples of suppliers would include custom cabinets, steel stairs and railings, etc. A supplier would not be a company that distributes items manufactured by others such as an electrical or plumbing supplier.

E. Warranty: A written guarantee from the manufacturer to the owner on the integrity of a product and its installation, and the manufacturers' responsibility to repair or replace the defective product or components within a specified time from the date of ownership. Warranty may also be used interchangeably with Guarantee. The following warranty types may be part of any specification within the Work associated with the Construction Documents:

1. Expressed Warranty: A warranty that provides specific repair or replacement for covered components of a product over a specified length of time.
2. Implied Warranty: A warranty that is not stated explicitly by a seller or manufacturer that the product is merchantable and fit for the intended purpose.
3. Standard Product Warranty: Preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner. Standard warranties may be for any amount of time but shall not be for anything less than one (1) year from the warranty date.
4. Special Warranty: A written warranty required by the Contract Documents either to extend the time limit provided under a standard warranty or to provide greater rights to the Owner.

F. Warranty Date: The effective date that begins all warranty periods required for products, installations, and work-manship associated with the execution of the Work for this contract. The Warranty Date shall be set by the CPM.

G. Related Damages and Losses: When correcting failed or damaged Warranted Work, remove and reinstall (or replace if necessary) the construction that has been damaged as a result of the failure or the construction that must be removed and replaced to obtain access for the correction of Warranted Work.

H. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected reinstate the warranty by a new written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation unless specifically noted otherwise in a specification.

I. Replacement Cost: All costs that may be associated with Work being replaced under warranty including but not limited to the following:
1. Related damages and losses
2. Labor, material and equipment
3. Permits and inspection fees
4. This shall be regardless of any benefit the Owner may have had from the Work through any portion of its anticipated useful service life.

J. Replacement Work: All materials, products, required labor, and equipment necessary to replace failed or damaged warranted to an acceptable condition that complies with the requirements of the original Construction Documents.

K. Owners Recourse: Expressed warranties made to the Owner are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law. Expressed warranty periods shall not be interpreted as limitations on the time in which the Owner can enforce such other duties, obligations, rights, and remedies.
1. Rejection of Warranties: The Owner reserves the right to reject any warranty and to limit the selection of products with warranties not in conflict with the requirements of the contract documents.
2. Where the Contract Documents require a Special Warranty or similar commitment on the Work or product, the Owner reserves the right to refuse acceptance of the Work until the Contractor presents evidence the entities required to countersign such required commitments have done so.

1.4. GENERAL CONTRACTORS RESPONSIBILITIES

A. The General Contractor (GC) shall be responsible to remedy, at their expense, any defect in the Work and any damage to City owned or controlled real or personal property when the damage is a result of:
1. The GC's failure to conform to Contract Document requirements.
   a. Any substitutions not properly approved and authorized may be considered defective.
2. Any defect in workmanship, materials, equipment, or design furnished by the GC or Sub-contractors.

B. All warranties as described in this specification and these Contract Documents shall take effect on the date established by the CPM, as noted in Section 1.3F above.
1. All warranties shall remain in effect for one (1) year thereafter unless specifically stated otherwise in the Contract Documents or where standard manufacturer warranties are greater.

C. The GC's warranty with respect to Work repaired or replaced, including restored or replaced Work due to damage, will run for one (1) year from the date of Owner Acceptance of said repair or replacement.
1. This shall be regardless of any benefit the Owner may have had from the Work through any portion of its anticipated useful service life.

D. Warranty Response
1. See Section 3.5 of this specification.

PART 2 – PRODUCTS - THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. WARRANTY CHECKLIST

A. All contractors shall be responsible for reviewing the drawings and specifications within their Divisions of Work to provide a complete and comprehensive list of all Warranty Requirements to the GC.

B. Each list shall indicate the title (and plan identifier when applicable) of the warranted item, the associated specification of the warranted item, the terms of the warranty (years), and a column to verify the item has been turned in and completed.

C. The GC shall be responsible for all of the following:

1. Consolidating all the warranty lists into one master Warranty Checklist.
    a. The checklist shall be in a tabular data format similar to the sample below.
2. Upload the completed checklist to the Submittal Library on the Project Management Web Site for review. See Specification 01 33 23 Submittals for more information on this procedure.
3. Resubmit the schedule as needed after initial reviews have been completed.

D. The GC shall work with all contractors to amend the Warranty Checklist throughout the execution of the project based on changes and modifications as necessary.

Title	Specification	Terms	Completed
Overhead Door Operator	08 36 00	MFR 2yr	
Exterior Bench and Trash Receptacles	12 93 00	MFR 3 year warranty on finish	
Kitchen Sink (SK-1)	22 42 00	MFR 5 year	
Disposal (D-1)	22 42 00	MFR 7 year parts and in-home service	
Toilet (WC-1)	22 42 00	MFR 1 year limited	

3.2. LETTERS OF WARRANTY

A. All letters of warranty shall be in a typed letter format and provide the following information:

1. The letter shall be on official company stationary including company name, address, and phone number.
2. Indicate WARNER PARK COMMUNITY RECREATION CENTER EXPANSION, contract number, and contract address the warranty is for on the reference line.
3. Provide a description of the warranty(ies) being provided.
    a. Include Division, Trade, or Specification information as necessary.
    b. Only combine warranties of related Divisional Work together. Create new letters for additional Divisions as necessary.
4. Indicate the effective Warranty Date. As noted in Section1.3.F above, the Warranty Date shall be the date the Certificate of Substantial Completion was signed by the City Engineer.
5. Contractor Letters of Warranty shall only be signed by a principal officer of the company.
6. After signing the letter provide the GC with a high quality color scanned image in PDF format and the original signed letter.

B. The GC shall be responsible for the Final Warranty submittal as identified in Section 3.4 below.

C. The GC shall obtain letters of warranty from all of the following:

1. The General Contractor shall provide warranty letters for all Work that was self performed under the contract documents, identify all trades or Divisions of Work.
2. All Sub-contractors shall provide warranty letters for Work performed under the contract documents; identify all trades or Divisions of Work.
3. Suppliers, as required by other specifications within the Construction Documents where the manufacture of a specific product unique to the Work of this contract was required.
    a. The terms and conditions of the Supplier Letter of Warranty shall be as defined by the specifications associated with the Work but shall not be less than the industry standard of repair, or replace defective materials and workmanship within one (1) year of the warranty date.
    b. When the supplier is also the installer a single written letter may be submitted identifying both the warranty for the manufacture of the product and the warranty for the installation of the product.
4. Installers as required by other specifications within the Construction Documents where the installation of a specific product unique to the Work of this contract was required.

1. The terms and conditions of the Installer Letter of Warranty shall be as defined by the specifications associated with the Work but shall not be less than the industry standard of repair, or replace defective materials and workmanship associated with the installation of the product within one (1) year of the warranty date.

5. Special Letters of Warranty shall be required from any contractor, supplier, installer or manufacturer who agrees to provide warranty services required by any Division Specification in excess of their Standard Product Warranty.

3.3. STANDARD PRODUCT WARRANTY

A. All contractors shall be responsible for collecting and providing copies of all standard product warranties for commercially available products purchased and installed under this contract.

B. Only one copy of the manufacturers' standard warranty needs to be submitted as representative for all quantities of the same model number used throughout the Work.

C. Provide the manufacturers certificate, letter, or other standard documentation for each Standard Product Warranty submitted as follows:

1. Whenever possible a PDF version of the document shall be used.
   a. If a PDF version is used all additional information shall be completed using simple PDF editing tools such as text boxes, highlight, etc.
   b. If a PDF version is not available and an original document is furnished the additional information shall be neatly hand written and highlighted on the document in such a fashion so that it does not obscure any part of the written warranty.
2. Provide the following additional information on each warranty document:
   a. Contract warranty date.
   b. Provide the manufacturer name and model number of the product if not specified within the warranty.
      i. Where the manufacturer name and model number is specified within the warranty it shall be highlighted for visibility.
   c. Provide the plan identifier (LAV-1, WC-2, etc) when applicable.

D. Each completed warranty shall be saved as a digital PDF. The file shall be named using the specification number and item description. I.E. 22 42 00 Toilet (WC-1).pdf
   a. Where an original certificate was furnished provide a high quality colored scan of the completed document with the additional information. Save the scanned image in PDF format and use the same naming convention as indicated above.

E. Provide all PDF files and any original documents to the GC for final consolidation to be provided to the Owner.

3.4. FINAL WARRANTY SUBMITTAL

A. The GC shall receive all required warranties (digital PDF and any original documents) from all contractors, suppliers, installers and manufacturers.

B. The GC shall inventory all received warranties with the Warranty Submittal List to ensure all required warranties have been received and all warranty periods are correct according to the specifications.

C. Provide with each Operation and Maintenance Manual a complete copy of any associated warranty.

D. Scan all warranties into a single organized electronic PDF file as follows:
1. Organize the PDF file into an orderly sequence based on the table of contents of the Specifications.
2. Provide a typed Table of Contents for the entire file at the front of the document.
3. Provide bookmarks and links to each individual PDF to enable quick navigation through the PDF document.

E. Upload the warranty submittal to the appropriate document library on the Project Management Web Site for review by the Project Architect (PA)/Project Engineer (PE) and CPM.

F. Correct any deficiencies or omissions and resubmit as necessary.

3.5. WARRANTY NOTIFICATION, RESPONSE, EXECUTION AND FOLLOW-UP

A. Warranty Notification:
1. The City of Madison, Project Management Web Site, uses an email notification system for all warranty related issues. The GC will be required to provide, and keep current during the warranty period, a minimum of two (2) email addresses and phone numbers of current employees to receive email notifications and provide response regarding Work associated with these construction documents.
   a. In the event a Warranty Issue is deemed by the City of Madison to be an emergency, the GC shall first receive a phone call with a follow-up email from the Project Management Web Site.

b. The Contract Closeout-Warranty Issue Library on the Project Management Web Site uses a form for each warranty issue that is logged into the system.
   i. The GC shall open each warranty issue form, review the issue description and any attached documentation or photos.
   ii. The GC shall also notify any other sub-contractor, supplier, or installer that may be required to review the warranty issue.

B. Warranty Response:
1. The GC shall upon notification by the City of Madison provide warranty response as follows:
   a. Critical Systems or equipment: Where damage to equipment and other building components, or injury to personnel is probable provide immediate emergency shut-down information and an on-site response team as soon as possible but in no case shall on-site response exceed 24 hours.
   b. For non-critical responses where damage or injury is unlikely provide on-site response no later than the next business day.
   c. Where Technical Assistance support is part of the written warranty provide all assistance necessary via phone, text, or internet systems as indicated by the warranty. If issues cannot be resolved provide on-site response no later than the next business day.
   d. If the request cannot be supported in sufficient time as outlined above the Owner (or Owner Representative) reserves the right to contact other contractors or service companies having similar capability to expedite the repair or replacement and shall invoice all associated costs to the Owner back to the GC.

C. Warranty Execution:
1. The GC shall provide all repairs or replacements as necessary to restore broken or damaged Work to the original level of acceptance as intended by the Contract Documents.
   a. Provide all materials, equipment, products, and labor necessary to complete the repair or replacement associated with the Warranty Issue.
   b. Provide all cleaning services as may be required before, during, and after the repair or replacement as per Specification 01 74 13 Progress Cleaning.
   c. Provide any protection necessary for existing construction as per Specification 01 76 00 Protecting Installed Construction
   d. Provide new letters of warranty when required.

D. Warranty Follow-up:
1. Logged Warranty Issues:
   a. The GC shall provide complete documented responses of all logged Warranty Issues. Responses shall provide a description of work completed, by who, inclusive dates, and photos of completed or repaired work.
      i. Provide call back response if work is not acceptable.
   b. The City Project Manager shall review the submitted response documentation and do a field inspection if necessary.
      i. If work is not acceptable, contact GC to review details and expectations of the repair as needed.
      ii. If work is acceptable close the Warranty Issue.
2. Quarterly Warranty Reviews:
   a. The GC shall be responsible for scheduling quarterly on-site review with all of the following:
      i. City Project Manager, and other City staff as needed
      ii. Owner and Owner Tenant Representative
      iii. Commissioning Agent (CxA)
      iv. Plumbing, Heating, Electrical Sub-contractors
      v. Other Sub-contractors that may be responsible for open Warranty issues
   b. Quarterly reviews shall be scheduled at 3 months, 6 months, and 11 months after the effective date of the warranty. The review meetings shall:
      i. Review the status of all open Warranty Issues, determine course of action and estimated date of completion.
      ii. In the appropriate quarter, provide shut-down, start-up, testing, and training of off-season equipment as required by the contract documents.
      iii. The 11th month review shall review all open Warranty Issues, final plan for resolution, and all Warranty Issues where a new letter of warranty may have been issued.

END OF SECTION

SECTION 01 78 39
AS-BUILT DRAWINGS

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PART 1 – GENERAL

1.1. SUMMARY

A. This specification is intended to provide clear guidelines and identify the responsibilities of all contractors as they pertain to City of Madison contract procedures regarding the accurate recording of the Work associated with the execution of this contract. This shall include but not be limited to work that will be hidden, concealed, or buried.

B. Each contractor shall be responsible for maintaining an accurate record of all installations, locations, and changes to the contract documents during the execution of this contract as it may relate to their specific division or trade.

C. The General Contractor (GC) shall be responsible for ensuring all contractors provide as-built record information to the Master As-Built Document Set as described in this specification.

1.2. RELATED SPECIFICAITONS

A. 00 31 21 Survey Information
B. 01 26 13 Request for Information
C. 01 31 23 Construction Bulletin
D. 01 32 33 Photographic Documentation
E. 01 26 63 Change Orders
F. 01 29 76 Progress Payment Procedures
G. 01 31 23 Project Management Web Site
H. 01 33 23 Submittals
I. 01 77 00 Closeout Procedures
J 01 91 00 Commissioning
K. Other Divisions and Specifications that may address more specifically the requirements for field recording the installation of all items associated with the execution of this contract by Division or Trade.

1.3. RELATED DOCUMENTS

A. Other related documents shall include but not be limited to the following:
1. Bidding documents including drawings, specifications, and addenda.
2. Required regulatory documents of conditional approval.
3. Field orders, verbal or written by inspectors having regulatory jurisdiction.
4. Shop drawings and installation drawings.

1.4. PERFORMANCE REQUIREMENTS

A. The GC shall be responsible for maintaining the “Master As-Built Document Set” in the job trailer at all times during the execution of this contract. This document set shall include all of the following:
1. Master As-Built Plan Set
2. Master As-Built Specification Set
3. Other Document Sets

B. The GC shall designate one person of the GC staff to be responsible for maintaining the Master As-Built Document Set at the job trailer. This shall include, posting updates, revisions, deletions and the monitoring of all contractors posting as-built information as described in this specification.

C. All contractors shall use this specification as a general guideline regarding the requirements for documenting their completed Work. Contractors shall explicitly follow additional specification requirements within their own Division of Trade as it may apply to this specification.

1.5. QUALITY ASSURANCE

A. The GC shall be responsible for all of the following:
   a. Spot checking all sub-contractors field documents to insure daily information is being recorded as work progresses.
   b. Discuss as-built recording to the plan set at weekly job meetings with all sub-contractors on site.
   c. Schedule time with sub-contractors in the job trailer for recording as-built information to the plan set.
   d. Insure that all sub-contractors are providing clear and accurate information to the plan set in a neat and organized manner.
   e. Insure sub-contractors who have completed work have finalized recording all as-built information to the plan set before releasing them from the project site.

B. The Project Architect, the City Project Manager, Commissioning Agent and other design team staff will perform random checks of the Master As-Built Document Set during the execution of this contract to ensure as-built information is being recorded in a timely fashion as the Work progresses. An updated and current Master As-Built Document Set is a stipulation for approval of the progress payment.

PART 2 – PRODUCTS

2.1. OFFICE SUPPLIES

A. The GC shall provide a sufficient supply of office products in the job trailer at all times for all contractors to use in recording as-built information into the plan set. This shall include but not be limited to the following:
   a. Red ink pens, medium point. Pens that bleed through paper, markers, and felt tips will not be accepted.
   b. The use of highlighters is acceptable. Assign colors to various trades for consistency in recording information.
   c. Straight edges of various lengths for drawing dimension, extension and other lines.
   d. Civil and Architectural scales
   e. Clear transparent, non-yellowing, single sided tape.
   f. Correction tape or correction fluid for correcting small errors.

PART 3 - EXECUTION

3.1. FIELD DOCUMENT AS-BUILTS

A. The GC and all Sub-contractors shall be responsible for keeping their own field set of as-built documents including plans, specifications and published changes.

B. Field sets shall be kept dry and in good condition at all times.

C. No Work shall be buried, covered, or hidden, by any additional Work, regardless of Contractor or Trade, until locations of all materials and equipment has been properly documented as described below.

D. All contractors shall be required to record the following as-built information:
   a. Notes on the daily installation of materials and equipment.
   b. Sketches, corrections, and markups indicating final location, positioning, and arrangement of materials and equipment such as pipes, conduits, valves, cleanouts, pull boxes and other such items. Note all final locations on plan sheets, indicate dimension off identifiable building features. Riser diagrams need only be corrected for significant changes in locations, routing or configuration.
      i. The use of photographs in lieu of hand drawn sketches is acceptable.
      ii. Photos shall be taken according to Specification 01 32 33 Photographic Documentation
      iii. Print photo and markup with dimensions or notes as necessary.
   c. Identify by the use of existing plan symbology and notes the size, type, quantity, and use as applicable of materials such as pipes, valves, conduits, etc.

d. Note whether horizontal runs are below slab or above ceiling, include dimensions above or below finished floor elevation.

E. All contractors shall be responsible for transferring the information from their field set of documents to the Master As-Built Plan Set kept in the GC job trailer. See Section 3.3.D. below for the proper procedure.

F. All contractors shall update the GC Master Plan Set as often as necessary, but not less than once per work week.

3.2. SITE SURVEY AS-BUILT

A. The Land Surveyor Sub-Contractor shall provide digital as-built information including but not be limited to the following:

a. For underground buried utility laterals and services of all types locate all of the following that may apply:

i. Connection points at all mains
ii. Storm discharge points to open air
iii. All corners and bends regardless of angle, large radius sweeps shall have multiple point locations sufficient to define the sweep.
iv. All vertical drops
v. All wells
vi. Private buried utilities such as buried electrical cables, irrigation systems, etc.
v. Other information that may need to be located in the future by the owner prior to digging

b. Record all surface features including but not limited to the following:

i. Building corners, pavement edges, and other permanent structural features.
ii. All surface covers for inlets, catch basins, cleanouts, access structures, curb stops and other such devices.
iii. Other permanent surface features such as hydrants, lamp posts, and other permanent site amenities.

c. The following data shall be recorded while locating items in sub-sections 3.2.a and 3.2.b above:

i. Flow lines at both ends of pipes
ii. Pipe sizes and material types
iii. Rim elevations for all covers
iv. Sump elevations and invert elevations of all structures
v. Spot elevations for all pads, driveways, walks, stoops, and floors

B. The Surveyor shall provide the final digital as-built on a media and in a format specified in Specification 00 31 21 Survey Information to the GC for turn in to the Project Architect and the Civil Engineer.

C. The Surveyor shall provide two printed as-built site plans to the GC for inclusion in the Master As-Built Plan Set as follows:

1. One sheet to show all features (but not contour information) with text neatly organized for each item identified.
2. One sheet showing contours, contour labels, and features from item 1 above, but with no additional text.

3.3. MASTER AS-BUILT DOCUMENT SET

A. The GC shall be responsible for maintaining the Master As-Built Document Set in the job trailer at all times.

1. The Master As-Built Plan Set (Plan Set) shall begin with one complete bid set of drawings and any additional sheets that were supplied by published addenda during the bidding process. The cover sheet shall be titled as the “Master As-Built Plan Set” in large bold red letters approximately 2” in height and shall not be used for any other purpose.

a. The Plan Set shall be kept dry, legible, and in good condition at all times.

b. The Plan Set shall be kept up to date with new revisions within two (2) working days of supplemental drawings being issued. Revisions shall be posted as follows:

i. Insert new, revised sheets into the plan set. Void old sheets but do not remove them from the plan set. Indicate date received and what document (RFI, CB, CO, etc) caused the change.
ii. Insert new, revised individual details into the plan set. Void old details, tape new details over the old details with a “tape hinge” to allow them to be viewed. Indicate date received and what document (RFI, CB, CO, etc) caused the change.
iii. Add new details in appropriate white space on relevant sheets. If no space is available use the back side of the previous sheet or insert a new sheet. Indicate date received and what document (RFI, CB, CO, etc) caused the change.

c. The Plan Set shall be available at anytime for easy reference during progress meetings and for emergency location information of new work already completed.

2. The Master As-Built Specification Set (Spec Set) shall begin with one complete bid set of specifications and any additional specifications that were supplied by published addenda during the bidding process. The Spec Set shall be provided in three "D" ring type binders of sufficient thickness to accommodate the specification set. Multiple binders are allowed as necessary. Label the front cover and binding edge with "Master As-Built Specifications" in bold red letters. Provide other information as necessary to distinguish the contents of multi-volume sets.
   a. The Spec Set shall be kept dry, legible, and in good condition at all times.
   b. The Spec Set shall be kept up to date with new revisions within two (2) working days of supplemental drawings being issued.
   c. The Spec Set shall be available at anytime for easy reference during progress meetings.
3. Other Document Sets may be kept at the GCs option in three "D" ring type binders of sufficient thickness to accommodate the documentation. Other documentation sets may include but not be limited to RFIs, CBs, COs, etc.

C. The Land Surveyor Sub-Contractor shall be required to use digital surveying for all exterior site surveying, and provide deliverable digital as-builts as specified in Specification 00 31 21 Survey Information. As soon as practical the surveyor shall provide the GC with a preliminary copy of installed buried utilities for inclusion with the plan set in the job trailer. The surveyor shall provide final digital as builts as per section 3.2 above.

D. All contractors shall be responsible for updating the Plan Set from their field sets at least once per work week. Updates shall include but not be limited to the following procedures:
   a. All updates shall be done only in red ink. Place a "cloud" around small areas of correction to call attention to the change.
   b. Whenever possible place general work notes, field sketches, supplemental details, photos, and other such information on the reverse side of the preceding sheet. Installation notes including dates shall be kept neatly organized in chronological order as necessary.
   c. Accurately locate items on the plan set as follows:
      i. For items that are located as dimensioned provide a check mark or circle indicating the dimension was verified.
      ii. For items that are within 5 feet of the location indicated on the plans leave as shown and:
         - Provide correct dimensions to existing dimension strings or,
         - Accurately locate with new dimension strings
      iii. For items that are more than 5 feet from the location indicated on the plans
         - Accurately draw the items in the new location as installed and,
         - Accurately locate with new dimension strings and,
         - Note that the existing location is void.
   d. Include dimensioned locations for items that will be buried, concealed, or hidden in the ground, under floors, in walls or above ceilings.
      i. Dimensions shall be pulled from identifiable building features, not from centers of columns or other buried features.
      ii. When necessary pull more dimensions as needed from opposing directions to properly locate single items.

3.4. AS-BUILT REVIEW AND ACCEPTANCE

A. The GC shall provide the Master As-Built Plan Set to the Project Architect (PA)/Project Engineer (PE), the City Project Manager (CPM), the Commissioning Agent (CxA) and other design team staff for content review prior to the Progress Payment Milestone indicated in Specification 01 29 76 Progress Payment Procedures. The submitted plan set shall include the digital survey information produced under Section 3.2 above.
   1. If the plan set is not approved:
      a. The PA/PE and CPM shall only be required to generalize deficiencies by trade there shall be no requirement or expectation to generate a "punch list" of required corrections.
      b. The GC and Sub-contractors as necessary shall be responsible for inspecting the installation and correcting the drawings as needed.
      c. The GC shall re-submit the plan set for review.
   2. If the plan set is approved the PA/PE shall take possession of the plan set to be used in providing the owner with digital CAD record drawings. Upon completion of transferring the information to CAD the PA/PE shall provide the Owner with CAD record drawings, record PDFs, and the Master As-Built Plan Set.

3.5. CHANGES AFTER ACCEPTANCE

A. No Contractor shall be responsible for making changes to the As-Built record documents after acceptance by the PA/PE and CPM except when necessitated by changes resulting from any Work made by the Contractor as part of their guarantee.

END OF SECTION

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SECTION 01 78 43
SPARE PARTS AND EXTRA MATERIALS

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PART 1 – GENERAL

1.1. SUMMARY

A. This specification is intended to provide clear guidelines and identify the responsibilities of all contractors as they pertain to City of Madison contract procedures regarding spare parts, special tools, special materials, and extra materials.

B. Each contractor shall be responsible for knowing the specific requirements of their Division Specifications as they may relate to the general information provided in this specification.

C. The General Contractor (GC) shall be responsible for ensuring all contractors provide spare parts and extra materials as described in this specification.

1.2. RELATED SPECIFICAITONS

A. 01 29 76 Progress Payment Procedures

B. 01 31 23 Project Management Web Site

C. 01 77 00 Closeout Procedures

D. Other Divisions and Specifications that may address more specifically how to proceed with spare parts, special tools, special materials, and extra materials.

1.3. DEFINITIONS

A. Spare Parts: Any component of a product or assembly that comes pre-packaged or was specially ordered for the explicit use of the product or assembly. This shall include but not be limited to fastening devices, mounting brackets, replacement parts, wheels, pulleys, wiring, alternate assembly pieces, etc.

B. Special Tools: Any tool of any kind that was pre-packaged or specially ordered, and is required to be used for the installation or maintenance of an installed product or assembly as part of this contract.

C. Special Materials: Any oil, lubricant, glue, touch-up paint, or other such material that comes pre-packaged or was specially ordered and is required to be used for the installation or maintenance of an installed product or assembly as part of this contract.

D. Extra Materials (Attic Stock): Any surplus materials in new and useable condition that was installed a part of this contract. Attic Stock shall include but not be limited to the following: ceiling tiles, paint, stain, floor coverings, ceramic tiles, light bulbs/lamps, filters, strainers, etc. Attic Stock shall include partially opened bulk items and additional unopened quantities as directed by other specifications.

1.4. PERFORMANCE REQUIREMENTS

A. All contractors shall be responsible for consolidating spare parts, special tools, special materials, and attic stock as it pertains to the specific Work within their Division or Trade.

B. All contractors shall use this specification as a general guideline regarding the requirements for turning spare parts, special tools, special materials, and attic stock over to the owner. Contractors shall explicitly follow specification requirements within their own Division of Trade.

1.5. QUALITY ASSURANCE

A. The General Contractor (GC) shall be responsible for all of the following:

1. Coordinate the location for and the delivery of all spare parts, special tools, special materials, and attic stock being provided by all contractors under this contract to one centralized location as designated by the Owner.
2. Verify that all items being delivered are:
   a. Clean, new, and in a usable condition.
   b. Properly sealed, protected, and labeled
   c. Properly documented

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. PACKAGING

A. Whenever possible all surplus items should remain in their original packaging such as parts envelopes.
B. Package small parts in re-sealable plastic bags (Ziploc) or envelopes with clasp fasteners. Do not use envelopes that seal with glue or tape envelopes closed. Do not leave packaging unsealed.
C. Package like parts together for products or assemblies. I.E. keep all spare parts for flushometers together.
D. Many small packages may be grouped together into a larger container by trade.
E. Do not use unrelated boxes or containers for packaging spare items. I.E. do not use a light fixture box for spare breakers, or flushometers parts.

3.2. LABELING

A. Whenever possible the original labeling indicating part numbers and other pertinent information shall remain on the original packaging.
B. If original labeling is not available the contractor shall label all parts and packages using tape or labels and permanent black markers. Tape or labels being used shall absorb the permanent marker without bleeding or allowing ink to be smeared or rubbed off.
C. Labels shall include the name of the product or equipment the item belongs to, part number and/or name, and any other information that would assist maintenance personnel in identifying the piece and related product.
D. Labels shall include plan or specification designations (WC-1, LAV-3, DF-2, CPT-1, etc) that identify the particular product or finish material it represents.
E. Labels for parts stored in clear re-sealable plastic bags may be placed inside the bag. Label shall face out and be able to be read from one side. Multiple bags shall be numbered individually for identification.
F. Label the outside of large containers with the trade name (Plumbing, Electrical, etc).

3.3. INVENTORY

A. All contractors shall provide the GC with complete inventories of all spare parts, special tools, special materials, and attic stock that they are providing at the end of the contract. The inventories shall be organized as follows:
   1. The cover sheet shall indicate the Contractors name, address, phone number, identify that the document is the “Spare Parts and Extra Materials Inventory”, and identify the Division or Trade the inventory is for.
   2. Provide an inventory in a tabular format of all items being provided under this and other specifications. The minimum information to be provided for each item on the inventory shall be as follows:
      a. Bag or container number, all items of one bag or container shall be grouped together on the inventory
      b. Item description
      c. Item size (if applicable)
      d. Total quantity provided
      e. Identify if item is a spare part, tool, special material, or attic stock
B. The GC shall consolidate inventories from all sub-contractors into one tabular data sheet organized by Division or Trade of Work.
   1. Upon completing the consolidated list the GC shall upload the completed inventory to the Contract Closeout-Attic Stock Library on the Project Management Web Site.
   2. The GC shall notify the Project Architect and City Project Manager that the scans have been uploaded.
   3. Consulting Staff and Owner Staff shall review the inventories prior to Final Review to verify that minimum required quantities have been met. Deficiencies shall be noted and returned back to the GC for corrective action.

3.4. STORAGE

A. Prior to the 80% Progress Payment milestone the GC shall coordinate with the City Project Manager and Maintenance Personnel where spare parts, special tools, special materials, and attic stock shall be stored.

B. The GC shall instruct all contractors as to the location and proper storage procedures.

C. The GC shall be responsible for ensuring the storage area is kept neat and orderly as follows:

1. Like items are stored together by material, product, or trade as necessary.
2. Liquids are stored in sealable containers and the lids have been properly installed to prevent drying out, spillage, etc.
3. All labels are clearly visible and provide the required information.

D. Large items shall be stored so as not to damage other items. Do not stack heavy items or items with distinct shapes/outlines on softer items that may get crushed or imprinted.

3.5. CLOSEOUT PROCEDURE

A. Prior to the 90% Progress Payment milestone the GC shall review all attic stock already stored by the contractors to ensure the following:

1. Materials are stored in the proper location(s).
2. All boxes, containers and items are properly labeled according to the submitted/approved inventory.
3. Quantities are correct according to the submitted/approved inventory.

B. The GC shall ensure that all deficiencies are corrected prior to conducting Demonstration and Training Sessions.

C. The GC shall review with Maintenance Staff all inventories and labeling during the scheduled Demonstration and Training Sessions.

D. Any discrepancies associated with Attic Stock shall be resolved and verified prior to the CPM releasing the 90% CT progress payment.

END OF SECTION

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SECTION 01 79 00
DEMONSTRATION AND TRAINING

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PART 1 – GENERAL

1.1. SUMMARY

A. The purpose of this specification is to provide clear responsibilities and guidelines related to providing Demonstration and Training (D&T) Sessions related to general facility use, equipment, systems, finishes, and materials to City of Madison Staff (Owner, Owner Representatives, Maintenance, and Custodial Personnel) as needed.

B. All D&T shall be coordinated through the General Contractor (GC), Project Architect (PA)/Project Engineer (PE) and City Project Manager (CPM), and will be based on or customized to the needs of City of Madison Staff being trained. New equipment and systems may have complete D&T sessions as described in this specification while equipment or systems staff is familiar with may have sessions more focused on maintenance only.

1.2. RELATED SPECIFICATIONS

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 78 13 Completion and Correction List
C. Section 01 78 19 Maintenance Contracts
D. Section 01 78 23 Operation and Maintenance Data
E. Section 01 78 36 Warranties
F. Section 01 78 39 As-Built Drawings
G. Section 01 78 43 Spare Parts and Extra Materials
H Section 01 91 00 Commissioning
I. Other Divisions and Specifications that may address more specifically the requirements for D&T sessions related to the installation of all items and equipment installed under the execution of the Work.

1.3. QUALITY ASSURANCE

A. All contractors shall have the responsibility of preparing for and conducting D&T sessions as determined by this and other Division or Trade related specifications, Owner Operation and Maintenance Manuals, and other such documentation related to the Work.

B. The GC shall have responsibility for:

1. Ensuring that all contractors required to conduct a D&T session have successfully completed all of the following:
    a. Turned in all required documentation for review and documentation has been approved/accepted prior to scheduling D&T sessions.
    b. Other required documentation as needed is available and ready for use during the D&T session.
    c. All systems have been started, tested, and running as per appropriate specification and/or manufacturers recommendations prior to scheduling D&T sessions.
    d. All contractors are sufficiently prepared for their D&T session
    e. Documents the D&T session including date, time, contractor and company name, attendees and other information regarding the session
2. Organizing the coordination and scheduling of all D&T sessions between all contractors and the appropriate representatives of the Owner. These representatives may include any of the following depending on the Work of the Contract:

a. Owner – end users
b. Facility Maintenance personnel
    i. Facility general operation procedures including custodial services
    ii. Electrical
    iii. Mechanical
    iv. Plumbing
    v. Site
c. Information Technology (IT) Department
d. Traffic Engineering – Radio Shop
e. Architects, Engineers and Facility Management staff as project completion overview

PART 2 – PRODUCTS – THIS SECTION NOT USED

PART 3 - EXECUTION

3.1. GENERAL REQUIREMENTS

A. The GC shall develop a specific D&T plan to be scheduled and conducted as described below but no sooner than the meeting discussed in 3.2.A.2 below.

C. The GC shall not schedule D&T sessions to preclude required personnel from attending multiple sessions.

3.2. COORDINATING AND SCHEDULING THE TRAINING

A. The GC, PA/PE, CxA and CPM, shall review all Training and Demonstration requirements during two (2) special meetings.
    1. The first meeting shall be held at the 50% Contract Total Payment. During this meeting the following shall be discussed:
        a. Preliminary schedule of training dates to be completed prior to beginning construction closeout.
        b. List of documentation and items that need to be completed and available before and during the training session.
        c. Who (Owner, Maintenance, etc) will be attending what training session(s).
    2. The second meeting shall be held at the 80% Contract Total Payment. This meeting shall review due outs that have not yet been completed for the 90% Contract Total Payment and the requirements necessary for Construction Closeout. All Demonstration and Training sessions shall be completed prior to receiving the 90% progress payment and beginning Construction Closeout Procedures (see Specification 01 77 00).
        a. This does not include any requirement associated with off season equipment preparation and/or demonstration and Training Sessions.

B. All of the Construction Work shall be operationally ready prior to conducting training as follows:
    1. All contractors shall have their As-Built Drawing Records available for reviewing locations of system components during training.
    2. All final and approved Operations and Maintenance Data shall be completed no less than two (2) full weeks prior to the scheduled training.
    3. All systems shall have been started, functionally tested, balanced, and fully operational, and all piping and equipment labeling complete at least two (2) days prior to the scheduled training.
        a. Seasonal equipment shall not be trained out of season. Contractors having seasonal equipment shall work with the GC and CPM for coordinating additional training sessions as appropriate for seasonal equipment.

C. Correction list items that prevent a piece of equipment or system from being fully operational for training shall be corrected prior to conducting the training.

3.3. TRAINING OBJECTIVES

A. For each piece of equipment or system installed train on the following objectives/topics as applicable:
    1. System design, concept, and capabilities
    2. Review of related contractor as-built drawings
    3. Facility walkthrough to identify key components of the system
    4. System operation and programming including weekly, monthly, annual test procedures
    5. System maintenance requirements
    6. System troubleshooting procedures
    7. Testing, inspection, and reporting requirements associated with any regulatory requirements
    8. Identification of any correction list items still outstanding

9. Review of system documentation including the following:
    a. Operation and maintenance data
    b. Warranties
    c. Valve charts, tags, and pipe identification markers

B. For each piece of specialty equipment train on the following objectives/topics as applicable:
1. Manufacturers operations instructions
2. Manufacturers use and care instructions
3. Manufacturers maintenance and troubleshooting instructions
4. System operation and programming including weekly, monthly, annual test procedures
5. Identification of any correction list items still outstanding
6. Review of system documentation including the following:
    a. Operation and maintenance data
    b. Warranties

C. End User Orientation
1. Facility walkthrough
2. Security and emergency features
3. General facility operation procedures

D. Facility General Use and Custodial Services – if requested
1. Facility walkthrough
2. Security and emergency features
3. General facility operation procedures
4. Care and maintenance of specialty items, finishes, etc as requested
5. Attic stock inventory and material designations

3.4. DEMONSTRATION AND TRAINING PROGRAM PREPARATION

A. Each contractor having a responsibility for providing D&T sessions shall meet with the GC, CPM, and other City Staff as needed to review the extent of the Training Objectives in section 3.3 above needed for each piece of equipment, system, finish, etc. This meeting shall occur no less than four (4) weeks prior to the anticipated training session.

B. The contractor shall use the information from item 3.4.A above to prepare a formal training program for each piece of equipment or system based on the Training Objectives in 3.3 above.
1. The formal training program shall include the following information:
    a. Session title
    b. List of systems, equipment, use, care, etc to be covered during the session
    c. Provide the following for each systems, equipment, use, care, etc to be covered during the session
        i. Name and affiliation of each instructor to be used. As needed and discretion of the Owner the GC to require attendance by the installing technician, installing Contractor and the appropriate trade or manufacturer's representative.
        ii. Qualifications of each instructor to be used. Practical building operation expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment as installed in this project is required by the training personnel. If Owner determines training was not adequate, the training shall be repeated until acceptable to Owner.
        iii. A checklist of all documentation and system/equipment requirements necessary to complete a successful training session and the current status of each
        iv. Any additional documents, training aids, video or other items to be used to complete the training
        v. Any special requirements or needs associated with item iv above to complete the training
    d. The intended audience for the training
    e. The approximate duration of each objective or topic to be covered
2. Submit the completed training program to the GC for review and approval by the PA/PE and CPM.

C. The PA/PE and CPM shall work with staff as necessary to ensure all points of anticipated training needs have been met. The PA/PE and CPM will approve the program as submitted or recommend changes for re-submittal as necessary.

3.5. CONDUCTING A DEMONSTRATION AND TRAINING SESSION

A. All contractors shall conduct their required D&T Sessions as follows:
1. Begin with a classroom session
    a. Provide a sign in sheet indicating all training to be conducted, instructors, etc.

b. Provide an overview of the training to be conducted including the approximate schedule.

2. Conduct a general walk-through of the site.
   a. Point out locations of various equipment, valves, charts, and other related items.
   b. Use the Division or Trade As-Built record drawings to indicate locations of hidden or buried items.
3. Provide a demonstration of general equipment/system operation including using the O&M manual.
   a. Startup and shutdown procedures.
   b. Normal operational levels as depicted by any gauges, software, etc.
   c. Indicate warning devices, signs etc. and demonstrate emergency shut-down procedures.
4. Provide a demonstration of all owner level maintenance using the O&M manual.
   a. Indicate frequency of maintenance.
   b. Provide and review all spare parts, special tools, and special materials.
5. Provide and review all spare parts, special tools, special materials, or attic stock as applicable.
6. While conducting D&T sessions:
   a. Allow hands on training whenever practical.
   b. Answer questions promptly
   c. Repeat demonstrations and procedures as necessary.

B. Within two (2) working days of completing the D&T session the contractor responsible for the session shall turn-in any documentation generated including the sign in roster to the GC.

C. The GC shall turn over all training documentation to the PA/PE and CPM upon completion of D&T sessions.

D. Re-schedule any training that has been determined to be inadequate or inappropriate for any reason including but not limited to any of the following;
   1. Unqualified instructor
   2. System installation incomplete or untested to the specifications
   3. Equipment failure during demonstration
   4. Un-expected cancellation

3.6. CLOSEOUT PROCEDURE

A. Prior to receiving the 90% Progress payment the GC shall:
   1. Verify with the PA/PE and CPM that each Demonstration and Training Session was conducted properly and according to the submitted plan.
   2. Any required “Off Season” equipment testing, balancing, and Demonstration and Training Sessions have been tentatively scheduled with the GC, necessary sub-contractors, instructors and Owner/Owner Representatives as necessary.

END OF SECTION

SECTION 01 81 13
SUSTAINABLE DESIGN REQUIREMENTS – LEED FOR NEW CONSTRUCTION V4.0

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PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to thisSection.

B. Comply with Wisconsin Commercial Building Codes/International Building Code (IBC).

C. Comply with Americans with Disabilities Architectural Guidelines, and ICC/ANSI A117.1-Latest Edition.

D. Comply with USGBC LEED prerequisites and credits shown in the attached checklist for Project to obtain certification based on USGBC's LEEDv4.0 BD&C: New Construction and MajorRenovations" Process.

E. Refer to attached LEED v4.0 for BD+C: New Construction and Major Renovations checklist, with LEED credits clearly marked yes or no.

1.2 SUMMARY

A. Project registration and review fees associated with GBCI and leedonline.com are paid by the City.

B. Section includes general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain certification based on USGBC's LEED BD&C: New Construction and Major Renovations" Version4.0.

1. Other LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
2. Additional LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.
3. A copy of the LEED Project checklist is attached at the end of this Section.
4. Specific requirements for LEED are included in greater detail in other Sections.

C. A significant portion of the credits required for certification are the responsibility of the A/E and Owner (design credits). These credits are not explicitly outlined in this specification section, however many aspects of the construction documents reflect intent to document and achieve the design credits. This section documents requirements of the contractor to meet the requirements for documenting the construction credits.

D. Related Sections: Divisions 01 through 32 Sections for LEED requirements specific to the work of each of these Sections. Requirements may or may not include reference to LEED.

1.3 DEFINITIONS

A. Albedo (a.k.a. solar reflectance): The ratio of the reflected electromagnetic energy to the incoming electromagnetic energy.

B. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.

C. Emissivity (a.k.a. infrared emittance): A parameter between 0 and 1 that indicates the ability of a material to shed infrared radiation.

D. Environmental Product Declarations: (EPD) is a transparent, objective report that communicates what a product is made of and how it impacts the environment across its entire life cycle.

E. Health Product Declaration (HPD) is a material ingredient reporting standard developed under the guidance of the HPD Collaborative.

F. Hydrofluorocarbons (HFCs): Refrigerants used in building equipment that do not deplete the stratospheric ozone layer.

G. LEED: Leadership in Energy and Environmental Design. Green Building Rating System representing the US Green Building Council's effort to provide a national standard for what constitutes a "green building". The standard requires quantitative and technical documentation to demonstrate compliance with goals described in the US Green Building Council's Green Building Rating System, Version 3.0.

H. LEED Project Administrator: LEED Certified Professional hired by the project owner to review LEED submittals.

I. Locally-Manufactured: Refers to the final assembly of components into the building product that is furnished and installed by the trades people. For example, if the hardware comes from Seoul, South Korea, the lumber from Vancouver, British Columbia, and the joist is assembled in Kent Washington, then the location of the final assembly is Kent, Washington.

J. Post-Consumer Recycled Content: The percentage of waste material by weight available from consumer use incorporated into a building material.

K. Pre-consumer (aka Post-Industrial Recycled) Content: The percentage of waste material by weight available from industrial use incorporated into a building material. Post-industrial recyclable materials are different from industrial scrap, a by-product of industrial processes that can easily be reused as a feedstock.

L. Potable Water: Water that is suitable for drinking and is supplied from wells or municipal water systems.

M. Recycling: The collection, reprocessing, marketing and use of materials that were recovered or diverted from the solid waste stream. Note that LEED uses the term "pre-consumer" rather than "post-industrial." Also note that when manufacturers and trade associations use the term "post- industrial" it often includes spills, scraps, and damaged and surplus materials that are fed back into the same manufacturing process and that these materials are not considered recycled content by the LEED rating systems.

N. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value. "Post-consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose. "Pre-consumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

O. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

P. Regionally Manufactured Materials: Materials that are manufactured within a radius of 500 miles from Project site. Manufacturing refers to the final assembly of components into the building product that is installed at Project site.

Q. Regionally Extracted and Manufactured Materials: Regionally manufactured materials made from raw materials that are extracted, harvested, or recovered within a radius of 500 miles from Project site.

R. Solar Reflectance: See "Albedo."

S. Sustainable Forestry: The practice of managing forest resources to meet the long-term product needs of humans while maintaining the biodiversity of forested landscapes. The primary goal is to restore, enhance, and sustain a full range of forest values, both economic and ecological.

T. Type A Finishes: Material and finishes with potential for short-term levels of off gassing from chemicals inherent in their manufacturing process, or which are applied in form requiring vehicles or carriers for spreading which release high level of particulate matter in process of installation and/or curing. Including, but not limited to:

1. Composite wood products, specifically including particleboard from which millwork, wood paneling, doors, or furniture may be fabricated.
2. Adhesives, sealants, and glazing compounds, specifically those with petrochemical vehicles or carriers.
3. Wood preservatives, finishes, and paint.
4. Control and/or expansion joint fillers.
5. Hard finishes requiring adhesive installation.
6. Gypsum board and associated finish processes.

U. Type B Finishes: Fuzzy material and finishes which are woven, fibrous, or porous in nature and tend to adsorb chemicals off-gassed by Type A finishes or may be adversely affected by particulates. These materials become "sink" for deleterious substances which may be released much later, or collectors of contaminants that may promote subsequent bacterial growth. Including, but not limited to:
1. Carpeting and padding.
2. Fabric wallcovering.
3. Insulation exposed to air stream.
4. Acoustic ceiling materials.
5. Fabric covered acoustic wall panels.
6. Upholstered furnishings.
7. Materials that can be categorized as both Type A and Type B.

V. Ventilation: The process of supplying and removing air to and from interior spaces by natural or mechanical means.

W. Volatile organic compounds (VOCs): Chemical compounds based on carbon and hydrogen structures that are vaporized at room temperatures. VOCs are one type of indoor air contaminant.

X. Waste Materials: Large and small pieces of materials indicated which are excess to contract requirements and generally include materials salvaged from existing construction and items of trimmings, cuttings, and damaged goods resulting from new installations which cannot be effectively used in Work.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Respond to questions and requests from Architect and the Green Building Certification Institute (GBCI; an agent of USGBC that handles the review process) regarding LEED credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until GBCI has made its determination on the project's LEED certification application. Document responses as informational submittals.

1.5 ACTION SUBMITTALS

A. General: Submit additional LEED submittals required by other Specification Sections.

B. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

C. LEED Submittals: Submit LEED related information under a separate Tab within each product submittal. The LEED submittal shall include:
1. Summary Sheet: A summary, on General Contractors letterhead, of all LEED information requested in specifications shall include:
   a. Project name.
   b. LEED Submittal List: A list of all materials being submitted. For products com- posed of multiple materials the submittal shall include a list of all materials composing the product.
   c. For Products in Divisions 2 - 10, include the following information:
      i. Material costs, for each material on the LEED submittal list, excluding labor costs, delivery cost, cost of installation, as well as profit and overhead.
      ii. The preconsumer and post-consumer recycled content of each material on the LEED submittal list.
      iii. List of all material manufacturing locations.
      iv. Provide distance between manufacturing and construction site.
   d. All other LEED information required in specification.
2. Manufacturer's literature with information highlighted that confirm the figures used in the summary report.
   a. If a range is used in the manufacturer's literature, the summary report shall use the lowest number in the range.

b. For VOC Submissions: Submit MSDS sheets or manufacturer's literature with VOC figure highlighted.

D. Project Material Costs Data: Provide a statement, on Contractor's letterhead, documenting the total material for the project. Include a spreadsheet tallying the material cost for all materials specified in Divisions 2 - 32. The total in the material cost data will be used in the LEED Online template to be completed by the Contractor as the actual material cost of the project.

E. LEED Action Plan: Provide preliminary submittal within 30 days of Notice to Proceed that contains:
1. Example spreadsheets for each construction credit identified in this section.
2. Contact information for Contractor's LEED coordinators.
3. Brief description of how the following requirements will be met.
a. SS Prerequisite: Construction Activities Pollution Prevention complying with Section 31 25 00, Erosion Control.
b. MR Prerequisite: Construction and Demolition Waste Management Reporting
c. MR Credit: Building Product Disclosure – Environmental Product Disclosures
d. MR Credit: Building Product Disclosure – Source Materials
e. MR Credit: Building Product Disclosure – Material Ingredients
f. MR Credit: Construction and Demo Waste Management complying with Section 01 74 19 Construction Waste Management and Disposal. Include a sample spreadsheet showing how the tipping information is going to be recorded to comply with LEED requirements.
g. IEQ Credit: Low-Emitting Materials
h. IEQ Credit: Construction IAQ Management Plan
4. After CPM approval of the Preliminary Action Plan the Contractor shall update the plan monthly with LEED information collected to date and be submitted as part of a monthly progress report.

F. LEED Progress Reports: Concurrent with each Application for Payment, submit reports comparing the actual construction and purchasing activities with LEED requirements for the following:
1. SS Prerequisite: Construction Activities Pollution Prevention
2. MR Prerequisite: Construction and Demolition Waste Management Reporting
3. MR Credit: Building Product Disclosure – Environmental Product Disclosures
4. MR Credit: Building Product Disclosure – Source Materials
5. MR Credit: Building Product Disclosure – Material Ingredients
6. MR Credit: Construction and Demo Waste Management
7. IEQ Credit: Low-Emitting Materials

G. LEED Documentation Online Submittals: The Contractor shall be responsible for completing the following LEED submissions using the LEED online tool for credit submission to USGBC. The LEED Project Administrator will determine if the information prepared by the Contractor is satisfactory for USGBC submission.
1. SS Prerequisite: Construction Activities Pollution Prevention
2. MR Prerequisite: Construction and Demolition Waste Management Reporting
3. MR Credit: Building Product Disclosure – Environmental Product Disclosures
4. MR Credit: Building Product Disclosure – Source Materials
5. MR Credit: Building Product Disclosure – Material Ingredients
6. MR Credit: Construction and Demo Waste Management
7. IEQ Credit: Low-Emitting Materials

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For LEED coordinator.

B. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:
1. Furniture.
2. Plumbing.
3. Mechanical.
4. Electrical.
5. Specialty items such as elevators and equipment.
6. Wood-based construction materials.

1.7 QUALITY ASSURANCE

A. LEED Coordinator: The Contractor is to engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

1.8 CONTRACTOR RESPONSIBILITIES

A. This project has been registered with USGBC via LEED Online. The Contractor shall provide all necessary documentation for LEED BD&C v4.0 certification in accordance with the specifications. Format and content of all construction documentation must be in accordance with the LEED Reference Guide requirements for supporting data required in event of USGBC audit of the particular credit. Contractor is required to coordinate all requirements for credits stated in this section to assure assembled data is acceptable to USGBC and respond to USGBC requests for additional construction data in the course of preparing the project for certification.

PART 2 – PRODUCTS

2.1 MATERIALS, GENERAL

A. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to LEED credits, the Contractor shall determine additional materials and procedures necessary to obtain LEED credits indicated.

B. Refer to LEED Guidebook for further information.

2.2 BUILDING PRODUCT DISCLOSURE AND OPTIMIZATION

A. MR Credit Product Disclosure and Optimization - Environmental Product Declarations (EPD)

1. At least 20 different products from at least five different manufacturers shall have Environmental Product Declarations that comply with LEED requirements. Industry-wide (generic) Environmental Product Declarations shall be valued as one-half of a product.

B. MR Credit Product Disclosure and Optimization – Sourcing of Raw Materials

1. At least 20 different products from at least five different manufacturers shall have publically released reports that comply with LEED requirements for raw material source and extraction reporting. Self-declared reports by manufacturers shall be valued as one-half of a product.

C. MR Credit Product Disclosure and Optimization – Material Ingredients

1. At least 20 different products from at least five different manufacturers shall comply with LEED requirements for material ingredient reporting.

2.3 LOW-EMITTING MATERIALS

A. Paints and Coatings

1. For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
    i. Flat Paints and Coatings: 50 g/L.
    ii. Non-flat Paints and Coatings: 50 g/L.
    iii. Dry-Fog Coatings: 150 g/L.
    iv. Primers, Sealers, and Undercoaters: 100 g/L.
    v. Rust-Preventive Coatings: 100 g/L.
    vi. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
    vii. Pretreatment Wash Primers: 420 g/L.
    viii. Clear Wood Finishes, Varnishes: 275 g/L.
    ix. Clear Wood Finishes, Lacquers: 275 g/L.
    x. Floor Coatings: 50 g/L.
    xi. Shellacs, Clear: 730 g/L.
    xii. Shellacs, Pigmented: 550 g/L.
    xiii. Stains: 100 g/L.
2. For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Adhesives and Sealants

1. For field applications that are inside the weatherproofing system, adhesives and sealants shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
    i. Wood Glues: 30 g/L.
    ii. Metal-to-Metal Adhesives: 30 g/L.
    iii. Adhesives for Porous Materials (Except Wood): 50 g/L.
    iv. Subfloor Adhesives: 50 g/L.
    v. Plastic Foam Adhesives: 50 g/L.

vi. Carpet Adhesives: 50 g/L.
vii. Carpet Pad Adhesives: 50 g/L.
viii. VCT and Asphalt Tile Adhesives: 50 g/L.
ix. Cove Base Adhesives: 50 g/L.
x. Gypsum Board and Panel Adhesives: 50 g/L.
xi. Rubber Floor Adhesives: 60 g/L.
xii. Ceramic Tile Adhesives: 65 g/L.
xiii. Multipurpose Construction Adhesives: 70 g/L.
xiv. Fiberglass Adhesives: 80 g/L.
xv. Contact Adhesives: 80 g/L.
xvi. Structural Glazing Adhesives: 100 g/L.
xvii. Wood Flooring Adhesives: 100 g/L.
xviii. Structural Wood Member Adhesives: 140 g/L.
xix. Single-Ply Roof Membrane Adhesives: 250 g/L.
xx. Special-Purpose Contact Adhesives (That Are Used to Bond Melamine-Covered Board, Metal, Unsupported Vinyl, Rubber, or Wood Veneer 1/16 Inch or Less in Thickness to Any Surface): 250 g/L.
xxi. Top and Trim Adhesives: 250 g/L.
xxii. Plastic Cement Welding Compounds: 250 g/L.
xxiii. ABS Welding Compounds: 325 g/L.
xxiv. CPVC Welding Compounds: 490 g/L.
xxv. PVC Welding Compounds: 510 g/L.
xxvi. Adhesive Primer for Plastic: 550 g/L.
xxvii. Sheet-Applied Rubber Lining Adhesives: 850 g/L.
xxviii. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.
xxix. Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.
xxx. Special-Purpose Aerosol Adhesives (All Types): 70 percent by weight.
xxxi. Other Adhesives: 250 g/L.
xxxii. Architectural Sealants: 250 g/L.
xxxiii. Non-membrane Roof Sealants: 300 g/L.
xxxiv. Single-Ply Roof Membrane Sealants: 450 g/L.
xxxv. Other Sealants: 420 g/L.
xxxvi. Sealant Primers for Nonporous Substrates: 250 g/L.
xxxvii. Sealant Primers for Porous Substrates: 775 g/L.
xxxviii. Modified Bituminous Sealant Primers: 500 g/L.
xxxix. Other Sealant Primers: 750 g/L.

2. For field applications that are inside the weatherproofing system, 90 percent of adhesives and sealants shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Flooring

1. Flooring shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Composite Wood

1. Composite wood, agrifiber products, and adhesives shall be made using ultra-low emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

G. Ceilings, Walls, and Thermal Insulation

1. Ceilings, walls, and thermal insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 – EXECUTION

3.1 NONSMOKING BUILDING

A. Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes.

3.2 CONSTRUCTION ACTIVITIES POLLUTION PREVENTION

A. SS Prerequisite - Construction Activities Pollution Prevention:
   1. Follow LEED instructions in LEED NCv4.0 Reference Guide and complying with Section 31 25 00, Erosion Control. Comply with EPA Construction General Permit (CGP) standard 2012.
   2. Contractor is responsible for completing the LEED online credit template and attaching the following information to the template:
      a. Provide record of compliance with Erosion and Sediment Control Plan:
         i. Monthly photographs of barriers and containment.
         ii. Monthly photographs of dust control measures
         iii. Records of inspections by agency in charge of overseeing compliance.
         iv. Include dust control measures
      b. Several early, a middle and several near end prevention plan checks and reports will be required as an upload to LEED Online – assume 6 checks and reports over the duration of the project.
   3. The LEED Project Administrator will determine if the information prepared by the Contractor is satisfactory for GBCI submission.

3.3 BUILDING PRODUCT DISCLOSURE AND OPTIMIZATION

A. MR Credits Building Product Disclosure Optimization – EPDs, Sourcing and Ingredients
   1. Environmental Product Declarations – comply with one or both of the following Options:
      a. Option 1: Environmental Product Declarations (1 point)
      b. Option 2: Multi-Attribute Optimization (1 point) including products that demonstrate impact reduction below industry average in global warming potential, ozone depletion, acidification of land and water, eutrophication, tropospheric ozone, or other USGBC approved program.
   2. Sourcing of Raw Materials – comply with one or both of the following Options:
      a. Option 1: Raw Material Source and Extraction Reporting (1 point)
      b. Option 2: Leadership Extraction Practices (1 point) including producer responsibility, bio-based materials, wood products, material reuse, recycle content or other approved USGBC program
   3. Material Ingredients - comply with one or two of the following Options:
      a. Option 1: Material Ingredient Reporting (1 point)
      b. Option 2: Material Ingredient Optimization (1 point) including GreenScreen v1.2 Benchmark, Cradle to Cradle Certification, REACH Optimization or other approved USGBC program.
      c. Option 3: Product Manufacturer Supply Chain Optimization (1 point) including products from manufacturers with validated and robust safety, health, hazard and risk programs that document 99% by weight of the ingredients used to make the product.
   4. Contractor to complete and submit the MR building product disclosure and optimization calculator, available with the project in LEED Online
   5. Contractor to submit supporting documentation including EPD and LCA reports, corporate sustainability reports, product declarations, labels, REACH, GreenScreen Benchmark, LT scores or other compliance summary documents. LEED project administrator and/or GBCI may require revisions and additions to this documentation and Contractor should plan accordingly.
   6. The LEED Project Administrator will determine if the information prepared by the Contractor is satisfactory for GBCI submission.

3.4 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT PLANNING

A. MR Prerequisite and Credit: Comply with Division 1 Section “Construction Waste Management and Disposal”.
   1. Contractor is required to create a Construction Waste Management Plan that includes:
      a. Establishing waste diversion goals for the project by identifying at least five material streams targeted for diversion. Approximate a percentage of the overall project waste that these materials represent.
      b. Specifying whether materials will be separated or commingled and describe the diversion strategies planned for the project. Describe where the material will be taken and how the recycling facility will process the material.
      c. A final report detailing all major waste streams generated, including disposal and diversion rates.
   2. Contractor is required to meet the following minimum goal:

a. Option 1 Path 2 – Divert 75% and four material streams, or
   i. A material stream can be a specific material category that is diverted in a specific way or a mixture of several material categories that are diverted in a specific way.
   ii. Best practice is that a material stream should constitute at least 5% (by weight or volume) of total diverted materials.
   iii. Examples of material streams include Plastic, Carpet, Paper/Cardboard, Wood, metal, Sheetrock, Brick, Concrete, Shingles, deconstructed materials, commingled waste, reuse of deconstructed materials onsite, source separation where each material is sent to a specific facility or suppliers take-back of materials.
b. Option 2 – Do not generate more than 2.5 pounds of construction waste per square foot of the buildings floor area (2 points).

3. Contractor is responsible for completing the LEED online credit template. Attached documentation in support of the credit shall include:
   a. Monthly photographs of waste recycling sorting area including:
      i. Debris control fencing.
      ii. Signage clearly identifying the containers content.
   b. Spreadsheet containing the following information:
      i. Diverted materials description.
      ii. Diverted materials/waste hauler name.
      iii. Date of each haul.
      iv. Quantity of material in each haul.
   c. Copies of recycling vender and waste hauler tipping receipts.
4. The LEED Project Administrator will determine if the information prepared by the Contractor is satisfactory for GBCI submission.

3.5 LOW EMITTING MATERIALS

A. IEQ Credit - Low Emitting Materials: Intent is to reduce concentrations of chemical contaminants that can damage air quality, human health, productivity and the environment.
1. Follow LEED instructions in LEED NCv4 Reference Guide.
2. Contractor is required to complete and upload the following documentation to LEED Online:
   a. USGBC low-emitting materials calculator (available at the project resources in LEED Online)
   b. Product information (e.g., MSDS, third party certifications, testing reports, etc) for relevant materials
3. Contractor is responsible for one of the following point options:
   a. Option 1: Product Category threshold compliance in 2 of the following categories (1 point)
      i. Interior paints and coatings applied onsite: 90% by volume for emissions, 100% VOC content
      ii. Interior adhesives and sealants applied onsite (including flooring adhesive): 90% by volume for emissions and 100% for VOC content
      iii. Flooring: 100% emissions
      iv. Composite Wood: 100% emissions (separate Composite Wood Evaluation)
      v. Ceilings, walls, thermal and acoustic insulation: 100% emissions
      vi. Furniture: 90% by cost (separate Furniture Evaluation)
   b. Option 2: If some products in a category do not meet the criteria, use the Budget Calculation Method meeting << >=50% and <70% (1 point) in any of the following categories:
      i. flooring,
      ii. ceilings,
      iii. walls,
      iv. thermal and acoustic insulation or
      v. furniture
4. Composite Wood Evaluation - Composite wood, agrifiber products, and adhesives shall be made using ultra-low emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde. Salvaged and reused architectural millwork more than one year old at the time of occupancy is considered compliant, provided it meets the requirements for any site-applied paints, coatings, adhesives, and sealants.
5. Furniture Evaluation - New furniture and furnishing items must be tested in accordance with ANSI/BIFMA Standard Method M7.1–2011. Comply with ANSI/BIFMA e3-2011 Furniture Sustainability Standard,

sections 7.6.1 and 7.6.2, using either the concentration modeling approach or the emissions factor approach. Model the test results using the open plan, private office, or seating scenario in ANSI/BIFMA M7.1, as appropriate. USGBC-approved equivalent testing methodologies and contaminant thresholds are also acceptable. Salvaged and reused furniture more than one year old at the time of use is considered compliant, provided it meets the requirements for any site-applied paints, coatings, adhesives, and sealants.

6. The LEED Project Administrator will determine if the information prepared by the Contractor is satisfactory for GBCI submission. Revisions and time to answer review questions should be assumed.

3.6 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT PLAN

A. IEQ Credit Construction IAQ Management Plan: Intent is to promote the well-being of construction workers and building occupants by minimizing indoor air quality problems associated with construction and renovation. Contractor to include at a minimum the following elements into the plan:
   1. Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."
   2. Prohibit the use of tobacco products inside the building and within 25 feet of the building entrances during construction.
   3. Protect absorptive materials stored on-site and installed from moisture damage.
   4. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 1 Section "Temporary Facilities and Controls", install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
   5. Replace all air filters immediately prior tooccupancy.

B. Provide record of compliance with Indoor Air Quality Management Plan:
   a. Monthly photographs of equipment and ductwork protection.
   b. Monthly photographs of filters used to protect air distribution and equipment.
   c. Contractor's report documenting that MERV 8 filters were used to protect equipment during construction and filters meeting final design requirements were installed prior to occupancy.

3.7 SUPPLEMENT

A. The supplement listed below, up to "End of Section," is a part of this Specification:
   1. LEED BD&C v4.0 Project Checklist.
      a. All credits listed for reference
      b. Only **Bold**, ***Italic*** credits or prerequisites listed with a "C" are in the Scope of the Contractor
      c. All identified construction Prerequisites are required to be achieved to complete the certification process and are the responsibility of the Contractor. Care needs to be taken to ensure all prerequisites are awarded to the project.
      d. All identified construction Credits are required to be achieved and are the responsibility of the Contractor. Given certain point totals and project specific circumstances as the project progresses, with proper notice to the CPM, certain credits or credit point thresholds can be eliminated from the project. Written notice and approval is required.
   2. Target CREL VOCs, Table 4-1 for Indoor Air Quality Testing

1

Warner Park Community Recreation Center Expansion
LEED v4.0 for BD+C: New Construction and Major Renovations
Project Checklist 05-16-2024

1	**0**	**0**	**0**		**Integrative Process**	**Possible Points:**	**1**
Y	?Y	?N	N	D/C			
1				D	Credit	Integrative Process	1
6	**0**	**0**	**10**		**Location and Transportation**	**Possible Points:**	**16**
Y	?Y	?N	N	D/C			
			0	D	Credit	LEED for Neighborhood Development Location	16 or
1				D	Credit	Sensitive Land Protection	1
			2	D	Credit	High Priority Site	1-2
2			**3**	D	Credit	Surrounding Density and Diverse Uses	1-5
1			**4**	D	Credit	Access to Quality Transit	1-5
1			**0**	D	Credit	Bicycle Facilities	1
1			**0**	D	Credit	Reduced Parking Footprint	1
			1	D	Credit	Green Vehicles	1
2	**0**	**0**	**8**		**Sustainable Sites**	**Possible Points:**	**10**
Y	?Y	?N	N	D/C			
Y	**-**	**-**	**-**	***C***	***Prereq***	***Construction Activity Pollution Prevention***	**-**
1				D	Credit	Site Assessment	1
			2	D	Credit	Site Development - Protect or Restore Habitat	1-2
1				D	Credit	Open Space	1
			3	D	Credit	Rainwater Management	2-3
			2	D	Credit	Heat Island Reduction	1-2
			1	D	Credit	Light Pollution Reduction	1
2	**0**	**0**	**9**		**Water Efficiency**	**Possible Points:**	**11**
Y	?Y	?N	N	D/C			
Y	-	-	-	D	Prereq	Water Use Reduction—20% Reduction	-
Y	-	-	-	D	Prereq	Water Efficient Landscaping	-
Y	-	-	-	D	Prereq	Innovative Wastewater Technologies	-
2				D	Credit	Outdoor Water Use Reduction	1-2
			6	D	Credit	Indoor Water Use Reduction	1-6
			2	D	Credit	Cooling Tower Water Use	1-2
			1	D	Credit	Water Metering	1

21	**0**	**0**	**12**		**Energy and Atmosphere**	Possible Points:	**33**
Y	?Y	?N	N	D/C			
Y	**-**	**-**	**-**	***C***	***Prereq***	***Fundamental Commissioning and Verification***	**-**
Y	-	-	-	D	Prereq	Minimum Energy Performance	-
Y	-	-	-	D	Prereq	Building Level Energy Metering	-
Y	-	-	-	D	Prereq	Fundamental Refrigerant Management	-
6				***C***	***Credit***	***Enhanced Commissioning***	***2-6***
9			**9**	D	Credit	Optimize Energy Performance	1-18
			1	D	Credit	Advanced Energy Metering	1
			2	D	Credit	Demand Response	2
3				D	Credit	Renewable Energy Production	1-3
1				D	Credit	Enhanced Refrigerant Management	1
2				D	Credit	Green Power and Carbon Offsets	1-2
5	**0**	**0**	**8**		**Materials and Resources**	Possible Points:	**13**
Y	?Y	?N	N	D/C			
Y	-	-	-	D	Prereq	Storage and Collection of Recyclables	-
Y	**-**	**-**	**-**	***C***	***Prereq***	***Construction and Demolition Waste Management Reporting***	**-**
			5	D	Credit	Building Life-Cycle Impact Reduction	2-5
1			**1**	***C***	***Credit***	***Building Product Disclosure - EPD***	***1-2 pts***
1			**1**	***C***	***Credit***	***Building Product Disclosure – Source Materials***	***1-2 pts***
1			**1**	***C***	***Credit***	***Building Product Disclosure – Material Ingredients***	***1-2 pts***
2				***C***	***Credit***	***Construction and Demo Waste Management***	***1-2 pts***
10	**0**	**0**	**6**		**Indoor Environmental Quality**	Possible Points:	**16**
Y	?Y	?N	N	D/C			
Y	-	-	-	D	Prereq	Minimum Indoor Air Quality Performance	-
Y	-	-	-	D	Prereq	Environmental Tobacco Smoke (ETS) Control	-
2				D	Credit	Enhanced Indoor Air Quality Strategies	1-2
3				**C**	**Credit**	**Low-Emitting Materials**	**1-3 pts**
1				**C**	**Credit**	**Construction IAQ Management Plan**	**1**
			2	**C**	**Credit**	**Indoor Air Quality Assessment**	**1-2 pts**
1				D	Credit	Thermal Comfort	1
1			**1**	D	Credit	Interior Lighting	1-2
1			**2**	D	Credit	Daylight	1-3
			1	D	Credit	Quality Views	1
1				D	Credit	Acoustic Performance	1

1	**0**	**0**	**4**		**Innovation and Design Process**		Possible Points:	**6**
Y	?Y	?N	N	D/C				
			0	D/C	Credit 1.1	Innovation in Design: X		1
1				D	Credit 2	LEED Accredited Professional		1
3	**0**	**0**	**0**		**Regional Priority Credits**		Possible Points:	**4**
Y	?Y	?N	N	D/C				
1				D/C	Credit 1.1	Regional Priority: Bicycle Facilities		1
1				D/C	Credit 1.2	Regional Priority: Sensitive Land		1
1				D/C	Credit 1.3	Regional Priority: Energy Performance		1
51	**0**	**0**	**59**		**Total**		Possible Points:	**110**
Y	?Y	?N	N					

1

Table 4-1 Target CREL VOCs and their maximum allowable concentrations

No.	Compound Name	CAS No.	Allowable Conc.[a] (µg/m^3)
1	Acetaldehyde	75-07-0	70
2	Benzene	71-43-2	30
3	Carbon disulfide	75-15-0	400
4	Carbon tetrachloride	56-23-5	20
5	Chlorobenzene	108-90-7	500
6	Chloroform	67-66-3	150
7	Dichlorobenzene (1,4-)	106-46-7	400
8	Dichloroethylene (1,1)	75-35-4	35
9	Dimethylformamide (N,N-)	68-12-2	40
10	Dioxane (1,4-)	123-91-1	1,500
11	Epichlorohydrin	106-89-8	1.5
12	Ethylbenzene	100-41-4	1,000
13	Ethylene glycol	107-21-1	200
14	Ethylene glycol monoethyl ether	110-80-5	35
15	Ethylene glycol monoethyl ether acetate	111-15-9	150
16	Ethylene glycol monomethyl ether	109-86-4	30
17	Ethylene glycol monomethyl ether acetate	110-49-6	45
18	n/a	n/a	n/a
19	Hexane (n-)	110-54-3	3,500
20	Isophorone	78-59-1	1,000
21	Isopropanol	67-63-0	3,500
22	Methyl chloroform	71-55-6	500
23	Methylene chloride	75-09-2	200
24	Methyl *t*-butyl ether	1634-04-4	4,000
25	Naphthalene	91-20-3	4.5
26	Phenol	108-95-2	100
27	Propylene glycol monomethyl ether	107-98-2	3,500
28	Styrene	100-42-5	450
29	Tetrachloroethylene	127-18-4	17.5
30	Toluene	108-88-3	150
31	Trichloroethylene	79-01-6	300
32	Vinyl acetate	108-05-4	100
33-35	Xylenes, technical mixture (m-, o-, p-xylene combined)	108-38-3, 95-47-6, 106-42-3	350

a) Refer to http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html. All maximum allowable concentrations are one-half the corresponding CREL adopted by Cal/EPA OEHHA with the exception of formaldehyde. For any future changes in the CREL list by OEHHA, values in Table 4.1 shall continue to apply until these changes are published in the Standard Method.

END OF SECTION

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SECTION 01 91 00
COMMISSIONING

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PART 1 – GENERAL

1.1. SUMMARY

A. Purpose: Define the responsibilities of the parties involved and the procedures related to the commissioning process

1.2. RELATED SPECIFICATIONS

A.	Section 01 31 13	Project Management and Coordination
B.	Section 01 31 19	Project Meetings
C.	Section 01 31 23	Project Management
D.	Section 01 32 26	Construction Progress Reporting
E.	Section 01 33 23	Submittals
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I.	Section 01 78 39	As-Built Drawings
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K.	Section 01 81 13	Sustainable Design Requirements
L.	Section 01 95 00	Measurement & Verification
M.	Section 23 05 93	Testing, Adjusting, and Balancing for HVAC
N.	Section 23 09 00	Instrumentation and Control for HVAC
O.	Section 23 09 23	Direct Digital Control (DDC) System for HVAC
P.	Section 23 09 93	Sequence of Operations for HVAC DDC

1.3 REFERENCES

A. ASHRAE Guideline 1.1-2007, “HVAC&R Technical Requirements for The Commissioning Process”.
B. ASHRAE Guideline 0-2013, “The Commissioning Process”.
C. ASTM E2947-16: Standard Guide for Building Enclosure Commissioning
D. ASTM E2813-12: Standard Practice for Building Enclosure Commissioning
E. NEBB – Procedural Standards for Building Systems Commissioning.

1.4 DEFINITIONS

A. Acceptance Phase. Phase of construction after startup and initial checkout when functional performance tests are performed.
B. Commissioning Authority (CxA). An independent entity, not otherwise associated with the A/E team members or the Contractor and reports directly to the Owner. The CxA directs and coordinates the commissioning activities.

C. Commissioning Plan (Cx Plan). An overall plan, developed before or after bidding, that provides the structure, schedule and coordination planning for the commissioning process. The Cx Plan is included in the bid documents and is to be reviewed by all contractors before submitting their bid.

D. Contract Documents. The documents binding on parties involved in the construction of this project (drawings, specifications, change orders, amendments, contracts, Cx Plan, etc.).

E. Construction Checklist (CC). a list of items to inspect and test equipment and components to verify proper installation of equipment. The CCs are provided by the CxA to the Sub.

F. Datalogging. - Monitoring flows, currents, status, pressures, etc. of equipment using stand-alone dataloggers separate from the control system.

G. Deferred System Performance Tests. SPT's that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that prevent the tests from being performed earlier.

H. Deficiency. A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the Owner's Project Requirements).

I. Factory Testing. Testing of equipment on-site or at the factory by factory personnel with an Owner's representative present.

J. Indirect Indicators. Indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100% closed.

K. Manual Test. Using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").

L. Monitoring. Recording parameters (flow, current, status, pressure, etc.) of equipment operation using dataloggers or the trending capabilities of control systems.

M. Over-written Value. Writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 75F to 50F to verify economizer operation). See also "Simulated Signal."

N. Owner's Project Requirements (OPR). A document that describes what the Owner and stakeholders want to achieve with this project and what expectations they have of the completed project.

O. Sampling. Reviewing or testing only a fraction of the total number of identical or near identical pieces of equipment.

P. Seasonal Performance Tests. SPT's that are deferred until the system(s) will experience conditions closer to their design conditions.

Q. Simulated Condition. Condition that is created for the purpose of testing the response of a system (e.g., applying a hair blower to a space sensor to see the response in a VAV box).

R. Simulated Signal. Disconnecting a sensor and using a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.

S. System Performance Test (SPT). Dynamic testing of entire systems (rather than just components of the system) under full operation.

T. Trending. Monitoring of control points using the building automation system.

1.5 DESCRIPTION

A. General: Commissioning (Cx) is a systematic process of verifying that all building systems perform interactively to meet the Owner's Project Requirements (OPR). This is achieved by beginning in the planning phase with documenting the OPR and continuing through design, construction, acceptance, and the warranty period with verification of performance. The Cx process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Cx during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:

1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
2. Verify and document proper performance of equipment and systems.
3. Verify that O&M documentation is complete.
4. Verify that the Owner's operating personnel are adequately trained.

B. The Cx process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

C. The commissioning authority (CxA) has no authority to change, modify or direct any work. The CxA can only provide comments and suggestions.

D. Commissioning Plan. The Cx Plan provides guidance in the execution of the Cx process. The CxA will update the Cx Plan regularly as the project progresses. The Drawings and Specifications will take precedence over the Cx Plan.

1.6 RESPONSIBILITIES

A. General Contractor (GC) and Subcontractors (Subs)

1. Construction and Acceptance Phase
   a. Provide assistance to the Construction Manager CM in the coordination of the Cx work by the CxA, and with the CM and CxA ensure that Cx activities are being scheduled into the master schedule.
   b. Provide an updated construction schedule to the CxA any time the schedule changes.
   c. Include the Cx activities in the contract.
   d. Furnish a copy of all submittals and shop drawings pertaining to the commissioned systems for review concurrently with the Architect and Engineers.
   e. Furnish a copy of all construction meeting agendas and minutes to the CxA.
   f. In each purchase order or subcontract written, include requirements for submittal data, O&M data, Cx tasks and training.
   g. GC will ensure that all Subs execute their Cx responsibilities according to the Contract Documents and schedule.
   h. A representative from the GC and each sub associated with the Cx process shall attend the Cx pre- construction meeting and the regular Cx meetings scheduled by the CxA to facilitate the Cx process.
   i. Coordinate and execute the training of Owner personnel.
   j. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
   k. Prepare and submit draft forms, including but not limited to start-up procedures, Testing and Balancing (TAB) forms, calibration forms, etc. for review by the CxA before execution.
   l. Submit test reports to the CxA of all tests performed on components and equipment to be commissioned that are not included as part of the Construction Checklist and SPT procedures.
   m. Complete all construction checklist and functional performance test forms as required by the Cx process.
   n. Support the CxA with verification of the completion of construction checklist and functional performance tests as outlined in PART 3.
   o. Complete and inspect all installations. Certify that all components and systems are operating as intended per Contract Documents.
   p. Remedy all deficiencies immediately as they are identified throughout construction.
   q. Demonstrate functionality of all systems and equipment.
   r. Maintain an updated set of record drawings (on a daily basis) on the construction site.
   s. Provide support and instrumentation to verify TAB reports, start-up reports, calibration reports, and any other report pertinent to the commissioned equipment and systems.
   t. Notify the CxA no less than 21 days before all testing, start-up, and training.
   u. Update the CxA on a weekly basis on the progress of the Cx activities.
   v. Submit trend data in electronic format or allow access to trending data by internet connection as requested by the CxA.
   w. Install access points by every sensor such that the sensor can be calibrated without removal (P/T plugs, plugged holes in ducts etc.).
2. Warranty Period
   a. Execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.
   b. Correct deficiencies and make necessary adjustments to O&M manuals and record drawings for applicable issues identified in any seasonal testing.

B. Equipment Suppliers

1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
2. Assist in equipment testing per agreements with Subs.
3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base

bid price to the Contractor, except for stand-alone data logging equipment that may be used by the CxA.

4. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
5. Review test procedures for equipment installed by factory representatives.

1.7 SYSTEMS TO BE COMMISSIONED

A. The entire Heating, Ventilation and Air Conditioning (HVAC) system (chillers, pumps, piping, and air distribution systems)
B. Building Automation System (BAS) for the HVAC system
C. Domestic Hot Water
D. Building envelope and roofing system
E. Lighting and Lighting Controls
F. Solar electric (PV) System

PART 2 – PRODUCTS

2.1 TEST INFORMATION

A. All instruments needed to verify sensor readings, component performance, and system performance will be provided by GC and Subs and be available to the CxA. These instruments will not be beyond what the contractors need to complete the work specified in these construction documents. Any data logging equipment required in addition to the BAS will be provided by the CxA.
B. All instruments shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Contract Documents. Refer to specification section 23 05 93- Testing, Adjusting, and Balancing for required instrument tolerances.

PART 3 - EXECUTION

3.1 COMMISSIONING TEAM

A. The members of the commissioning team consist of the Commissioning Authority (CxA), the Owner's Project Manager (PM), the designated representative of the Owner's Construction Management team (CM), the General Contractor (GC or Contractor), the architect and design engineers, the Mechanical Contractor, the Electrical Contractor, the TAB Contractor, the Controls Contractor, any other installing subcontractors or suppliers of equipment.
B. Each Cx Team member shall designate one person who is responsible for coordinating the commissioning efforts with the CxA.

3.2 SCHEDULING AND MEETINGS

A. Scheduling. The CxA will work with the other members of the Cx Team according to established protocols to schedule the Cx activities. The CxA will provide sufficient notice to the Cx Team for scheduling Cx activities. The GC will integrate all Cx activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the Cx process.
B. The CxA will provide the initial schedule of primary Cx events at the Cx pre-construction meeting. The Cx Plan provides a format for this schedule. As construction progresses more detailed schedules are developed by the CxA. The Cx Plan also provides a format for detailed schedules.
C. Pre-Construction Meeting. Within 60 days of selection of the GC, the CxA will schedule, plan, and conduct a Cx pre-construction meeting with the entire Cx team in attendance. Meeting minutes will be distributed to all parties by the CxA. Information gathered from this meeting will allow the CxA to revise the Cx Plan which will also be distributed to all parties.
D. Meetings. The Cx meetings will be scheduled approximately once a month during construction. These meetings will be scheduled directly before or after the regular construction meetings if practical. These meetings will cover coordination, deficiency resolution and planning issues with particular Subs. The CxA will plan these meetings and will minimize unnecessary time being spent by Subs

3.3 REPORTING

A. The CxA will provide regular reports to the Owner as construction and Cx progresses. Standard forms are provided and referenced in the Cx Plan.

B. The CxA will regularly communicate with all members of the Cx team, keeping them apprised of Cx progress and scheduling changes through memos, progress reports, etc.

C. Testing or review approvals and non-conformance and deficiency reports are made regularly with the review and testing as described in later sections.

3.4 RECORD DRAWINGS

A. The CxA will verify that the record drawings are updated throughout the construction. If a discrepancy is found between the record drawings and the installations, the CxA will notify the GC immediately. It is the GC and subcontractors responsibility to then inspect the installations and immediately and completely update the record drawings such that they accurately reflect the installation.

3.5 CONSTRUCTION COMMISSIONING PROCEDURES

A. The following procedures apply to all equipment to be commissioned.

B. General. Construction checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that system performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full checkout. No sampling strategies are used. All construction checklists for a given system must be successfully completed prior to formal system performance testing of equipment or subsystems of the given system.

C. Construction Checklists.

1. The primary purpose of the construction checklists is to provide the individual workers with the key criteria for a successful installation. The secondary purpose is to track the progress of the delivery and installation.
2. The CxA will develop construction checklists for all commissioned equipment and distribute these to the responsible contractor. The GC and Subs will review the construction checklists for each equipment type and provide comments to the CxA. The CxA will then print and distribute the construction checklist for each individual component.
3. The GC and Subs are responsible for all requirements in the specification, not only the requirements listed on the checklists.
4. The checklists answer format will be to circle yes /no or provide a brief answer such as providing the model or serial numbers.
5. These checklists are provided by the CxA to the GC. The GC determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form may have more than one trade responsible for its execution.
6. The construction checklists shall be completed as delivery is completed and the installation progresses.
7. Only individuals who have direct knowledge and witnessed that a line item task on the construction checklist was actually performed shall initial or check that item off. It is not acceptable for supervisors without direct knowledge or who have not witnessed the line item task on the construction checklist to fill out these forms.
8. Any negative response shall immediately be brought to the attention of the CxA. All negative replies shall be explained in detail on the construction checklist.
9. The GC and Subs are responsible for recording the completion of the checklists. Checklists shall be submitted electronically to SharePoint in .pdf format in separate files by Division. Each file shall be bookmarked by checklist tag.
10. Non-itemized installations such as wiring, ductwork, piping etc. will not have checklists to be completed, but the GC and Subs will be provided the key criteria for successful installation.
11. The CxA will verify the construction checklist completion by a sampling of the delivered and installed equipment. The sampling process will be described in the Cx Plan.

D. Sensor Calibration. Calibration of all sensors shall be included as part of the construction checklists performed by the Contractors. Calibration information is provided in specification Section 23 09 23 - Direct Digital Control System for HVAC

E. Deficiencies, Non-Conformance and Approval in Checklists and Startup.

1. The Subs shall clearly list any outstanding items of the construction checklist that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CxA within two days of task completion.
2. The CxA reviews the report and submits either a non-compliance report or an approval form to the Sub or CM. The CxA shall work with the Subs and vendors to correct deficiencies or

uncompleted items. The CxA will involve the CM and others as necessary. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CxA as soon as outstanding items have been corrected and include a Statement of Correction on the original non- compliance report. When satisfactorily completed, the CxA recommends approval of the completion of the checklists to the CM using a standard form.

3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party.

F. System Performance Tests (SPT). SPTs shall be performed to demonstrate that each system is operating according to the documented OPR and Contract Documents. System testing differs to the tests required in the Construction Checklist in that they facilitate bringing all the individual components together to verify that they operate collectively on a system level to provide the required design conditions.

1. Development of Test Procedures. The CxA shall prepare the SPT forms and procedures in accordance with the criteria defined in the Cx Plan. The GC and Subs shall assist the CxA in the preparation of these procedures by answering queries and forwarding site-specific information. A sample System Performance Test form is provided at the end of this specification section.
2. Participation: The GC and the Subs are responsible for testing all systems to be commissioned such that they function as described in the contract documents. The CxA will verify the performance of the systems. The CxA will direct, witness and document the SPT verification and GC and Subs will execute the verification tests.

G. Problem Solving. The CxA will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the GC, Subs and A/E.

H. Seasonal Testing. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CxA shall coordinate this activity. Tests will be executed, documented and deficiencies corrected by the appropriate Subs, with facilities staff and the CxA witnessing. Any final adjustments to the O&M manuals and record documents due to the testing will be made.

I. Unforeseen Deferred Tests. If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the PM. These tests will be conducted in the same manner as the seasonal tests.

3.6 SENSOR AND ACTUATOR CALIBRATION

A. Calibrate all field-installed temperature, relative humidity, carbon monoxide, carbon dioxide, and pressure sensors and gages, and all actuators (dampers and valves) on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.

B. Calibrate using the methods described below; alternate methods may be used, if approved by Owner beforehand. See PART 2 for test instrument requirements. Record methods used on the relevant Construction Checklist or other suitable forms, documenting initial, intermediate and final results.

C. All Sensors:

1. Verify that sensor location is appropriate and away from potential causes of erratic operation.
2. Verify that sensors with shielded cable are grounded only at one end.
3. For sensor pairs that are used to determine a temperature or pressure difference, for temperature make sure they are reading within 0.2 degree F (0.1 degree C) of each other, and for pressure, within tolerance equal to 2 percent of the reading, of each other.
4. Tolerances for critical applications may be tighter.

D. Sensors without Transmitters - Standard Application:

1. Make a reading with a calibrated test instrument within 6 inches (150 mm) of the site sensor.
2. Verify that the sensor reading, via the permanent thermostat, gage or building automation system, is within the tolerances in the table below of the instrument-measured value.
3. If not, install offset, calibrate or replace sensor.

E. Sensors with Transmitters - Standard Application.

1. Disconnect sensor.
2. Connect a signal generator in place of sensor.
3. Connect ammeter in series between transmitter and building automation system control panel.
4. Using manufacturer's resistance-temperature data, simulate minimum desired temperature.
5. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter.
6. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the building automation system.

7. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction.
8. Reconnect sensor.
9. Make a reading with a calibrated test instrument within 6 inches (150 mm) of the site sensor.
10. Verify that the sensor reading, via the permanent thermostat, gage or building automation system, is within the tolerances in the table below of the instrument-measured value.
11. If not, replace sensor and repeat.
12. For pressure sensors, perform a similar process with a suitable signal generator.

F. Sensor Tolerances for Standard Applications: Plus/minus the following maximums:
1. Watthour, Voltage, Amperage: 1 percent of design.
2. Pressure, Air, Water, Gas: 3 percent of design.
3. Air Temperatures (Outside Air, Space Air, and Duct Air): 0.4 degrees F (0.2 degree C).
4. Relative Humidity: 4 percent of design.
5. Barometric Pressure: 0.1 inch of Hg (340 Pa).
6. Flow Rate, Air: 10 percent of design.
7. Flow Rate, Water: 4 percent of design.
8. Flow Rate, Steam: 3 percent of design.
9. AHU Wet Bulb and Dew Point: 2.0 degrees F (1.1 degrees C).
10. Hot Water Coil and Boiler Water Temperature: 1.5 degrees F (0.8 degrees C).
11. Cooling Coil, Chilled and Condenser Water Temperatures: 0.4 degrees F (0.2 degree C).
12. Combustion Flue Temperature: 5.0 degrees F (2.8 degrees C).
13. Oxygen and CO2 Monitors: 0.1 percentage points.
14. CO Monitor: 0.01 percentage points.
15. Natural Gas and Oil Flow Rate: 1 percent of design.

G. Critical Applications: For some applications more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.

H. Valve/Damper Stroke Setup and Check:
1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
2. Set pump/fan to normal operating mode.
3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
4. Command valve/damper to open; verify position is full open and adjust output signal as required.
5. Command valve/damper to a few intermediate positions.
6. If actual valve/damper position does not reasonably correspond, replace actuator

I. Isolation Valve or System Valve Leak Check: For valves not associated with coils.
1. With full pressure in the system, command valve closed.
2. Use an ultra-sonic flow meter to detect flow or leakage.

3.7 NON-CONFORMANCE

A. All deficiencies or non-conformance issues shall be noted and reported by the GC to the CM on a standard non-compliance form.

B. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.

C. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the CM and the Owner.

D. As tests progress and a deficiency is identified, the CxA discusses the issue with the executing contractor.
1. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:
a. The CxA documents the deficiency and the Sub's response and intentions and they go on to another test or sequence. After the day's work, the CxA submits the non-compliance reports to the CM for signature, if required. A copy is provided to the Sub and CxA. The Sub corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CxA.
b. The CxA reschedules the test and the test is repeated.
2. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:

a. The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the CM and to the Sub representative assumed to be responsible.
b. Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Project Manager.
c. The CxA documents the resolution process.
d. Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved.

3. Cost of Retesting.
a. The cost incurred by the Subs to retest a construction checklist item or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the GC.
b. For a deficiency identified, not related to any construction checklist or start-up fault, the following shall apply: The CxA and CM will direct the retesting of the equipment once at no "charge" to the GC for their time. However, the CxA's and CM's time for a second retest will be charged to the GC, who may choose to recover costs from the responsible Sub.
c. The time for the CxA and CM to direct any retesting required because a specific construction checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be backcharged to the GC, who may choose to recover costs from the party responsible for executing the faulty installation or test.
d. The Contractor shall respond in writing to the CxA and CM at least as often as Cx meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during Cx. Discussion shall cover explanations of any disagreements and proposals for their resolution.
e. The CxA retains the original non-conformance forms until the end of the project.
f. Failure Due to Manufacturer Defect. If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the CM or PM. In such case, the Contractor shall provide the Owner with the following:
g. Within one week of notification from the CM or PM, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the CM or PM within two weeks of the original notice.
h. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation. The CM or PM will determine whether a replacement of all identical units or a repair is acceptable.
i. Two examples of the proposed solution will be installed by the Contractor and the CM will be allowed to test the installations for up to one week, upon which the CM or PM will decide whether to accept the solution.
j. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

E. Approval. The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA and by the CM, if necessary. The CxA recommends acceptance of each test to the CM using a standard form. The CM gives final approval on each test using the same form, providing a signed copy to the CxA and the Contractor.

END OF SECTION

SECTION 01 95 00
MEASUREMENT AND VERIFICATION

PART 1 – GENERAL 1
1.1 SUMMARY 1
1.2 DEFINITIONS 1
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PART 1 – GENERAL

1.1 SUMMARY

A. Purpose: This section includes general requirements that apply to implementation of measurement and verification.

B. RELATED WORK AND REQUIREMENTS

1. Section 01 31 13 Project Coordination
2. Section 01 31 19 Project Meetings
3. Section 01 31 23 Project Management Web Site
4. Section 01 91 00 Commissioning
5. Section 23 09 00 Instrumentation and Control for HVAC
6. Section 23 09 23 Direct Digital Control (DDC) System for HVAC
7. Section 23 09 93 Sequence of Operations for HVAC DDC
8. Section 26 24 13 Switchboards
9. Section 26 24 16 Panelboards

1.2 DEFINITIONS

A. BAS - Building Automation System
B. DHW - Domestic Hot Water
C. M&V - Measurement and Verification
D. kW - Electric power read from utility meter
E. KWh - Electric energy consumption read from utility meter
F. Plug Loads – Electric power and consumption from wall receptacles

1.3 MECHANICAL CONTRACTOR RESPONSIBILITIES

A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform M&V activities including, but not limited to, the following:

1. Follow activities identified in the M&V Plan.
2. Coordinate connection of gas and DHW monitoring equipment with BAS.
3. Cooperate with the M&V Provider and Controls Contractor for resolution of issues related to data collection.
4. Attend team meetings during construction and post-construction M&V period (1 year).

1.4 ELECTRICAL CONTRACTOR RESPONSIBILITIES

A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform M&V activities including, but not limited to, the following:

1. Follow activities identified in the M&V Plan.
2. Coordinate connection of electrical monitoring equipment with BAS
3. Cooperate with the M&V Provider and Controls Contractor for resolution of issues related to data collection.

4. Attend team meetings during construction and post-construction M&V period (1 year).

1.5 CONTROLS CONTRACTOR RESPONSIBILITIES

A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform M&V activities including, but not limited to, the following:
   1. Follow activities identified in the M&V Plan.
   2. Coordinate connection of electrical, gas, and DHW monitoring equipment with BAS
   3. Cooperate with the M&V Provider Mechanical Contractor and Electrical Contractor for resolution of issues related to establishing connection between BAS and monitoring meters and equipment.
   4. Attend team meetings during construction and post-construction M&V period (1 year).

1.6 M&V PROVIDERS RESPONSIBILITIES

A. Providers responsibilities include:
   1. Organize and lead the M&V team.
   2. Provide M&V plan.
   3. Convene M&V meetings as needed.
   4. Cooperate with the Mechanical Contractor, Electrical Contractor, and Controls Contractor for resolution of issues related to establishing connection between BAS and monitoring meters and equipment.
   5. Provide an M&V report at 1 year post construction.

PART 2 – PRODUCTS – THIS SECTION NOT USED

2.1 METERS AND SUB-METERS

A. Monitoring meters and sub-meters, both gas and electric, to have the ability to connect to the BAS and provide data to BAS at a minimum of 15 minute intervals. It is acceptable to use the utility for this purpose if allowable by utility company.

PART 3 - EXECUTION

3.1 METER

A. Provide real-time monitoring of the whole building electricity kW and kWh use by using a signal from the building utility meter serving the HVAC, lighting, and plug loads and provide the data input to the Building Automation System (BAS). The BAS must be capable of trending this kW and kWh data. Data is to be collected in 15 minute intervals. Storage of at least 3 months of 15 minute data is required on the BAS. Data older than 3 months is to be automatically saved and archived on the BAS computer without being overwritten. Data older than 5 years can be overwritten. It is the responsibility of the electrical contractor to coordinate this work.

3.2 NATURAL GAS

A. Provide real-time monitoring of whole building natural gas consumption by using a signal from the building utility meter to provide the data input to the BAS. The BAS must be capable of trending gas consumption. Data is to be collected in 15 minute intervals. Storage of at least 3 months of 15 minute data is required on the BAS. Data older than 3 months is to be automatically saved and archived on the BAS computer without being overwritten. Data older than 5 years can be overwritten. It is the responsibility of the mechanical contractor to coordinate this work.

3.3 TEMPORARY MONITORING

A. Provide easy access to allow for the temporary installation of split-core current sensors and voltage sensors for the electrical measurement and datalogging on the following systems:
   1. Lighting
   2. Plug loads
   3. HVAC equipment including chillers, fans, circulation pumps, and air handling units

3.4 DDC TRENDS

A. The Controls Contractor is to provide provision for remote access to BAS to view status of building and the ability to download trendable points.

END OF SECTION

SECTION 01 95 01
MONITORING-BASED COMMISSIONING

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3.4 HEATING HOT WATER 3
3.5 CHILLED WATER 3
3.6 TEMPORARY MONITORING 3
3.7 DDC TRENDS 3

PART 1 – GENERAL

1.1 SUMMARY

A. Purpose: This section includes general requirements that apply to implementation of monitoring-based commissioning (MbCx). MbCx is a component of the LEED v4.0 Rating System and the Commissioning Process. This process replaces the Measurement and Verification process that was used in the LEED v3 Rating System.

B. RELATED WORK AND REQUIREMENTS

1. Section 01 31 13 Project Coordination
2. Section 01 31 19 Project Meetings
3. Section 01 31 23 Project Management Web Site
4. Section 01 91 00 Commissioning
5. Section 23 09 00 Instrumentation and Control for HVAC
6. Section 23 09 23 Direct Digital Control (DDC) System for HVAC
7. Section 23 09 93 Sequence of Operations for HVAC DDC
8. Section 26 24 13 Switchboards
9. Section 26 24 16 Panelboards

1.2 DEFINITIONS

A. BAS - Building Automation System
B. Cx - Commissioning
C. DHW - Domestic Hot Water
D. MbCx Monitoring-Based Commissioning
E. kW - Electric power read from utility meter
F. KWh - Electric energy consumption read from utility meter
G. Plug Loads – Electric power and consumption from wall receptacles

1.3 MECHANICAL CONTRACTOR RESPONSIBILITIES

A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform MbCx activities including, but not limited to, the following:

1. Follow activities identified in the Cx Plan.
2. Coordinate connection of gas and DHW monitoring equipment with BAS.
3. Cooperate with the Cx Agent, owner, Electrical Contractor and Controls Contractor for resolution of issues related to data collection.
4. Attend team meetings during construction and post-construction MbCx period (1 year). Attend quarterly meetings.
5. Followup training or repairs needed to maintain performance.

1.4 ELECTRICAL CONTRACTOR RESPONSIBILITIES

A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform MbCx activities including, but not limited to, the following:
   1. Follow activities identified in the Cx Plan.
   2. Coordinate connection of electrical monitoring equipment with BAS
   3. Cooperate with the Cx Agent, owner, Mechanical Contractor and Controls Contractor for resolution of issues related to data collection.
   4. Attend team meetings during construction and post-construction MbCx period (1 year). Attend quarterly meetings.
   5. Followup training or repairs needed to maintain performance.

1.5 CONTROLS CONTRACTOR RESPONSIBILITIES

A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform MbCx activities including, but not limited to, the following:
   1. Follow activities identified in the Cx Plan.
   2. Coordinate connection of electrical monitoring equipment with BAS
   3. Coordinate connection of gas and DHW monitoring equipment with BAS.
   4. Coordinate connection of measurement requirements (points, data access) with BAS.
   5. Cooperate with the Cx Agent, owner, Mechanical Contractor and Electrical Contractor for resolution of issues related to data collection.
   6. Attend team meetings during construction and post-construction MbCx period (1 year). Attend quarterly meetings.
   5. Followup training or repairs needed to maintain performance.

1.6 MBCX PROVIDERS RESPONSIBILITIES

A. The Cx Agents responsibilities related to MbCx include:
   1. Organize and lead the MbCx team.
   2. Provide a Cx plan that includes the following procedures and information:
      a. roles and responsibilities as they relate to MbCx;
      b. measurement requirements (meters, points, metering systems, data access);
      c. the points to be tracked, with frequency and duration for trend monitoring;
      d. the limits of acceptable values for tracked points and metered values (where appropriate, predictive algorithms may be used to compare ideal values with actual values);
      e. the elements used to evaluate performance, including conflict between systems, out-of sequence systems components, and energy and water usage profiles;
      f. an action plan for identifying and correcting operational errors and deficiencies;
      g. training to prevent errors;
      h. planning for repairs needed to maintain performance; and
      i. the frequency of analyses in the first year of occupancy (at least quarterly).
   3. Convene MbCx meetings as needed, but at least quarterly for 1 year post construction.
   4. Cooperate with the Mechanical Contractor, Electrical Contractor, and Controls Contractor for resolution of issues related to establishing connection between BAS and monitoring meters and equipment.
   5. Provide a final MbCx report at 1 year post construction.
   6. Update the systems manual with any modifications or new settings, and give the reason for any modifications from the original design.

PART 2 – PRODUCTS

2.1 METERS AND SUB-METERS

A. Monitoring meters and sub-meters, both gas and electric, to have the ability to connect to the BAS and provide data to BAS at a minimum of 15 minute intervals. It is acceptable to use the utility for this purpose if allowable by utility company.

PART 3 - EXECUTION

3.1 ELECTRIC METER

A. Provide real-time monitoring of the whole building electricity kW and kWh use by using a signal from the building utility meter serving the HVAC, lighting, and plug loads and provide the data input to the Building Automation System (BAS). The BAS must be capable of trending this kW and kWh data. Data is to be collected in 15 minute intervals. Storage of at least 3 months of 15 minute data is required on the BAS. Data older than 3 months is to be automatically saved and archived on the BAS computer without being overwritten. Data older than 5 years can be overwritten. It is the responsibility of the electrical contractor to coordinate this work.

3.3 NATURAL GAS

A. Provide real-time monitoring of whole building natural gas consumption by using a signal from the building utility meter to provide the data input to the BAS. The BAS must be capable of trending gas consumption. Data is to be collected in 15 minute intervals. Storage of at least 3 months of 15 minute data is required on the BAS. Data older than 3 months is to be automatically saved and archived on the BAS computer without being overwritten. Data older than 5 years can be overwritten. It is the responsibility of the mechanical contractor to coordinate this work.

3.4 HEATING HOT WATER

A. Provide real-time monitoring of the heating hot water (HW) system by measuring water flow to the boiler(s) and HW supply and return temperatures and providing data input to the BAS. The BAS must be capable of trending. Data is to be collected in 15 minute intervals. Storage of at least 3 months of 15 minute data is required on the BAS. Data older than 3 months is to be automatically saved and archived on the BAS computer without being overwritten. Data older than 5 years can be overwritten. It is the responsibility of the mechanical contractor to coordinate this work.

3.5 CHILLED WATER

A. Provide real-time monitoring of the chilled water (CW) system by measuring water flow to the chillers(s) and CW supply and return temperatures and providing data input to the BAS. The BAS must be capable of trending. Data is to be collected in 15 minute intervals. Storage of at least 3 months of 15 minute data is required on the BAS. Data older than 3 months is to be automatically saved and archived on the BAS computer without being overwritten. Data older than 5 years can be overwritten. It is the responsibility of the mechanical contractor to coordinate this work.

3.6 TEMPORARY MONITORING

A. Provide easy access to allow for the temporary installation of split-core current sensors and voltage sensors for the electrical measurement and datalogging on the following systems:
   1. Lighting
   2. Plug loads
   3. HVAC equipment including chillers, fans, circulation pumps, and air handling units
   4. DHW equipment

B. Temporary monitoring equipment will be provided by the Cx Agent.

3.7 DDC TRENDS

A. The Controls Contractor is to provide provision for remote access to BAS to view status of building and the ability to download trendable points per the MbCx requirements in the Cx Plan.

END OF SECTION

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SECTION 02 20 00
GENERAL SITEWORK REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. The work under this section shall consist of providing all work, materials, labor, equipment, and supervision necessary to provide the work on the site as provided for in the technical specifications and on the Drawings.

B. All work on public facilities or on public lands and/or public rights-of-way shall conform to the applicable City of Madison Construction Standards stated below.

C. All work shall be in accordance with applicable manufacturer's instructions.

1.2 RELATED WORK AND PROVISIONS

A. This section relates to all Division 2 sections as they pertain to "sitework" to be performed.

B. This specification shall apply to all site work unless otherwise specified.

C. Applicable provisions of Division 1 shall govern all work under Division 2 and all Division 2 specifications.

1.3 REFERENCE STANDARDS

A. Abbreviations of standards or organizations referenced in this specification are as follows:

AASHTO	American Association of State Highway and Transportation Officials
ABMA	American Boiler Manufacturers Association
ACPA	American Concrete Pipe Association
AGA	American Gas Association
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASME	American Society of Mechanical Engineers
ASPE	American society of Plumbing Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
CISPI	Cast Iron Soil Pipe Institute
CS	Commercial Standards, Products Standards Sections, Office of Eng. Standards Service, NBS
EPA	Environmental Protection Agency
FS	Federal Specifications, Superintendent of Documents, U.S. Government Printing Office
IAPMO	International Association of Plumbing & Mechanical Officials
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
MSS	Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
NBS	National Bureau of Standards
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
PDI	Plumbing and Drainage Institute
STI	Steel Tank Institute
UL	Underwriters Laboratories Inc.

B. Where reference is made to the "Construction Standards," it shall be construed to mean the pertinent section of the City of Madison's Construction Standards.

1.4 SUBSTITUTIONS

A. Substitution of Materials: Refer to the General Conditions of the Contract.

B. Where equipment, accessories, or materials are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated in the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the intended performance from the system into which these items are placed.

1.5 CONTINUITY OF EXISTING TRAFFIC, PARKING, AND UTILITIES

A. Refer also to Division 1 - Contract General Requirements.

B. Do not interrupt or change existing traffic, delivery, parking, or utility services without prior written approval from the Construction Representative. When interruption is required, coordinate schedule with the Owner agency to minimize disruptions. Unless specifically stated, all work involved in interrupting or changing existing services is to be done during normal working hours.

C. Verify the locations of any water, drainage, gas, sewer, electric, drainage, gas, sewer, electric, telephone, fuel, steam lines or other utilities, and site features which may be encountered in any excavations or other sitework. All lines shall be properly underpinned and supported to avoid disruption of service. Any service connections encountered which are to be removed shall be cut off at the limits of the excavation and capped in accordance with the requirements of permits governing such removals. Any permits required for this work will be obtained by the Owner upon request of the Contractor.

D. The Contractor shall comply with Wisconsin Statutes 62.15(11) Street Obstructions specifically that doing any work which shall in any manner obstruct the streets or sidewalks shall put up and maintain barriers conforming to the standards for traffic control devices in the manual adopted by the Department of Transportation under s. 84.02 (4) (e) to prevent accidents, and be liable for all damages caused by failure so to do. All contracts shall contain a provision covering this liability, and also a provision making the contractor liable for all damages caused by the negligent digging up of streets, alleys or public grounds, or which may result from the Contractor's carelessness in the prosecution of such work.

1.6 PROTECTION OF EXISTING WORK AND FACILITIES

A. Verify the locations of, and protect, any signs, paved surfaces, buildings, structures, landscaping, streetlights, utilities, and all other such facilities that may be encountered or interfered with during the progress of the work. Take all measures necessary to safeguard all existing work and facilities which are outside the limits of the work or items which are within the construction limits but are intended to remain.

B. Protect all paved, turfed, and landscaped surfaces to remain. Protect all areas outside of the construction limits from the effects of erosion in accordance with the Erosion Control specification section.

1.7 CONSTRUCTION LIMITS

A. Construction Limits are indicated on the Drawings. In the absence of such a designation on the Drawings, confine work to the minimum area reasonably necessary to undertake the work as determined by the Engineer. All areas disturbed by excavation and grading, plus such additional areas as are disturbed by construction related activities including construction access and storage and installation of materials shall be considered the "Construction Area."

1.8 EQUIPMENT AND MATERIALS FURNISHED BY OTHERS

A. None.

1.9 SUBMITTALS

A. Refer also to Division 1 - Contract General Requirements.

B. Submit manufacturer's preproduction (shop) drawings for any off-site constructed sitework items for approval prior to the start of manufacturing and any electrically powered equipment.

1.10 CERTIFICATIONS AND INSPECTIONS

A. Refer also to Division 1 - General Conditions of the Contract.

B. Obtain and pay for all required sampling, testing, inspections, and certifications except those provided by the Architect/Engineer (A/E). Deliver originals of certificates and documents to the Owner's Project Representative. Include copies of the certifications and documents in the Operating and Maintenance instructions.

1.11 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Refer also to Division 1 - Contract General Requirements.

B. Assemble material in an operating and maintenance manual composed of three-ring or post binders, using and index at the front of each volume and tabs for each system or type of equipment installed. In addition to the data indicated in the General Requirements, include the following information:

1. Copies of all approved shop drawings;
2. Manufacturer's wiring diagrams for electrically powered equipment;
3. Records of tests performed to certify compliance with system requirements;
4. Certificates of inspection by regulatory agencies;

5. Parts lists for manufactured equipment;
6. Lubrication instructions, including lists of frequency of lubrication during construction;
7. Warranties and/or guarantees; and
8. Additional information as indicated in the technical specification sections.

1.12 TRAINING OF OWNER PERSONNEL

A. Instruct Owner's personnel or their designee in the proper operation and maintenance of systems and equipment provided as part of this project.

1.13 RECORD DRAWINGS

A. Refer also to Division 1 - Contract General Requirements.
B. Include copies of record drawings with the Operating and Maintenance instructions.

PART 2 - PRODUCTS

2.1 TRAFFIC CONTROL - BARRICADES, SIGNS, AND WARNING DEVICES

A. Provide traffic barricades, traffic signs, and warning devices in accordance with governing codes and regulations and the Manual of Uniform Traffic Control Devices (MUTCD).
B. Provide excavation barrier fencing in plastic, blaze orange color together with all supports and braces necessary to provide an adequate safety barrier to unattended excavations.

2.2 WARNING SIGNS

A. Provide all necessary warning signing as required by OSHA, these specifications, as directed by the City of Madison's Construction Representative and as shown on the Drawings. Payment for providing, placing, maintaining, and removing traffic control devices will be paid under the traffic control bid item as a lump sum item for all project areas.

PART 3 - EXECUTION

3.1 PROJECT SITE CONDITIONS

A. Maintain a clean, safe, and orderly site.
B. Provide adequate barricades, guards, warning lights, and other protection required at excavation and hazards created by work.
C. Control access to the site by only authorized personnel and vehicles.
D. Maintain site housekeeping to provide for a safe and orderly project site. Collect and dispose of debris as it accumulates.
E. Provide shoring, bracing, sheet piling, planking, and forming required by the work.
F. Locate and protect overhead and underground utilities, sidewalks, drains, curbs, trees (including roots) shrubs, ground cover, bench marks, monuments, other reference points, adjacent buildings, materials, and property owned by others that are to remain.
G. Protect items, bearing responsibility for and replacement cost of damage arising from all operations connected with the work. If items are disturbed or destroyed, replace as directed by the Owner's representative.
H. Fence and/or box in all trees and plant material which are to remain at the drip line before work is started. Do not permit heavy equipment or stockpiles within branch spread. Remove interfering branches without injury to trunks and cover scars with tree paint.
I. Control grading around structures; pitch ground to prevent water running into excavated areas.
J. Pits, trenches within building lines, and other excavations shall be maintained free of water.
K. Provide trenching, pumping, and other facilities required.
L. Notify City and Owner's Project Representatives if springs or running water are encountered in excavation; provide discharge by trenches and drains pumping to point outside of excavation. Provide information to Owner's Project Representative of points and areas that water will be discharged. Control discharge with methods acceptable to Wisconsin Department of Natural Resources (WDNR), the City's Project Representative and Local Municipal Regulations. At the Engineer's option, the Contractor shall drain the spring to the storm sewer system by the use of field tile.
M. Be responsible for control measures to prevent damage from flooding, erosion, and sedimentation to on-site and off-site areas.

N. Install and maintain temporary desilting basins, terraces, contour furrows, channel linings, waterways, and other measures as shown on Drawings and as described in the Wisconsin Pollutant Discharge Elimination System (WPDES) and City of Madison permits obtained for the project to prevent damage.

3.2 WATER (DUST CONTROL)

A. Contractor shall apply water to the subgrade as directed by the City of Madison's Construction Representative for dust control. Water shall be provided by the contractor and placed in accordance with Section 624 of the State Specifications. Water for base compaction shall be incidental to the base aggregate items and will not be paid under this item.

3.3 SITE RESTORATION

A. Unless otherwise specified or noted on the Drawings, fully and completely restore the site to a condition present prior to the work. Restore the surface of all disturbed areas to a like condition of the surface prior to the work. Sawcut and remove all damaged pavements to the nearest existing joints, or with prior permission, to straight and neat lines and repair with like materials to the full depth of the pavement as existed prior to the work.

B. See applicable sections for specific restoration requirements.

3.4 CLEAN UP

A. Level off/shape all waste disposal areas and clean up areas used for the storage of materials or the temporary deposit of excavated earth. Remove all surplus material, tools and equipment.

B. Burning is not permitted.

C. Thoroughly clean all sewers and structures and remove and dispose of all debris and mud.

END OF SECTION

SECTION 02 32 00
GEOTECHNICAL INVESTIGATION

PART 1 - GENERAL

1.1 SCOPE

A. The work under this section shall consist of providing all work, materials, labor, section provides information resulting from subsurface investigations completed at the site as part of this project. This section may contain information applicable to ALL sitework and other technical specification sections as well. All contractors are expected to review this information as part of their duties to familiarize themselves with the site.

B. Results of the geotechnical investigation apply only to the locations at which data was collected and at the specific time it was collected. Geotechnical conditions may differ elsewhere on the site.

C. Supplementary Geotechnical Exploration Report (boring report and report logs) for the proposed Warner Park Community Recreation Center building in Madison, Wisconsin, prepared by Soils & Engineering Services, Inc. (SES) dated December 16, 1997 (Boring Report and Logs No. 11243 R2).

D. Prior to making additional investigations of his/her own using test pits, borings, or other methods, Bidder shall first gain permission from property owner and Owner's Project Manager.

E. Geotechnical investigations completed by Bidder shall comply with all applicable requirements of Division 1 through Division 16 of this project.

1.2 RELATED WORK

A. Applicable provisions of Division 1 govern work under this Section. Related sections include:

1. Section 31 05 00 - Common Work Results for Earthwork
2. Section 31 20 00 - Earthmoving
3. Section 31 22 16.15 - Subgrade Preparation
4. Section 32 11 23 - Aggregate Base Course
5. Section 32 17 23 - Pavement Markings

PART 2 - PRODUCTS

2.1 REPORTS

A. The Geotechnical Investigation Report at the end of this section is included for the Contractor's information.

B. This report is also available by contacting the Geotechnical Consultant:

1. Soils & Engineering Services, Inc., 1102 Stewart Street, Madison, WI 53713 (Phone: 608-274-7600).

PART 3 - EXECUTION

Not used.

END OF SECTION

CGC, Inc.
Construction • Geotechnical
Consulting Engineering/Testing

March 24, 2023
C23051-6

Ms. Amy Loewenstein Scanlon, AIA
Department of Public Works – Engineering Division
City County Building, Room 115
210 Martin Luther King, Jr. Blvd.
Madison WI 53703-3342

Re: Geotechnical Exploration Report
Proposed Warner Park Rec Center Gym Addition
1625 Northport Drive
Madison, WI

Dear Ms. Lowenstein Scanlon:

Construction • Geotechnical Consultants, Inc. (CGC) has completed the subsurface exploration program for the above-referenced project. The purpose of this program was to evaluate the subsurface conditions within the proposed construction area and to provide geotechnical recommendations regarding site preparation, foundation, floor slab, below-grade wall, retaining wall and pavement design/construction. A determination of the site class for seismic design and a discussion regarding stormwater infiltration potential are also included. We are sending you an electronic copy of this report, and we can provide a paper copy upon request.

SITE AND PROJECT DESCRIPTION

We understand that a multi-purpose gym space addition is proposed for the Warner Park Community Rec Center in Madison, WI. The existing building is a single-story, slab-on-grade building with parking lots to the south and southeast. The site of the planned addition is bounded by a public access road to the east, parking to the south, the existing rec center to the west, and undeveloped land/lawn to the north. Existing site grades within the construction area slope down from the northeast towards the southwest at elevations ranging from about EL 873 ft to EL 861 ft based on a provided topographic site plan (JSD Professional Services; 1-ft contours).

The addition is planned approximately on the southeast corner of the existing rec center building, which is planned to include a multi-purpose gym space and a storage/pre-function area. New handicapped parking is planned directly south of the addition, as well as a new stormwater management facility to the north of the rec center. We anticipate that finished floor elevation of the new addition will be at about the same elevation as the existing building, which appears to be about EL 862 ft based on the provided topographic site plan, and that parking grades will generally follow current site topography. Considering the existing site topography, the north and/or east walls or the planned addition may be partially backfilled following construction.

2921 Perry Street, Madison WI 53713
Telephone: 608/288-4100
FAX: 608/288-7887

SUBSURFACE CONDITIONS

Subsurface conditions for this study were explored by drilling four (4) Standard Penetration Test (SPT) soil borings near the planned corners of the gym addition to depths of 30 ft below current site grades. The soil borings were conducted by Americas Drilling Company (ADC; under subcontract to CGC) on March 2 and 8, 2023, using a truck-mounted CME-55 drill rig equipped with hollow stem augers and an automatic SPT hammer. The specific procedures used for drilling and sampling are described in Appendix A.

In addition to the soil borings, one test pit was performed within the planned stormwater management area. The test pit was excavated by Hellenbrand Brothers Excavating (HBE; under subcontract to CGC) and logged in the field by CGC on February 14, 2023. The test pit was extended to 10 feet below the ground surface.

The soil boring and test pit locations and depths were selected by JSD and field-staked by CGC and are shown in plan on the Soil Boring & Test Pit Location Exhibit attached in Appendix B. Ground surface elevations were surveyed by JSD and provided to CGC.

The subsurface profiles at the boring and test pit locations were fairly consistent, and the following strata were typically encountered (in descending order):

- About 4 to 15 in. of ***topsoil***; over
- Loose to very dense ***sand*** soils with varying silt and gravel contents as well as zones including scattered cobbles and boulders to the maximum depths explored.

Groundwater was encountered in the borings at depths between 13 and 23.5 ft below the ground surface during and up to approximately 1 hour after the completion of drilling. Groundwater was not encountered in the test pit during or upon the completion of excavating. Groundwater levels are expected to fluctuate with seasonal variations in precipitation, infiltration, evapotranspiration, the water level in nearby waterbodies as well as other factors.

A more detailed description of the site soil and groundwater conditions is presented on the Soil Boring Logs attached in Appendix B, and on the WDSPS *Soil and Site Evaluation – Storm* form for the test pit, which is attached in Appendix E. A representative sample taken from the test pit was analyzed with regard to its particle size distribution (gradation) to aid in classification, and the lab report is also attached in Appendix E.

DISCUSSION AND RECOMMENDATIONS

Subject to the limitations discussed below and based on the subsurface exploration, it is our opinion that the site is generally suitable for construction and that the proposed addition can be supported by a conventional spread footing foundation system bearing on medium dense to very dense native granular

soil. Our recommendations for site preparation, foundation, floor slab, below-grade wall, retaining wall and pavement design/construction, along with our assessment of the site class for seismic design and discussion of stormwater infiltration potential, are presented in the following subsections. Additional information regarding the conclusions and recommendations presented in this report is discussed in Appendix C.

1. Site Preparation

We recommend that topsoil be stripped at least 10 ft beyond the proposed construction area, including areas requiring fill beyond the building footprint and new pavement limits. The topsoil can be stockpiled on-site and later re-used as fill in landscaped areas. As noted previously, topsoil thicknesses ranged from about 4 to 15 in. in the borings and the test pit, but variable topsoil thicknesses should be expected between and beyond boring/test pit locations due to previous grading activities.

After topsoil stripping, we envision that the next step in site development will include excavation up to about 11 ft below current site grades to the slab elevation, with additional excavation to footing grades (and potential undercuts). Based on the current site layout, we anticipate that excavation sidewalls can generally be sloped back according to OSHA requirements. The sand soils with generally high amounts of fines (denoted as SM on the boring logs) are expected to control excavation slopes, and these soils are generally classified as OSHA "Type B" soils, with excavation slopes of 1.0H:1.0V expected to be at least temporarily stable. Note that flatter side slopes may be required where perched or seeping water is present that destabilizes the side slopes. *The appropriate excavation side slopes should be determined by a competent person completing the earthwork in accordance with OSHA slope guidelines.* Where adequate sloping is not possible, temporary shoring (earth retention) will be required. We recommend shoring systems be designed by an appropriately qualified professional engineer.

Following excavation to grade, where required, exposed subgrades are largely expected to consist of loose to dense native sand soils. In areas remaining at-grade or requiring fill, we recommend that cohesive and fine-grained subgrades (i.e., clay and silt), if present, be statically recompacted (i.e., without vibration) and subsequently proof-rolled with a piece of heavy rubber-tire construction equipment, such as a loaded tri-axle dump truck, to check for soft/yielding areas. Where soft/yielding areas are observed, these soils should be undercut and replaced with granular backfill compacted to at least 95% compaction based on modified Proctor methods (ASTM D1557) in accordance with our Recommended Compacted Fill Specifications presented in Appendix D. Alternatively, 3-in. dense graded base (DGB) that is placed in loose 10-in. lifts and compacted until deflection ceases can also be used to restore grades in undercut areas. Granular subgrades (i.e., sand and gravel) should be thoroughly recompacted with a vibratory smooth-drum roller, and zones that remain loose after recompaction should be undercut and replaced as described above.

2. Foundation Design

We assume that the finished floor elevation of the addition will match the existing building at about 862 ft, and we anticipate perimeter footings to extend at least 4 ft below the floor elevation (or finished exterior site grades) for frost protection. Interior footings or perimeter footings where the building walls are partially backfilled may also bear at shallower elevations. Accordingly, we expect footing subgrades to largely consist of medium dense to very dense sand soils. Isolated zones of loose sand soils could occur beneath footings and may need to be subsequently undercut and replaced if/where encountered.

Provided that the recommendations outlined above and in further detail below are followed, we recommend the following parameters be used for foundation design:

- Maximum net allowable bearing pressure: 5,000 psf

- Minimum foundation widths:
  - Continuous wall footings: 18 in.
  - Column pad footings: 30 in.

- Minimum footing depths below finish site grades:
  - Exterior/perimeter footings: 4 ft
  - Interior footings: no minimum requirement

Where new footings are planned adjacent to existing building foundations, the effects of overlapping soil stresses must be considered, and the recommended maximum net allowable bearing pressure must not be exceeded. If the existing building footings are designed for a lower allowable bearing pressure, the lower bearing pressure will control the maximum allowable overlapping soil stresses. Care must also be exercised not to undermine the existing building foundations during new footing and undercut excavations.

As a variety of subsurface conditions may be encountered across the building footprint, foundation subgrades should be checked by a CGC field representative to document that the subgrade soils are suitable for footing support or otherwise advise on corrective measures, such as undercutting. We recommend using a smooth-edged backhoe bucket for footing and undercut excavations. Granular soils exposed at footing grade should be thoroughly recompacted with a large vibratory plate compactor or an excavator-mounted hoe-pack prior formwork/concrete placement. Granular soils which remain loose following recompaction will require undercutting and replacement. Soils potentially susceptible to disturbance from vibratory compaction (e.g., cohesive/fine-grained soils or sands with elevated moisture contents) should be hand-trimmed. OSHA slope guidelines should be followed if workers need to enter the excavations.

Undercutting will generally be required where loose or disturbed sand soils that cannot be recompacted satisfactorily remain at and slightly below footing grades. *The base of undercut excavations should be widened beyond the footing edges at least 0.5 ft in each direction for each foot of undercut depth for stress distribution purposes.* Where undercutting of loose sand is required, we recommend that the base of the undercut be thoroughly recompacted, followed by replacement of the excavated sand to restore footing grades. The backfill should be compacted to at least 95% compaction based on modified Proctor methods (ASTM D1557), in accordance with the Recommended Compacted Fill Specifications presented in Appendix D. Alternatively, imported granular fill soils compacted to 95% modified Proctor or 3-in. DGB that is placed in loose 10-in. lifts and compacted until deflection ceases can also be used to restore foundation grades.

Provided the foundation design/construction recommendations discussed above are followed, we estimate that total and differential settlements should be on the order of 1.0 and 0.5 in., respectively.

3. Seismic Site Class

In our opinion, the average soil properties in the upper 100 ft of the site [based on SPT blow counts (N-values) projected to be between 15 and 50 blows/ft, on average, in the granular soils underlying the site] may be characterized as a stiff soil profile. This characterization would place the site in Site Class D for seismic design according to the International Building Code and ASCE 7.

4. Floor Slab

Based on a presumed finished floor elevation of about EL 862 ft, floor slab subgrades are generally anticipated to consist of native sand soils, with minor placement of structural fill possibly required near the southwest building corner. We recommend that granular floor slab subgrades be thoroughly recompacted with a vibratory smooth-drum roller prior to concrete placement. Cohesive and fine-grained floor slab subgrades (if present) should be statically recompacted (i.e., without vibration) and subsequently proof-rolled. Areas that remain loose after recompaction or where soft/yielding zones are observed should be undercut and replaced with well-compacted compacted 3-in. DGB or granular backfill. *Some subgrade improvement should be expected where loose sands are present at floor slab grades, possibly near borings B-1 and B-4 (based on the assumed FFE), and we recommend that the project budget include a contingency for such operations.*

To act as a capillary break below the slab, we recommend including a minimum 6-in. thick layer of well-graded sand/gravel with less than 5% by weight passing the No. 200 U.S. standard sieve. Note, however, that some structural engineers require a layer of dense graded base, such as 1¼-in. DGB, rather than sand/gravel below floor slabs to increase the subgrade modulus immediately below the slab. To further reduce the potential for moisture migration through the slab, a plastic vapor barrier can also be utilized. Fill and base layer material below the floor slab should be placed as described in the Site Preparation section of this report. Slabs constructed on a minimum 6-in. thick dense graded base layer may be designed utilizing a subgrade modulus of 150 pci, and a subgrade modulus of 100 pci should

be used for the design of slabs that are constructed on a sand/gravel layer. The design subgrade moduli are based on a firm or adequately stabilized, recompacted subgrade such that non-yielding conditions are developed. The slab should be structurally separated from the footings with a compressible filler and have construction joints and reinforcement for crack control.

5. Below-Grade Walls

If exterior building walls will be (partially) backfilled with soil, such as potentially at the north and east sides of the addition, we assume these walls will be laterally restrained against rotating by structural means. Therefore, *at-rest* lateral earth pressures should be used during design of these walls. To reduce the buildup of such pressures, high-quality backfill should be placed within 4 to 6 ft of the walls. We recommend that a perimeter drainage system be installed to intercept potential surface water infiltration, and that the granular backfill be continuously connected to the drainage system, which discharges water to one or more sumps. The granular backfill should be well-graded sand or gravel having no more than 12% by weight passing the No. 200 U.S. standard sieve (i.e., USCS designations SP, SP-SM, GP or GP-GM). Native sand soils with higher fines-content (denoted SM on the borings logs) may potentially also be used as below-grade wall backfill if a three-dimensional drainage board is included in the wall design. Soils containing cobbles/boulders should not be used in direct contact with below-grade walls. To impede the inflow of surface moisture, the final 2 ft of backfill in unpaved areas should consist of a clayey fill cap. The clayey cap (or pavement) should be graded to promote positive drainage away from the walls.

Before placing the wall backfill, the exterior walls should be damp-proofed with spray-applied or mopped-on rubber or bituminous sealer. Compaction of the backfill within 3 to 5 ft of the walls should be performed with lightweight equipment to avoid the development of excessive lateral earth pressures. The backfill should generally be compacted to a minimum compaction level of 93% modified Proctor following Appendix D guidelines. Below-grade walls constructed in accordance with the above recommendations may be designed for an equivalent fluid pressure of 55 psf per ft of depth (*at-rest* conditions). Additionally, the wall design should also account for surcharge effects that could be applied during or after construction.

6. Retaining Walls

Site retaining walls that are not laterally restrained from rotating can be designed for *active* earth pressures behind the walls and *passive* pressures in front of the walls. Lateral earth pressures behind the retaining walls can be reduced by backfilling with sand with less than 12% by weight passing the No. 200 U.S. standard sieve, as described in the preceding section. In addition, weepholes should be placed near the base of these walls on 10-ft centers to provide drainage of the wall backfill. The weepholes should be hydraulically connected with the backfill and should be protected with a non-woven geotextile fabric to minimize soil loss through the weepholes. The wall designer may have other and/or additional drainage requirements.

Assuming the inclusion of free-draining wall backfill, retaining walls that are free to rotate and constructed in accordance with the above recommendations may be designed for an *active* equivalent fluid pressure of 35 psf per ft of depth. *Passive* pressures are expected to be on the order of 200 psf per ft of depth. The passive pressure value includes a safety factor of 2 to prevent excessive wall deflection. The retaining wall design should also take into account surcharge effects which could be applied during or after construction.

We recommend using an *ultimate* concrete-to-soil friction factor of 0.3 for retaining wall footings bearing on at least medium stiff clay and silt soils. For footings bearing on sand, an *ultimate* concrete-to-soil friction factor of 0.4 may be implemented.

7. Pavement Design

We anticipate that pavement design will be controlled by the shallow sand soils, and subgrades should be prepared as described in the Site Preparation section of this report, with recompaction/proof-rolling completed prior to base course placement. Areas requiring undercutting/stabilization and the depth of undercutting should be determined in the field by proof-rolling prior to installing the base course layer. We anticipate that asphalt pavement on this site will primarily be exposed to automobile traffic with less than one 18-kip equivalent single axle load (ESAL) per day. In view of this, we have assumed Traffic Class I following Wisconsin Asphalt Pavement Association (WAPA) recommendations for smaller parking areas and driveways that are mainly used by light passenger vehicles. However, main sections of the driveways are likely to experience heavier traffic loads (e.g., due to large trucks). For pavement areas where trucks will routinely travel, as well as parking lots with 50 or more stalls, we have assumed a traffic load of up to 5 ESALs per day and Traffic Class II according to WAPA. The pavement sections summarized in Table 1 below were selected assuming a Soil Support Value "SSV" of about 4.0 for a firm or adequately stabilized silty sand subgrade and a design life of 20 years.

TABLE 1
Recommended Pavement Sections

Material	Thicknesses (in.)		WDOT Specification [(1)]
	Traffic Class I (Light Duty)	Traffic Class II (Medium Duty)	
Bituminous Upper Layer [(2,3)]	1.75	1.75	Section 460, Table 460-1
Bituminous Lower Layer [(2,3)]	1.75	2.25	Section 460, Table 460-1
Dense Graded Base Course [(2,4)]	8.0	10.0	Sections 301 and 305
Total Thickness	**11.5**	**14.0**	

Notes:

1) Wisconsin DOT *Standard Specifications for Highway and Structure Construction*, latest edition, including supplemental specifications, and *Wisconsin Asphalt Pavement Association 2020 Asphalt Pavement Design Guide*.

2) Compaction requirements:
   - Bituminous concrete: Refer to Section 460-3.
   - Base course: Refer to Section 301.3.4.2, Standard Compaction

3) Mixture Type LT (or E-0.3) bituminous; refer to Section 460, Table 460-2 of the *Standard Specifications*.

4) The upper 4 in. should consist of 1¼-in. DGB; the bottom part of the layer can consist of 3-in. DGB.

The medium-duty pavement section may be considered across the entire area for constructability purposes. The recommended pavement sections assume regular maintenance (crack sealing, etc.) will occur, as needed. Note that if traffic volumes are greater than those assumed, CGC should be allowed to review the recommended pavement sections and adjust them accordingly. Alternative pavement designs may prove acceptable and should be reviewed by CGC. If there is a delay between subgrade preparation and placing the base course, the subgrade should be recompacted.

Where concrete pavement may be used, such as in pavement areas subjected to concentrated wheel loads (e.g., entrance slabs, etc.), we recommend that the concrete be at least 6 in. thick and contain adequate reinforcement for crack control. Concrete slabs underlain by a minimum 6-in. thick dense graded base layer over a firm or stabilized subgrade can be designed utilizing a subgrade modulus of 150 pci.

8. Stormwater Infiltration Potential

We understand that a stormwater management feature is planned to the northwest of the proposed building addition, and test pit TP-1 was performed in this area to evaluate the subsurface conditions with regard to their stormwater infiltration potential. The profile in TP-1 was comprised of 15 in. of surficial topsoil (silt loam), underlain by sandy loam to gravelly sandy loam strata to the maximum depth explored.

Provided the infiltration system extends through the shallow silt loam horizon and into the coarser-grained layers (or lower-permeability soils are undercut below the bottom of the infiltration system and replaced with appropriate sandier soils), we anticipate that some infiltration will likely be possible. Note, however, that the granular soils were found to contain occasional seams of lower-permeability soil (e.g., *silty clay loam*), which are expected to control the vertical infiltration rate. In addition, the

granular soils are apparent overconsolidated glacial till, and the relatively high density may also reduce the infiltration potential. In an effort to improve the infiltration potential, we recommend the soils be excavated and blended (or deep-tilled, ripped, etc.) in order to break up the existing soil structure and fairly thin lower-permeability seams. *Thicker silt and clay layers will require excavation and removal.* After removal of the overlying lower-permeability strata, we recommend that the deep-tilling process extend at least 5 ft (potentially deeper pending field observations) below the bottom of the infiltration system. Samples of the mixed soils should be collected during construction to document that the gradations of the mixed samples are consistent with the soil texture that the design infiltration rate is based upon (per Table 2 of WDNR Tech. Std. 1002). *Variability in the soil conditions should be expected across the site that could result in a wide range of undercut depths to reach soil suitable for the design infiltration rate.*

Infiltration Potential: The following is a summary of the estimated infiltration rates for the soils encountered in Test Pit TP-1, per Table 2 of the WDNR Conservation Practice Standard 1002, *Site Evaluation for Storm Water Infiltration*. *Where lower-permeability soil (e.g., silty clay loam, silt loam, etc.) seams/layers exist within otherwise more permeable soils (e.g., granular, coarse-grained soils), the infiltration rate of the lower-permeability seams/layers will control the overall vertical infiltration rate, unless the lower-permeability seams are removed or the layer (with scattered seams) is excavated and blended, as previously discussed*. The estimated infiltration rates are as follows:

- Silty clay loam (SiCL) 0.04 in./hr
- Silt loam (SiL) 0.13 in./hr
- Sandy loam (SL) 0.50 in./hr
- Gravelly sandy loam (FSL) 0.50 in./hr

Note that the infiltration rates should be considered approximate since they are merely based on soil texture and do not account for in-place soil density and other factors, which will affect the infiltration rate. We recommend that, at the time of construction, the soils at and several feet below the bottom of stormwater management system be checked by a certified soil tester *in conjunction with the basin designer* to document that the soils are appropriate for the design infiltration rate or recommend remedial measures, if necessary. Please refer to the WDSPS Soil and Site Evaluation – Storm form for the test pit, contained in Appendix E, for a more detailed description of the encountered subsurface conditions.

Groundwater: Groundwater was not encountered in the test pit During or upon the completion of excavating. Based on the soil borings performed within the planned building area, the depth to groundwater ranges between about 13 and 23.5 ft below existing site grades, although seasonally higher groundwater levels are also likely.

Bedrock: Bedrock was not encountered in the test pit or soil borings performed for this study. The depth of bedrock should be expected to vary across the site.

During construction, appropriate erosion control should be provided to prevent eroded soil from contaminating the stormwater management area. Where appropriate, the stormwater system design should include pretreatment to remove fine-grained soils (silt/clay) and clogging materials (oils/greases) from stormwater prior to entering the infiltration area. Additionally, a regular maintenance plan should be developed to remove silt/clay soils and clogging materials that may accumulate in the bottom of the stormwater management area over time. Failure to adequately control fine-grained soils and clogging materials from entering the infiltration area or failure to regularly remove fine-grained soils and clogging materials that accumulate at the base of the stormwater infiltration system will likely cause the stormwater management system to fail. Additionally, it is important that the soils in the bottom of the infiltration system do not become compacted during construction or measures are taken to mitigate soils that are compacted during construction. Refer to WDNR *Conservation Practice Standards 1002, 1003 and 1004*, as well as *NR151* for additional information.

CONSTRUCTION CONSIDERATIONS

Due to variations in weather, construction methods and other factors, specific construction problems are difficult to predict. Soil related difficulties which could be encountered on the site are discussed below:

- Due to the potentially sensitive nature of some of the on-site soils, we recommend that final site grading activities be completed during dry weather, if possible. Construction traffic should be avoided on prepared subgrades to minimize potential disturbance.

- Contingencies in the project budget for subgrade stabilization with coarse aggregate in pavement and floor slab areas should be increased if the project schedule requires that work proceed during adverse weather conditions.

- Earthwork construction during the late fall through early spring could be complicated as a result of wet weather and freezing temperatures. During cold weather, exposed subgrades should be protected from freezing before and after footing construction. Fill should never be placed while frozen or on frozen ground.

- Excavations extending greater than 4 ft in depth below the existing ground surface should be sloped or braced in accordance with current OSHA standards. Earth retention systems, if needed, should be designed by an appropriately qualified professional engineer.

- Care must be exercised not to undermine the existing building foundations during new foundation and potential undercut excavations. The need for underpinning or working in discrete sections should be evaluated by the contractor.

- Based on the observations made during our field exploration, we generally do not anticipate groundwater to be encountered during construction. However, water accumulating at the bottom of excavations as a result of precipitation or seepage should be quickly removed, with dewatering means and methods the contractor's responsibility.

RECOMMENDED CONSTRUCTION MONITORING

The quality of the foundation, floor slab and pavement subgrades will be largely determined by the level of care exercised during site development. To check that earthwork and foundation construction proceed in accordance with our recommendations, the following operations should be monitored by CGC:

- Topsoil stripping and subgrade proof-rolling/compaction;
- Fill/backfill placement and compaction;
- Foundation excavation/subgrade preparation; and
- Concrete placement.

*** * * * ***

It has been a pleasure to serve you on this project. If you have any questions or need additional consultation, please contact us.

Sincerely,

CGC, Inc.

Emma L. Carew, EIT
Staff Engineer

Tim F. Gassenheimer, PE, CST
Senior Staff Engineer

Encl: Appendix A - Field Exploration
Appendix B - Soil Boring & Test Pit Location Exhibit
Logs of Test Borings (4)
Log of Test Boring-General Notes
Unified Soil Classification System
Appendix C - Document Qualifications
Appendix D - Recommended Compacted Fill Specifications
Appendix E - WDSPS *Soil and Site Evaluation – Storm* Form
Particle Size Distribution Test Report

APPENDIX A

FIELD EXPLORATION

APPENDIX A

FIELD EXPLORATION

Subsurface conditions for this study were explored by drilling four (4) Standard Penetration Test (SPT) soil borings to depths of 30 ft below current site grades, which were sampled at 2.5-ft intervals to a depth of 10 ft and at 5-ft intervals thereafter. The samples were obtained in general accordance with specifications for standard penetration testing, ASTM D 1586. The specific procedures used for drilling and sampling are described below.

1. Boring Procedures between Samples

   The boring is extended downward, between samples, by a hollow-stem auger.

2. Standard Penetration Test and Split-Barrel Sampling of Soils
   (ASTM Designation: D 1586)

   This method consists of driving a 2-inch outside diameter split-barrel sampler using a 140-pound weight falling freely through a distance of 30 inches. The sampler is first seated 6 inches into the material to be sampled and then driven 12 inches. The number of blows required to drive the sampler the final 12 inches is recorded on the log of borings and is known as the Standard Penetration Resistance.

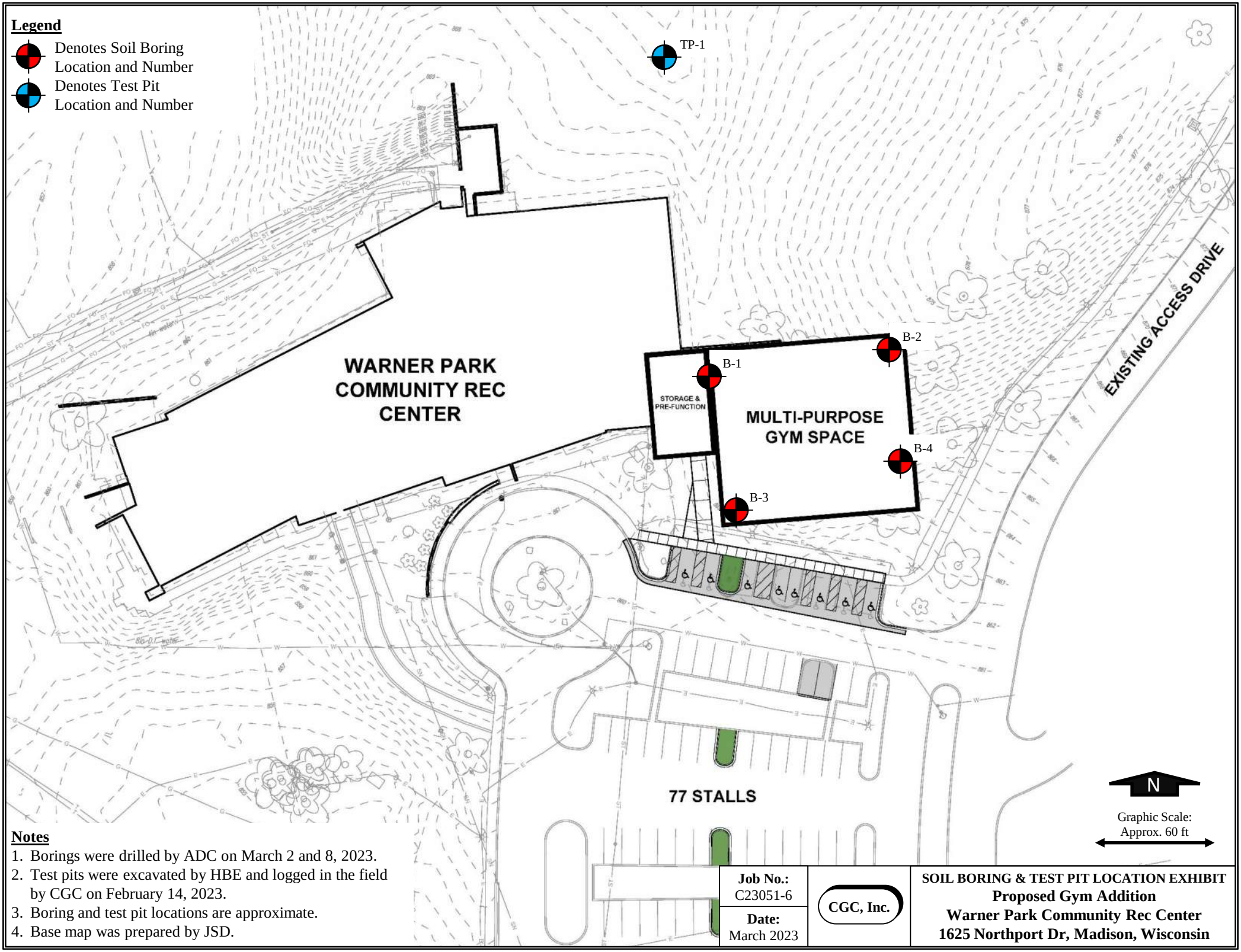
During the field exploration, the driller visually classified the soil and prepared a field log. *Field screening of the soil samples for possible environmental contaminants was not conducted by the driller as these services were not part of CGC's work scope.* Water level observations were made in each boring during and after drilling and are shown at the bottom of each boring log. Upon completion of drilling, the borings were backfilled with bentonite to satisfy WDNR regulations, and the soil samples were delivered to our laboratory for visual classification. The soils were visually classified by a geotechnical engineer using the Unified Soil Classification System (USCS).

In addition to the soil borings, one test pit was excavated within the planned stormwater management area. The excavation was logged (per the USDA classification system) in the field by a certified soil tester (CST) and subsequently backfilled with excavation spoils to reach original site grades.

The final boring logs prepared by the engineer, along with a Soil Boring & Test Pit Location Exhibit and a description of the Unified Soil Classification System are presented in Appendix B. The WDSPS *Soil and Site Evaluation – Storm* form for the test pit is contained in Appendix E.

APPENDIX B

SOIL BORING LOCATION EXHIBIT
LOGS OF TEST BORINGS (4)
LOG OF TEST BORING-GENERAL NOTES
UNIFIED SOIL CLASSIFICATION SYSTEM



Notes

1. Borings were drilled by ADC on March 2 and 8, 2023.
2. Test pits were excavated by HBE and logged in the field by CGC on February 14, 2023.
3. Boring and test pit locations are approximate.
4. Base map was prepared by JSD.

Job No.: C23051-6 **Date:** March 2023	CGC, Inc.	**SOIL BORING & TEST PIT LOCATION EXHIBIT** **Proposed Gym Addition** **Warner Park Community Rec Center** **1625 Northport Dr, Madison, Wisconsin**

CGC Inc.

LOG OF TEST BORING

Project **Warner Park Rec Center**

Location **Madison, WI**

Boring No. **B-1**
Surface Elevation (ft) **862.9**
Job No. **C23051-6**
Sheet **1** of **1**

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE No.	TYPE	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	qu (qa) (tsf)	W	LL	PL	LOI
						4 ± in. TOPSOIL					
1	■	16	M	8		Loose, Brown Fine to Medium SAND, Some Silt, Trace Clay, Little to Some Gravel (SM; Possible Fill)					
2	■	18	M	21	5	Medium Dense, Tan Fine to Medium SAND, Trace to Little Silt, Some Gravel (SP/SP-SM)					
3	■	18	M	51		Very Dense, Brown Fine to Medium SAND, Some Silt and Gravel (SM)					
4	■	12	M	64	10	Very Dense, Tan Silty Fine SAND, Some Gravel (SM)					
5	■	6	M	50/3"	15	Very Dense, Brown Fine to Medium SAND, Some Silt and Gravel, Scattered Cobbles and Boulders (SM)					
6	■	18	W	73	20	Very Dense, Brown Fine to Coarse SAND, Trace to Little Silt, Some Gravel (SP/SP-SM)					
7	■	12	W	73	25						
8	■	14	W	50/4"	30	Very Dense, Tan Silty Fine SAND, Some Gravel, Scattered Cobbles and Boulders (SM)					
						End of Boring at 30 ft Borehole Backfilled with Bentonite Chips and Soil Cuttings					
					35						

WATER LEVEL OBSERVATIONS

While Drilling ▽ **18.5'** Upon Completion of Drilling _____
Time After Drilling _____ _____ _____ **1 hr**
Depth to Water _____ _____ _____ **13** ▼
Depth to Cave in _____ _____ _____ **15**

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start **3/8/23** End **3/8/23**
Driller **ADC** Chief **KD** Rig **CME-55**
Logger **DB** Editor **ELC**
Drill Method **2.25" HSA; Autohammer**

CGC Inc.

LOG OF TEST BORING

Project: **Warner Park Rec Center**

Location: **Madison, WI**

Boring No. **B-2**
Surface Elevation (ft) **873.2**
Job No. **C23051-6**
Sheet **1** of **1**

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE No.	TYPE	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	qu (qa) (tsf)	W	LL	PL	LOI
						8 ± in. TOPSOIL					
1	■	12	M	7		Loose, Brown Fine to Medium Clayey SAND, Trace Gravel (SC)					
2	■	12	M	9		Loose to Very Dense, Brown Fine to Medium SAND, Some Silt and Gravel, Scattered Cobbles and Boulders (SM)					
3	■	16	M	19	5						
4	■	14	M	41							
5	■	8	M	50/4"	10						
6	■	18	M	69	15						
7	■	18	W	74	20						
8	■	14	W	75	25	Very Dense, Tan Fine SAND, Trace to Little Silt, Trace Gravel (SP/SP-SM)					
					30	End of Boring at 30 ft Borehole Backfilled with Bentonite Chips and Soil Cuttings					
					35						

WATER LEVEL OBSERVATIONS

While Drilling ▽ **23.5'**	Upon Completion of Drilling			
Time After Drilling				**1 hr**
Depth to Water				**22** ▼
Depth to Cave in				**23**

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start **3/8/23** End **3/8/23**
Driller **ADC** Chief **KD** Rig **CME-55**
Logger **DB** Editor **ELC**
Drill Method **2.25" HSA; Autohammer**

LOG OF TEST BORING

CGC Inc.

Project **Warner Park Rec Center**

Location **Madison, WI**

Boring No. **B-3**
Surface Elevation (ft) **862.3**
Job No. **C23051-6**
Sheet **1** of **1**

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE No.	TYPE	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	qu (qa) (tsf)	W	LL	PL	LOI
						10 ± in. TOPSOIL					
1		6	M	14		Medium Dense to Dense, Brown Fine to Medium SAND, Some Silt and Gravel, Scattered Cobbles and Boulders (SM)					
2		6	M	32	5						
						Occasional Pockets of Topsoil in Sample 1.					
3		12	M	24		Medium Dense, Tan Fine to Medium SAND, Trace to Little Silt, Little Gravel (SP/SP-SM)					
4		16	M	51	10	Very Dense, Brown Fine to Medium SAND, Some Silt and Gravel, Scattered Cobbles and Boulders (SM)					
5		18	W	61	▽ 15	Very Dense, Tan Silty Fine SAND, Trace Gravel (SM)					
6		14	M/W	50/4"	20	Very Dense, Brown Fine to Medium SAND, Some Silt and Gravel, Scattered Cobbles and Boulders (SM)					
7		18	W	57	25	Very Dense, Brown Fine to Coarse SAND, Trace Silt, Some Gravel (SP)					
8		14	W	81	30	Very Dense, Brown Fine to Medium SAND, Little Silt, Some Gravel (SP-SM)					
						End of Boring at 30 ft Borehole Backfilled with Bentonite Chips and Soil Cuttings					
					35						

WATER LEVEL OBSERVATIONS

While Drilling ▽ **13.5'** Upon Completion of Drilling _____
Time After Drilling _____ _____ _____ **30 min.**
Depth to Water _____ _____ _____ _____ ▼
Depth to Cave in _____ _____ _____ **11**

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start **3/8/23** End **3/8/23**
Driller **ADC** Chief **KD** Rig **CME-55**
Logger **DB** Editor **ELC**
Drill Method **2.25" HSA; Autohammer**

CGC Inc.

LOG OF TEST BORING

Project **Warner Park Rec Center**

Location **Madison, WI**

Boring No. **B-4**
Surface Elevation (ft) **866.2**
Job No. **C23051-6**
Sheet **1** of **1**

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	TYPE	Rec (in.)	Moist	N	Depth (ft)		qu (qa) (tsf)	W	LL	PL	LOI
						12 ± in. TOPSOIL					
1		10	M	8		Loose to Medium Dense, Brown Fine to Medium SAND, Some Silt and Gravel (SM)					
2		14	M	12	5						
3		16	M	25							
4		16	M	34	10	Dense, Tan Fine to Coarse SAND, Little Silt, Some Gravel (SP-SM)					
5		5	M	50/5"	15	Dense to Very Dense, Brown Silty Fine SAND, Trace Gravel, Scattered Cobbles (SM)					
6		18	M/W	49	20						
7		12	W	31	25	Dense, Brown Fine to Coarse SAND, Trace to Little Silt, Little Gravel (SP/SP-SM)					
8		14	W	34	30	Occasional Silt Seams in Sample 7.					
						End of Boring at 30 ft Borehole Backfilled with Bentonite Chips and Soil Cuttings					
					35						

WATER LEVEL OBSERVATIONS

While Drilling ▽ **18.5'** Upon Completion of Drilling _____
Time After Drilling _____
Depth to Water _____
Depth to Cave in _____

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start **3/2/23** End **3/2/23**
Driller **ADC** Chief **KD** Rig **CME-55**
Logger **DB** Editor **ELC**
Drill Method **2.25" HSA; Autohammer**

CGC, Inc.

LOG OF TEST BORING

General Notes

DESCRIPTIVE SOIL CLASSIFICATION

Grain Size Terminology

Soil Fraction	Particle Size	U.S. Standard Sieve Size
Boulders	Larger than 12”	Larger than 12”
Cobbles	3” to 12”	3” to 12”
Gravel: Coarse	¾” to 3”	¾” to 3”
Fine	4.76 mm to ¾”	#4 to ¾”
Sand: Coarse	2.00 mm to 4.76 mm	#10 to #4
Medium	0.42 to mm to 2.00 mm	#40 to #10
Fine	0.074 mm to 0.42 mm	#200 to #40
Silt	0.005 mm to 0.074 mm	Smaller than #200
Clay	Smaller than 0.005 mm	Smaller than #200

Plasticity characteristics differentiate between silt and clay.

General Terminology

Physical Characteristics
Color, moisture, grain shape, fineness, etc.
Major Constituents
Clay, silt, sand, gravel
Structure
Laminated, varved, fibrous, stratified, cemented, fissured, etc.
Geologic Origin
Glacial, alluvial, eolian, residual, etc.

Relative Density

Term	“N” Value
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

Relative Proportions Of Cohesionless Soils

Proportional Term	Defining Range by Percentage of Weight
Trace	0% - 5%
Little	5% - 12%
Some	12% - 35%
And	35% - 50%

Consistency

Term	q_u-tons/sq. ft
Very Soft	0.0 to 0.25
Soft	0.25 to 0.50
Medium	0.50 to 1.0
Stiff	1.0 to 2.0
Very Stiff	2.0 to 4.0
Hard	Over 4.0

Organic Content by Combustion Method

Soil Description	Loss on Ignition
Non Organic	Less than 4%
Organic Silt/Clay	4 – 12%
Sedimentary Peat	12% - 50%
Fibrous and Woody Peat	More than 50%

Plasticity

Term	Plastic Index
None to Slight	0 - 4
Slight	5 - 7
Medium	8 - 22
High to Very High	Over 22

The penetration resistance, N, is the summation of the number of blows required to effect two successive 6” penetrations of the 2” split-barrel sampler. The sampler is driven with a 140 lb. weight falling 30” and is seated to a depth of 6” before commencing the standard penetration test.

SYMBOLS

Drilling and Sampling

CS – Continuous Sampling
RC – Rock Coring: Size AW, BW, NW, 2”W
RQD – Rock Quality Designation
RB – Rock Bit/Roller Bit
FT – Fish Tail
DC – Drove Casing
C – Casing: Size 2 ½”, NW, 4”, HW
CW – Clear Water
DM – Drilling Mud
HSA – Hollow Stem Auger
FA – Flight Auger
HA – Hand Auger
COA – Clean-Out Auger
SS - 2” Dia. Split-Barrel Sample
2ST – 2” Dia. Thin-Walled Tube Sample
3ST – 3” Dia. Thin-Walled Tube Sample
PT – 3” Dia. Piston Tube Sample
AS – Auger Sample
WS – Wash Sample
PTS – Peat Sample
PS – Pitcher Sample
NR – No Recovery
S – Sounding
PMT – Borehole Pressuremeter Test
VS – Vane Shear Test
WPT – Water Pressure Test

Laboratory Tests

q_a – Penetrometer Reading, tons/sq ft
q_a – Unconfined Strength, tons/sq ft
W – Moisture Content, %
LL – Liquid Limit, %
PL – Plastic Limit, %
SL – Shrinkage Limit, %
LI – Loss on Ignition
D – Dry Unit Weight, lbs/cu ft
pH – Measure of Soil Alkalinity or Acidity
FS – Free Swell, %

Water Level Measurement

▽- Water Level at Time Shown
NW – No Water Encountered
WD – While Drilling
BCR – Before Casing Removal
ACR – After Casing Removal
CW – Cave and Wet
CM – Caved and Moist

Note: Water level measurements shown on the boring logs represent conditions at the time indicated and may not reflect static levels, especially in cohesive soils.

CGC, Inc.

Madison - Milwaukee

Unified Soil Classification System

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size)			
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)		
		GW	Well-graded gravels, gravel-sand mixtures, little or no fines
		GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)		
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)		
		SW	Well-graded sands, gravelly sands, little or no fines
		SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)		
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)			
SILTS AND CLAYS Liquid limit less than 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS		PT	Peat and other highly organic soils

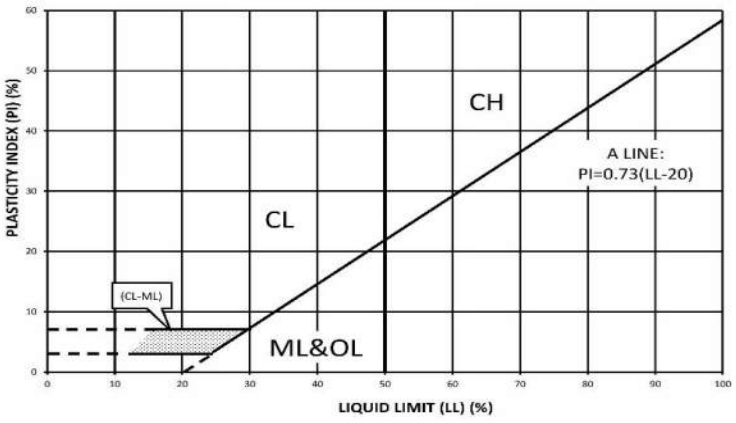
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limts below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limts above "A" line or P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent ..... GW, GP, SW, SP
More than 12 percent ..... GM, GC, SM, SC
5 to 12 percent ..... Borderline cases requiring dual symbols

PLASTICITY CHART



APPENDIX C

DOCUMENT QUALIFICATIONS

APPENDIX C
DOCUMENT QUALIFICATIONS

I. GENERAL RECOMMENDATIONS/LIMITATIONS

CGC, Inc. should be provided the opportunity for a general review of the final design and specifications to confirm that earthwork and foundation requirements have been properly interpreted in the design and specifications. CGC should be retained to provide soil engineering services during excavation and subgrade preparation. This will allow us to observe that construction proceeds in compliance with the design concepts, specifications and recommendations, and also will allow design changes to be made in the event that subsurface conditions differ from those anticipated prior to the start of construction. CGC does not assume responsibility for compliance with the recommendations in this report unless we are retained to provide construction testing and observation services.

This report has been prepared in accordance with generally accepted soil and foundation engineering practices and no other warranties are expressed or implied. The opinions and recommendations submitted in this report are based on interpretation of the subsurface information revealed by the test borings indicated on the location plan. The report does not reflect potential variations in subsurface conditions between or beyond these borings. Therefore, variations in soil conditions can be expected between the boring locations and fluctuations of groundwater levels may occur with time. The nature and extent of the variations may not become evident until construction.

II. IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes. While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. *No one except you* should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one - not even you* - should apply the report for any purpose or project except the one originally contemplated.

READ THE FULL REPORT

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, *do not rely on a geotechnical engineering report* that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes - even minor ones - and request an assessment of their impact. *CGC cannot accept responsibility or liability for problems that occur because our reports do not consider developments of which we were not informed.*

SUBSURFACE CONDITIONS CAN CHANGE

A geotechnical engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

MOST GEOTECHNICAL FINDINGS ARE PROFESSIONAL OPINION

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgement to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ - sometimes significantly - from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most

effective method of managing the risks associated with unanticipated conditions.

A REPORT'S RECOMMENDATIONS ARE NOT FINAL

Do not over-rely on the confirmation-dependent recommendations included in your report. *Those confirmation-dependent recommendations are not final*, because geotechnical engineers develop them principally from judgement and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *CGC cannot assume responsibility or liability for the report's confirmation-dependent recommendations if we do not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical engineering report. Confront that risk by having CGC participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

DO NOT REDRAW THE ENGINEER'S LOGS

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

GIVE CONSTRUCTORS A COMPLETE REPORT AND GUIDANCE

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

READ RESPONSIBILITY PROVISIONS CLOSELY

Some clients, design professionals, and constructors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineer's responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

ENVIRONMENTAL CONCERNS ARE NOT COVERED

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

OBTAIN PROFESSIONAL ASSISTANCE TO DEAL WITH MOLD

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

RELY ON YOUR GEOTECHNICAL ENGINEER FOR ADDITIONAL ASSISTANCE

Membership in the Geotechnical Business Council (GBC) of Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with CGC, a member of GBC, for more information.

Modified and reprinted with permission from:

Geotechnical Business Council
of the Geoprofessional Business Association
8811 Colesville Road, Suite G 106
Silver Spring, MD 20910

APPENDIX D

RECOMMENDED COMPACTED FILL SPECIFICATIONS

APPENDIX D

CGC, INC.

RECOMMENDED COMPACTED FILL SPECIFICATIONS

General Fill Materials

Proposed fill shall contain no vegetation, roots, topsoil, peat, ash, wood or any other non-soil material which by decomposition might cause settlement. Also, fill shall never be placed while frozen or on frozen surfaces. Rock, stone or broken concrete greater than 6 in. in the largest dimension shall not be placed within 10 ft of the building area. Fill used greater than 10 ft beyond the building limits shall not contain rock, boulders or concrete pieces greater than a 2 sq ft area and shall not be placed within the final 2 ft of finish subgrade or in designated utility construction areas. Fill containing rock, boulders or concrete pieces should include sufficient finer material to fill voids among the larger fragments.

Special Fill Materials

In certain cases, special fill materials may be required for specific purposes, such as stabilizing subgrades, backfilling undercut excavations or filling behind retaining walls. For reference, WisDOT gradation specifications for various types of granular fill are attached in Table 1.

Placement Method

The approved fill shall be placed, spread and leveled in layers generally not exceeding 10 in. in thickness before compaction. The fill shall be placed at moisture content capable of achieving the desired compaction level. For clay soils or granular soils containing an appreciable amount of cohesive fines, moisture conditioning will likely be required.

It is the Contractor's responsibility to provide all necessary compaction equipment and other grading equipment that may be required to attain the specified compaction. Hand-guided vibratory or tamping compactors will be required whenever fill is placed adjacent to walls, footings, columns or in confined areas.

Compaction Specifications

Maximum dry density and optimum moisture content of the fill soil shall be determined in accordance with modified Proctor methods (ASTM D1557). The recommended field compaction as a percentage of the maximum dry density is shown in Table 2. Note that these compaction guidelines would generally not apply to coarse gravel/stone fill. Instead, a method specification would apply (e.g., compact in thin lifts with a vibratory compactor until no further consolidation is evident).

Testing Procedures

Representative samples of proposed fill shall be submitted to CGC, Inc. for optimum moisture-maximum density determination (ASTM D1557) prior to the start of fill placement. The sample size should be approximately 50 lb.

CGC, Inc. shall be retained to perform field density tests to determine the level of compaction being achieved in the fill. The tests shall generally be conducted on each lift at the beginning of fill placement and at a frequency mutually agreed upon by the project team for the remainder of the project.

Table 1
Gradation of Special Fill Materials

Material	WisDOT Section 311	WisDOT Section 312	WisDOT Section 305			WisDOT Section 209		WisDOT Section 210
	Breaker Run	Select Crushed Material	3-in. Dense Graded Base	1 1/4-in. Dense Graded Base	3/4-in. Dense Graded Base	Grade 1 Granular Backfill	Grade 2 Granular Backfill	Structure Backfill
Sieve Size	Percent Passing by Weight							
6 in.	100							
5 in.		90-100						
3 in.			90-100					100
1 1/2 in.		20-50	60-85					
1 1/4 in.				95-100				
1 in.					100			
3/4 in.			40-65	70-93	95-100			
3/8 in.				42-80	50-90			
No. 4			15-40	25-63	35-70	100 (2)	100 (2)	25-100
No. 10		0-10	10-30	16-48	15-55			
No. 40			5-20	8-28	10-35	75 (2)		
No. 100						15 (2)	30 (2)	
No. 200			2-12	2-12	5-15	8 (2)	15 (2)	15 (2)

Notes:

1. Reference: Wisconsin Department of Transportation *Standard Specifications for Highway and Structure Construction.*
2. Percentage applies to the material passing the No. 4 sieve, not the entire sample.
3. Per WisDOT specifications, both breaker run and select crushed material can include concrete that is 'substantially free of steel, building materials and other deleterious material'.

Table 2
Compaction Guidelines

Area	Percent Compaction (1)	
	Clay/Silt	Sand/Gravel
Within 10 ft of building lines		
Footing bearing soils	93 - 95	95
Under floors, steps and walks		
- Lightly loaded floor slab	90	90
- Heavily loaded floor slab and thicker fill zones	92	95
Beyond 10 ft of building lines		
Under walks and pavements		
- Less than 2 ft below subgrade	92	95
- Greater than 2 ft below subgrade	90	90
Landscaping	85	90

Notes:

1. Based on Modified Proctor Dry Density (ASTM D 1557)

APPENDIX E

WISCONSIN DEPARTMENT OF SAFETY & PROFESSIONAL SERVICES
***SOIL AND SITE EVALUATION – STORM* FORM**
PARTICLE SIZE DISTRIBUTION TEST REPORT

Division of Industry Services
P.O. Box 2658
Madison, Wisconsin 53701

Attachment 2:

SOIL AND SITE EVALUATION - STORM

In accordance with SPS 382.365, 385, Wis. Adm. Code, and WDNR Standard 1002

Attach a complete site plan on paper not less than 8 ½ x 11 inches in size. Plan must include, but not limited to: vertical and horizontal reference point (BM), direction and percent of slope, scale or dimensions, north arrow, and BM referenced to nearest road

Please print all information

Personal information you provide may be used for secondary purposes [Privacy Law, s. 15.04(1)(m)]

County	Dane
Parcel I.D.	251/0809-361-0096-8
Reviewed by:	
Date:	

Property Owner: City of Madison Parks, Warner Playfield Stadium		Property Location: Govt. Lot NW ¼ NE ¼ S 36 T 8 N R 9 E	
Property Owner's Mail Address: 330 E Lakeside St		Lot #	Block# / Subd. Name or CSM #
City: Madison	State: WI / Zip Code: 53715 / Phone Number	[X] City [ ] Village [ ] Town: Madison	Nearest Road: Northport Drive
Drainage area: _____ [ ] sq ft [ ] acres		Hydraulic Application Test Method	Soil Moisture: Date of soil borings: _____
Test site suitable for (check all that apply): [ ] Site not suitable;		[X] Morphological Evaluation	USDA-NRCS WETS Value: [ ] Dry = 1;
[ ] Bioretention; [ ] Subsurface Disperal System;		[ ] Double Ring Infiltrometer	[ ] Normal = 2;
[ ] Reuse; [ ] Irrigation; [ ] Other _____		[ ] Other: (specify) _____	[ ] Wet = 3.

TP-1 #OBS. [X] Pit [ ] Boring Ground surface elevation 866.5 ft. Elevation of limiting factor <856.5 ft.

Horizon	Approx. Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	% Rock Frags.	% Fines (P200)	Hydraulic App Rate Inches/Hr
1	0-15	10YR 4/1	none	SiL	2mgr	mfr	cs	<5		0.13
2	15-43	10YR 4/4	none	SL, *SiCL Seams*	1fsbk	mfr	gs	<5		0.04-0.50 (1)
3	43-120	10YR 5/4	none	GRSL	0sg	ml	n/a	15 (2)	23 (2)	0.50

Comments: Groundwater was not encountered during or upon the completion of excavating.

(1) Vertical infiltration rate is expected to be controlled by occasional *silty clay loam seams* , but can potentially be improved by excavating/turning over the granular deposit to break up the lower-permeability seams; samples should be collected during construction to check that the texture of the blended soil is consistent with the deisgn infiltration rate.

(2) Based on a sample taken at about 7 ft below grade.

Overall Site Comments: See Comments above and Stormwater Infiltration Potential section in our *Geotechnical Exploration Report* (CGC Project No. C23051-6; dated March 24, 2023).

Name (Please Print)	Tim F. Gassenheimer	Signature		Credential Number: SP-011900004
Address	129 Milky Way, Madison, WI 53718		Date Evaluation Conducted: February 14, 2023	Telephone Number: (608) 288-4100

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	11.6	3.5	10.9	51.2	22.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	92.9		
3/8	91.8		
#4	88.4		
#8	85.5		
#10	84.9		
#16	82.9		
#30	79.7		
#40	74.0		
#50	63.2		
#80	41.5		
#100	34.6		
#200	22.8		

* (no specification provided)

Material Description

Brown Fine to Medium Sand, Some Silt, Little Gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 6.2510 D_{85}= 2.0794 D_{60}= 0.2770
D_{50}= 0.2195 D_{30}= 0.1269 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Sample Number: TP-1/S-1

Date: 2/16/23

CGC,Inc.

Client: Madison City- Parks Division
Project: Warner park Community Center Addition

Project No: C23051-6 **Figure**

Tested By: JFS **Checked By:** KJS

SECTION 02 41 19
SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes (all items might not apply – see below and drawings):
   1. Demolition and removal of selected portions of building or structure.
   2. Demolition and removal of selected site elements.
   3. Salvage of existing items to be reused or recycled.

1.2 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
   1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.3 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Engineering Survey: Submit engineering survey of condition of building.

B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of selective demolition activities with starting and ending dates for each activity.

D. Predemolition photographs or video.

E. Statement of Refrigerant Recovery if any noted to be removed: Signed by refrigerant recovery technician.

1.5 CLOSEOUT SUBMITTALS

A. Inventory of items that have been removed and salvaged.

1.6 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.7 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
   1. Before selective demolition, Owner will remove the following items:
      a. All furniture, fixtures, and equipment (i.e., items not mounted or anchored to building) within project work area.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work because the building was constructed in 1999.
   1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

G. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.8 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
   1. Engage a professional engineer to perform the survey if beyond capability of General Contractor or Demolition Contractor. Cost of Engineering Services to be included in bid.
C. Inventory and record the condition of items to be removed and salvaged.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
   2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
   3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
   4. Maintain fire watch during and for at least two hours after flame-cutting operations.
   5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
   6. Dispose of demolished items and materials promptly.
B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
C. Removed and Salvaged Items:
   1. Clean salvaged items.
   2. Pack or crate items after cleaning. Identify contents of containers.
   3. Store items in a secure area until delivery to Owner.
   4. Transport items to Owner's storage area on-site unless directed otherwise in drawings.
   5. Protect items from damage during transport and storage.
D. Removed and Reinstalled Items:
   1. Clean and repair items to functional condition adequate for intended reuse.
   2. Pack or crate items after cleaning and repairing. Identify contents of containers.
   3. Protect items from damage during transport and storage.
   4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.
F. The following items are to be salvaged or reinstalled:
   1. See drawings.

3.6 CLEANING

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 01 74 19 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION

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SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

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PART 1 – GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2. SUMMARY

A. Section Includes:
   1. Form-facing material for cast-in-place concrete.

1.3. DEFINITIONS

A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.

B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4. PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review the following:
      a. Construction, movement, contraction, and isolation joints
      b. Forms and form-removal limitations.
      c. Anchor rod and anchorage device installation tolerances.

1.5. ACTION SUBMITTALS

A. Product Data: For each of the following:
   1. Exposed surface form-facing material.
   2. Concealed surface form-facing material.
   3. Form ties.
   4. Waterstops.
   5. Form-release agent.

B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
   1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
   2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.
      a. Location of construction joints is subject to approval of the Architect.
   3. Indicate proposed schedule and sequence of stripping of forms.

C. Samples:
   1. For waterstops.

1.6. INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Minutes of preinstallation conference.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 – PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
   1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
   2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.
      a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:
   1. Provide continuous, true, and smooth concrete surfaces.
   2. Furnish in largest practicable sizes to minimize number of joints.
   3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:
      a. Plywood, metal, or other approved panel materials.
      b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
         1) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.
   1. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 WATERSTOPS

A. Flexible Rubber Waterstops: U.S. Army Corps of Engineers CRD-C 513, **with factory-installed metal eyelets,** for embedding in concrete to prevent passage of fluids through joints, with factory fabricated corners, intersections, and directional changes.
   1. Profile: Ribbed with center bulb.
   2. Dimensions: 4 inches by 3/16 inch thick; nontapered.

B. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

2.4 RELATED MATERIALS

C. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners shall be acceptable to form liner manufacturer.

F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.

PART 3 – EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.
B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.
C. Limit concrete surface irregularities as follows:
1. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
D. Construct forms tight enough to prevent loss of concrete mortar.
1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.
E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, reglets, recesses, and other accessories, for easy removal.
F. Do not use rust-stained, steel, form-facing material.
G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
1. Provide and secure units to support screed strips
2. Use strike-off templates or compacting-type screeds.
H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.
I. Chamfer exterior corners and edges of permanently exposed concrete.
J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.
K. Construction and Movement Joints:
1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated on Drawings.
a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
L. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.
M. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
N. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
O. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.
   1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
   3. Clean embedded items immediately prior to concrete placement.

3.3 INSTALLATION OF WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.
   1. Install in longest lengths practicable.
   2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
   3. Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 033000 "Cast-In-Place Concrete."
   4. Secure waterstops in correct position at 12 inches on center.
   5. Field fabricate joints in accordance with manufacturer's instructions using heat welding.
      a. Miter corners, intersections, and directional changes in waterstops.
      b. Align center bulbs.
   6. Clean waterstops immediately prior to placement of concrete.
   7. Support and protect exposed waterstops during progress of the Work.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.
   1. Install in longest lengths practicable.
   2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
   3. Protect exposed waterstops during progress of the Work.

3.4 REMOVING AND REUSING FORMS

A. Formwork for sides of walls and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for **24** hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

B. Clean and repair surfaces of forms to be reused in the Work.
   1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
   2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
   1. Align and secure joints to avoid offsets.
   2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCING

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Steel reinforcement bars.
   2. Welded-wire reinforcement.

B. Related Requirements:
   1. Section 034100 "Precast Structural Concrete" for reinforcing used in precast structural concrete.
   2. Section 034500 "Precast Architectural Concrete" for reinforcing used in precast architectural concrete.
   3. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Each type of steel reinforcement.
   2. Epoxy repair coating.
   3. Zinc repair material.
   4. Bar supports.
   5. Mechanical splice couplers.
   6. Structural thermal break insulated connection system.

B. Shop Drawings: Comply with ACI SP-066:
   1. Include placing drawings that detail fabrication, bending, and placement.
   2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
   3. For structural thermal break insulated connection system, indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.

C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
   1. Location of construction joints is subject to approval of Architect.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For testing and inspection agency.

B. Delegated Design Engineer Qualifications: Include the following:
   1. Experience providing delegated design engineering services of the type indicated.
   2. Documentation that delegated design engineer is licensed in the state in which Project is located.

C. Welding certificates.
   1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.

D. Material Certificates: For each of the following, signed by manufacturers:
   1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
   2. Dual-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
E. Material Test Reports: For the following, from a qualified testing agency:
   1. Steel Reinforcement:
      a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.
   2. Mechanical splice couplers.
F. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
   1. Store reinforcement to avoid contact with earth.
   2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
   3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
   4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance of Structural Thermal Break Insulating Connection System: Structural thermal break insulated connection system to withstand the following loads and stresses:
   1. Dead Loads: As indicated on Drawings.
      a. Shear Load: As indicated on Drawings.
      b. Bending Moment: As indicated on Drawings.
   2. Live Loads: As indicated on Drawings.
      a. Shear Load: As indicated on Drawings.
      b. Bending Moment: As indicated on Drawings.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60deformed.
B. Headed-Steel Reinforcing Bars: ASTM A970/A970M.
C. Epoxy-Coated Reinforcing Bars:
   1. Steel Bars: ASTM A615/A615M, Grade 60, deformed bars.
   2. Epoxy Coating: ASTM A775/A775M or ASTM A934/A934M with less than 2 percent damaged coating in each 12-inch bar length.
D. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
E. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
B. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, ASTM A775/A775M epoxy coated.
C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.
   1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
      a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

b. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
c. For dual-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
d. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
e. For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

D. Mechanical Splice Couplers: ACI 318 [**Type 1**] [**Type 2**], same material of reinforcing bar being spliced; [**compression-only type**] [**tension-compression type**] [**dowel-bar type**] [**mechanical-lap type**].

E. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.
1. Finish: Plain.

2.4 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:
1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.
1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.
1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.
3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

G. Install welded-wire reinforcement in longest practicable lengths.
1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed 12 inches.
2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

H.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.

B. Inspections:

1. Steel-reinforcement placement.
2. Steel-reinforcement mechanical splice couplers.
3. Steel-reinforcement welding.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

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PART 1 - GENERAL

1.1 SUMMARY

A. In general, the work includes the following:
   1. 1. Footings
   2. Stoops (at doors)
   3. Aprons (at overhead doors, including concrete infill between stoops and aprons)
   4. Cast-in-place concrete work
   5. Interior slabs on grade
   6. Vapor retarder (barrier)
   7. Recessed slab, below-slab drain containment and other concrete work below the floor slabs.
   8. Floor trenches or utility trenches
   9. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
3. Section 079200 “Joint Sealant”
4. Section 321313 "Concrete Paving" for concrete pavement and walks.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **Project site**.

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete Subcontractor.
2. Review the following:
   a. Construction joints, control joints, isolation joints, and joint-filler strips.
   b. Semirigid joint fillers.
   c. Vapor-retarder installation.
   d. Anchor rod and anchorage device installation tolerances.
   e. Cold and hot weather concreting procedures.
   f. Concrete finishes and finishing.
   g. Curing procedures.
   h. Forms and form-removal limitations.
   i. Methods for achieving specified floor and slab flatness and levelness.
   j. Floor and slab flatness and levelness measurements.
   k. Concrete repair procedures.
   l. Concrete protection.
   m. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
   n. Protection of field cured field test cylinders.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Aggregates.
5. Admixtures:
   a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
6. Fiber reinforcement.
7. Vapor retarders.
8. Floor and slab treatments.
9. Liquid floor treatments.
10. Curing materials.
    a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.
11. Joint fillers.
12. Repair materials.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.

3. Durability exposure class.
4. Maximum w/cm.
5. Slump limit.
6. Air content.
7. Nominal maximum aggregate size.
8. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
9. Intended placement method.
10. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:
1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
a. Location of construction joints is subject to approval of the Architect.

D. Samples: For **vapor retarder**.

E. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:
1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each of the following, signed by manufacturers:
1. Cementitious materials.
2. Admixtures.
3. Fiber reinforcement.
4. Curing compounds.
5. Floor and slab treatments.
6. Bonding agents.
7. Adhesives.
8. Vapor retarders.
9. Semirigid joint filler.
10. Joint-filler strips.
11. Repair materials.

B. Material Test Reports: For the following, from a qualified testing agency:
1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Aggregates.
5. Admixtures:

C. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

D. Research Reports:
1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.

E. Preconstruction Test Reports: For each mix design.

F. Field quality-control reports.

G. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

B. Field Quality-Control Testing Agency Qualifications: An independent agency, **acceptable to authorities having jurisdiction,** qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests to be qualified as an ACI Concrete Field-Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

C. Mockups: Before casting architectural concrete, build mockups, using the same procedures, equipment, materials, finishing procedures, and curing procedures that will be used for producing architectural concrete, to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, color, texture, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed work:
   1. Build mockups in the location and of the size indicated or, if not indicated, as directed by architect.
   2. Build mockups of typical wall of cast-in-place architectural concrete as shown on drawings, including vertical and horizontal rustication joints, and any sculptured features.
   3. Construct mockups to include at least two lifts having heights equal to those anticipated for construction.
   4. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.
   5. In presence of architect, damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair to match adjacent undamaged surfaces.
   6. In presence of architect, demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.
   7. Obtain architect's approval of mockups before casting architectural concrete.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
   1. Include the following information in each test report:
      a. Admixture dosage rates.
      b. Slump.
      c. Air content.
      d. Seven-day compressive strength.
      e. 28-day compressive strength.
      f. Permeability.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.
   1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   3. Do not use frozen materials or materials containing ice or snow.
   4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
   5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
   1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
   2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 FORM-FACING MATERIALS

A. Form-Facing wood forms:

1. Finishes: As cast.

a. Exterior-grade rough sawn board form planks, that will provide continuous, true, and pattern architectural concrete surfaces, Douglas Fir, construction grade, or better, mill-applied release agent and edge sealed, complying with DOC PS 1.

2. Location: Where noted on drawings.

3. Size: 4-inch nominal height

2.3 CONCRETE MATERIALS

A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.

2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.

3. Obtain aggregate from single source.

4. Obtain each type of admixture from a single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, **Type I/II**, **gray**.

2. Fly Ash: ASTM C618, Class C or F.

C. Normal-Weight Aggregates: ASTM C33/C33M, **Class 3S** coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: **1-1/2 inches** nominal.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Air-Entraining Admixture: ASTM C260/C260M.

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride **in steel-reinforced concrete**.

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1. Water-Reducing Admixture: ASTM C494/C494M, Type A.

2. Retarding Admixture: ASTM C494/C494M, Type B.

3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.

4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.

5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.

6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

7. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.

8. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

F. Superplasticizer shall be used in all interior flatwork and any pumped concrete unless otherwise approved in writing by the Architect. All concrete with W/C of 0.48 or less, and where pumping equipment is used, requires this admixture. In general, concrete shall be delivered to the site with a slump of 3" to 3 ½". Admixture shall be site added in lieu of any additional water.

G. Water and Water Used to Make Ice: ASTM C94/C94M, potable **or complying with ASTM C1602/C1602M, including all limits listed in Table 2 and the requirements of paragraph 5.4**

2.4 FIBER REINFORCEMENT

A. Synthetic Macro-Fiber: Synthetic macro-fibers engineered and designed for use in concrete, complying with ASTM C1116/C1116M, Type III, [**1 to 2-1/4 inches**] <**Insert dimensions**> long.

2.5 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 15 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.6 LIQUID FLOOR TREATMENTS (SC-1)

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
   1. Provide Prosoco SLX100 Water and Oil Repellant or equal.

2.7 CURING MATERIALS (SC-2)

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
   1. Color:
      a. Ambient Temperature Below 50 deg F: Black.
      b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
      c. Ambient Temperature Above 85 deg F: White.
D. Water: Potable or complying with ASTM C1602/C1602M.
E. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

2.8 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: **ASTM D1751, asphalt-saturated cellulosic fiber**.
B. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:
   1. **Types I and II, nonload bearing**, for bonding hardened or freshly mixed concrete to hardened concrete.

2.9 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
   1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
   2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
   4. Compressive Strength: Not less than 5**000 psi** at 28 days when tested in accordance with ASTM C109/C109M.
B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
   1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
   2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
   4. Compressive Strength: Not less than **5000 psi** at 28 days when tested in accordance with ASTM C109/C109M.

2.10 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.
   1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash or Other Pozzolans: 20 percent by mass.
   2. Slag Cement: 35 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
   1. Use **water-reducing** admixture in concrete, as required, for placement and workability.
   2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   3. Use water-reducing admixture in **pumped concrete, concrete for heavy-use industrial slabs**.

2.11 CONCRETE MIXTURES

A. Class **A**: Normal-weight concrete used for footings.
   1. Exposure Class: ACI 318 **F1-S0-W0-C0**.
   2. Minimum Compressive Strength**3500 psi** at 28 days.
   3. Maximum w/cm: 0.55.
   4. Slump Limit: **4 inches, plus or minus 1 inch**.
   5. Air Content:
      a. Exposure Class F1: **4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size**.

B. Class **B**: Normal-weight concrete used for foundation walls.
   1. Exposure Class: ACI 318 **F1**-**S0**-**W0**-**C0**.
   2. Minimum Compressive Strength: **4000 psi** at 28 days.
   3. Maximum w/cm: **0.45**
   4. Slump Limit: **4 inches, plus or minus 1 inch**.
   5. Air Content:
      a. Exposure Class F1: **5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size**
   6. Limit water-soluble, chloride-ion content in hardened concrete to **1.00** percent by weight of cement.

C. Class **C**: Normal-weight concrete used for interior slabs-on-ground.
   1. Exposure Class: ACI 318 **F0-S0-W0-C0**.
   2. Minimum Compressive Strength: **4500 psi** at 28 days.
   3. Maximum w/cm: **0.40**.
   4. Slump Limit: **5 inches, plus or minus 1 inch**.
   5. Air Content:
      a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
   6. Synthetic Macro-Fiber: Where indicated on plans, uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of **5 lb/cu. yd.**.

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
   1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
   2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
   1. Daily access to the Work.
   2. Incidental labor and facilities necessary to facilitate tests and inspections.
   3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
   4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
   1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.

3.4 INSTALLATION OF VAPOR RETARDER

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
   1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
   2. Face laps away from exposed direction of concrete pour.
   3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
   4. Lap joints 6 inches and seal with manufacturer's recommended tape.
   5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
   6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
   7. All overlapped conditions and terminations shall be sealed off and taped in a watertight manner.
   8. Protect vapor retarder during placement of reinforcement and concrete.
      a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.5 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
   1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
   2. Place joints perpendicular to main reinforcement.
      a. Continue reinforcement across construction joints unless otherwise indicated.
      b. Do not continue reinforcement through sides of strip placements of floors and slabs.
   3. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
   4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least **one-fourth** of concrete thickness as follows:
   1. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
   2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
   1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
   2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.
D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.
E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
    1. If a section cannot be placed continuously, provide construction joints as indicated.
    2. Deposit concrete to avoid segregation.
    3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
    4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
        a. Do not use vibrators to transport concrete inside forms.
        b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
        c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
        d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
    1. Do not place concrete floors and slabs in a checkerboard sequence.
    2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
    3. Maintain reinforcement in position on chairs during concrete placement.
    4. Screed slab surfaces with a straightedge and strike off to correct elevations.
    5. Level concrete, cut high areas, and fill low areas.
    6. Slope surfaces uniformly to drains where required.
    7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
    8. Do not further disturb slab surfaces before starting finishing operations.

G. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hang-troweling operation, free of trowel marks, uniform in texture and appearance, and with a level surface plane so that depressions between high spots do not exceed tolerances listed below. Grind smoot defects which would telegraph through applied floor covering system only in acceptable to Architect.
    1. Finish tolerances:
        a. All locations except as noted:
            1) specified overall $F_F = 50$
            2) specified overall $F_L = 35$
            3) specified local $F_F = 30$
            4) specified local $F_L = 20$

3.7 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:
    1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
        a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
        b. Remove projections larger than 1 inch.
        c. Tie holes do not require patching.
        d. Surface Tolerance: ACI 117 Class D.
        e. Apply to concrete surfaces **not exposed to public view**.
    2. ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
        a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
        b. Remove projections larger than 1/4 inch.
        c. Patch tie holes.
        d. Surface Tolerance: ACI 117 Class B.

e. Locations: Apply to concrete surfaces **exposed to public view**.

3. ACI 301 Surface Finish SF-3.0:
   a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
   b. Remove projections larger than 1/8 inch.
   c. Patch tie holes.
   d. Surface Tolerance: ACI 117 Class A.
   e. Locations: Apply to concrete surfaces **exposed to public view**.

3.8 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish:
   1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
   2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
   3. Apply float finish to surfaces **to receive trowel finish**.

C. Trowel Finish:
   1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
   2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
   3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   4. Do not add water to concrete surface.
   5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
   6. Apply a trowel finish to surfaces **exposed to view**.
   7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:
      a. Slabs on Ground:
         1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed **1/8 inch**.

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:
   1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
   2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
   3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct concrete bases **4 inches** high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
   3. Minimum Compressive Strength: **3000 psi** at 28 days.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
   6. Prior to pouring concrete, place and secure anchorage devices.
      a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      b. Cast anchor-bolt insert into bases.
      c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.
   1. Cast-in inserts and accessories, as shown on Drawings.

2. Screed, tamp, and trowel finish concrete surfaces.

3.10 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
   1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
   2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
   3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305.1, before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:
   1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
   2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
   3. If forms remain during curing period, moist cure after loosening forms.
   4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
      a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
      b. Continuous Sprinkling: Maintain concrete surface continuously wet.
      c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
      d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
      e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
         1) Recoat areas subject to heavy rainfall within three hours after initial application.
         2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:
   1. Begin curing immediately after finishing concrete.
   2. Interior Concrete Floors:
      a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
         1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
            a) Lap edges and ends of absorptive cover not less than 12 inches.
            b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
         2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
            a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
            b) Cure for not less than seven days.
         3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
            a) Water.
            b) Continuous water-fog spray.
      b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
         1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
            a) Lap edges and ends of absorptive cover not less than 12 inches.
            b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
         2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
            a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
            b) Cure for not less than seven days.
         3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
            a) Water.

b) Continuous water-fog spray.

c. Floors to Receive Polished Finish: Contractor has option of the following:
1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
a) Lap edges and ends of absorptive cover not less than 12 inches.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
a) Water.
b) Continuous water-fog spray.

d. Floors to Receive Chemical Stain:
1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
3) Butt sides of curing paper tight; do not overlap sides of curing paper.
4) Leave curing paper in place for duration of curing period, but not less than 28 days.

e. Floors to Receive Urethane Flooring:
1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
2) Rewet absorptive cover and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors to Receive Curing Compound:
1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer **unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project**.

g. Floors to Receive Curing and Sealing Compound:
1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Repeat the process 24 hours later and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.11 TOLERANCES

A. Conform to ACI 117.

3.12 APPLICATION OF LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.
1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than **14** days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
4. Rinse with water; remove excess material until surface is dry.
5. Apply a second coat in a similar manner if the surface is rough or porous.

3.13 JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least **six** month(s).
2. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.14 CONCRETE SURFACE REPAIRS

A. Defective Concrete:
1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
a. Limit cut depth to 3/4 inch.
b. Make edges of cuts perpendicular to concrete surface.
c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
d. Fill and compact with patching mortar before bonding agent has dried.
e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
b. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:
1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
a. Correct low and high areas.
b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing them with patching mortar.
a. Finish repaired areas to blend into adjacent concrete.
5. Correct other low areas scheduled to remain exposed with repair topping.
a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
d. Place, compact, and finish to blend with adjacent finished concrete.
e. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
b. Dampen cleaned concrete surfaces and apply bonding agent.
c. Place patching mortar before bonding agent has dried.
d. Compact patching mortar and finish to match adjacent concrete.
e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: **Engage** a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
1. Testing agency to be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
1) Project name.
2) Name of testing agency.
3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
4) Name of concrete manufacturer.
5) Date and time of inspection, sampling, and field testing.
6) Date and time of concrete placement.
7) Location in Work of concrete represented by samples.
8) Date and time sample was obtained.
9) Truck and batch ticket numbers.
10) Design compressive strength at 28 days.
11) Concrete mixture designation, proportions, and materials.
12) Field test results.
13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
14) Type of fracture and compressive break strengths at seven days and 28 days.

B. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.
C. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C143/C143M:
a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
b. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete.
a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M:
a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M:

a. Cast and laboratory cure two sets of **two** 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C39/C39M.
   a. Test one set of **two** laboratory-cured specimens at seven days and one set of two specimens at 28 days.
   b. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
10. Additional Tests:
   a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
   b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
      1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.6.6.3.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within **24** hours of completion of floor finishing and promptly report test results to Architect.

3.16 PROTECTION

A. Protect concrete surfaces as follows:
1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION

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SECTION 03 33 00
ARCHITECTURAL CONCRETE

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place architectural concrete, including form facings, reinforcement accessories, concrete materials, concrete mixtures, concrete placement, and concrete finishes.
2. Requirements in Section 033000 "Cast-in-Place Concrete" apply to this Section.

1.2 DEFINITIONS

A. Cast-in-Place Architectural Concrete: Concrete that is exposed to view, is designated as architectural concrete, and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.

B. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

C. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **Project si**te.

1. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Cast-in-place architectural concrete Subcontractor.

2. Review the following:
a. Construction joints, control joints, isolation joints, and joint-filler strips.
b. Reinforcement accessory installation.
c. Cold- and hot-weather concreting procedures.
d. Concrete finishes and finishing.
e. Curing procedures.
f. Forms and form-removal limitations.
g. Shoring and reshoring procedures.
h. Concrete repair procedures.
i. Protection of cast-in-place architectural concrete.
j. Initial curing and field curing of field test cylinders (ASTM C31/C31M).
k. Protection of field-cured field test cylinders.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following:
1. Form-facing panels.
2. Form liners.
3. Form joint tape.
4. Form joint sealant.
5. Wood sealer.
6. Form-release agent.
7. Surface retarder.
8. Form ties.
9. Bar supports.
10. Portland cement.
11. Fly ash.
12. Slag cement.
13. Aggregates.
14. Admixtures:
a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
15. Repair materials.

B. Design Mixtures: For each concrete mixture, include the following:
1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Slump limit.
6. Air content.
7. Nominal maximum aggregate size.
8. Amounts of mixing water to be withheld for later addition at Project site if permitted.
9. Intended placement method.
10. Alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:
1. Formwork: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
a. Show formwork construction, including form-liner layout, form-liner termination details, dimensioned locations of form-facing material joints, rustications, construction and contraction joints, form joint-sealant details, form-tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.
b. ct cast-in-place architectural concrete.

1) Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
2) Location of construction joints is subject to approval of Architect.

D. Samples for Verification: Architectural concrete Samples, cast vertically, approximately 18 by 18 by 2 inches (450 by 450 by 50 mm), of finishes, colors, and textures to match design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:
1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.

B. Material Certificates: For each of the following:
1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Repair materials.

C. Material Test Reports: For the following, by a qualified testing agency:
1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Aggregates.

D. Research Reports: For concrete admixtures in accordance with ICC AC198.

E. Preconstruction Test Reports: For each mix design.

F. Concrete Repair: Submit a written, detailed description of materials, methods, equipment, and sequence of operations to be used for repairing architectural concrete, including protection of surrounding materials and Project site.
1. If materials and methods other than those indicated are proposed for any repairs to architectural concrete, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project and Installer's ability to use such materials and methods properly.
2. Project and Installer's ability to use such materials and methods properly.

G. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Installer Qualifications: An experienced cast-in-place architectural concrete installer, as evidenced by not less than five consecutive years' experience, specializing in installing cast-in-place architectural concrete similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
1. Provide written evidence of qualifications and experience.
2. Include locations, descriptions, and photographs of completed projects, including name of architect, substantiating the quality of the installer's experience.

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Technical Manager.
1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Level I.
2. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Level II.

D. Field Sample Panels: After approval of verification sample and before casting architectural concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, cast vertically, approximately 48 by 48 by 6 inches (1200 by 1200 by 150 mm) minimum, to demonstrate the expected range of finish, color, and texture variations.
1. Locate panels as indicated or, if not indicated, as directed by Architect.
2. Demonstrate methods of curing, aggregate exposure, wood sealers, and coatings, as applicable.

3. In presence of Architect, damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.
4. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
5. Demolish and remove field sample panels when directed.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.
1. Include the following information in each test report:
a. Admixture dosage rates.
b. Slump.
c. Air content.
d. Seven-day compressive strength.
e. 28-day compressive strength.
f. Permeability.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301 (ACI 301M).

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with Section 033000 "Cast-in-Place Concrete."
B. Hot-Weather Placement: Comply with Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 (ACI 301M) unless modified by requirements in the Contract Documents.

2.2 FORM-FACING MATERIALS

A. Comply with Section 031000 "Concrete Forming and Accessories" for formwork and other form-facing material requirements, and as specified in this Section.
B. Source Limitations: Obtain each type of form-facing material from single source from single manufacturer.

2.3 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place.
1. Manufacture bar supports in accordance with CRSI's "Manual of Standard Practice."
2. Where legs of wire bar supports contact forms, use **gray, all-plastic** bar supports.

2.4 CONCRETE MATERIALS

A. Cementitious Materials:
1. Portland Cement: ASTM C150/C150M, **Type I/IIgray**.
2. Fly Ash: **ASTM C618, Class C or Class F**.
B. Normal-Weight Aggregates: ASTM C33/C33M, **Class 5S** coarse aggregate or better, graded. Provide aggregates from single source from single manufacturer.
1. Maximum Coarse-Aggregate Size: **1 inch (25 mm)**.
2. Gradation: **Uniformly** graded.
C. Normal-Weight Fine Aggregate: **ASTM C33/C33M**, manufactured or natural sand, free of materials with deleterious reactivity to alkali in cement, from same source for entire Project.
D. Air-Entraining Admixture: As specified in Section 033000 "Cast-in-Place Concrete."
E. Chemical Admixtures: As specified in Section 033000 "Cast-in-Place Concrete," and certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
F. Water and Water Used to Make Ice: ASTM C94/C94M, potable.

2.5 CURING MATERIALS

A. Comply with Section 03 30 00 "Cast-in-Place Concrete."
   1. For integrally colored concrete, curing materials to be approved by color pigment manufacturer.
   2. For concrete indicated to be sealed, curing materials to be compatible with sealer.

2.6 REPAIR MATERIALS

A. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

2.7 CONCRETE MIXTURES, GENERAL

A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.

B. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301 (ACI 301M).
   1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs, based on laboratory trial mixtures.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

2.8 CONCRETE MIXTURES

A. Class **K**: Normal-weight concrete.
   1. Exposure Class: ACI 318 (ACI 318M) **F1**.
   2. Minimum Compressive Strength: **4000 psi (27.6 MPa)** at 28 days.
   3. Maximum w/cm: 0.45.
   4. Slump Limit: **4 inches (100 mm), plus or minus 1 inch (25 mm)**.
   5. Air Content:
      a. Exposure Class F1: **5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**.
   6. Limit water-soluble, chloride-ion content in hardened concrete to **1.00** percent by weight of cement.

2.9 CONCRETE MIXING

A. **Ready-Mixed** Architectural Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.
   1. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
   2. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
   3. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
   4. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with Section 031000 "Concrete Forming and Accessories" for formwork, embedded items, and shoring and reshoring, and as specified in this Section.

B. Limit deflection of form-facing panels to not exceed ACI 301 (ACI 301M) requirements.

C. Limit cast-in-place architectural concrete surface irregularities, as follows:
   1. Surface Finish-1.0: ACI 117 (ACI 117M) Class D, 1 inch (25 mm).
   2. Surface Finish-2.0: ACI 117 (ACI 117M) Class B, 1/4 inch (6 mm).
   3. Surface Finish-3.0: ACI 117 (ACI 117M) Class A, 1/8 inch (3.0 mm).

D. Construct forms to result in cast-in-place architectural concrete that complies with ACI 117 (ACI 117M).

E. Seal form joints, chamfers, rustication joints, and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.
   1. Provide closure backing materials if indented rustication is used over a ribbed form line, and seal joint between rustication strip and form with joint sealant.

F. **Chamfer** exterior corners and edges of cast-in-place architectural concrete.

G. Coat contact surfaces of wood rustications and chamfer strips with wood sealer before placing reinforcement, anchoring devices, and embedded items.

H. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.

3.2 INSTALLATION OF REINFORCEMENT AND ACCESSORIES

A. Comply with Section 032000 "Concrete Reinforcing" for fabricating and installing steel reinforcement and accessories.

3.3 JOINTS

A. Construction Joints: Install construction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
2. Form keyed joints as indicated. **Embed keys at least 1-1/2 inches (38 mm) into concrete.** Align construction joint within rustications attached to form-facing material.
3. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at top of footings or floor slabs.
5. Space vertical joints in walls **as indicated on Drawings**. Unless otherwise indicated on Drawings, locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use **bonding agent** at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

B. Contraction Joints: Form weakened-plane contraction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.

3.4 CONCRETE PLACEMENT

A. Comply with Section 033000 "Cast-in-Place Concrete."

3.5 FINISHING FORMED SURFACES

A. Comply with Section 033000 "Cast-in-Place Concrete."

B. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.

C. As-Cast Surface Finishes: Comply with Section 033000 "Cast-in-Place Concrete" for the following:

1. ACI 301 (ACI 301M) Surface Finish-1.0 (SF-1.0).
2. ACI 301 (ACI 301M) Surface Finish-2.0 (SF-2.0).
3. ACI 301 (ACI 301M) Surface Finish-3.0 (SF-3.0).

D. Final Concrete Finish: Comply with Section 033000 "Cast-in-Place Concrete" for the following:

1. Smooth-rubbed finish.

E. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.

F. Maintain uniformity of architectural concrete finishes over construction joints unless otherwise indicated.

3.6 CONCRETE CURING

A. Comply with Section 033000 "Cast-in-Place Concrete" using identical curing procedures to that used for **field sample panels**.

3.7 REPAIR

A. Comply with ACI 301 (ACI 301M).

B. Repair damaged finished surfaces of cast-in-place architectural concrete when repairing is approved by Architect.

C. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved **field sample panels**.

D. Remove and replace cast-in-place architectural concrete that cannot be repaired to Architect's approval.

3.8 FIELD QUALITY CONTROL

A. Comply with Section 033000 "Cast-in-Place Concrete."

3.9 CLEANING

A. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.

B. Wash and rinse surfaces in accordance with concrete finish applicator's written instructions.

1. Protect other Work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

3.10 PROTECTION

A. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.

B. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.

3.11 FINAL ACCEPTANCE

A. Final acceptance of completed architectural concrete Work will be determined by Architect by comparing approved **design reference sample** with installed Work, when viewed at a distance of **20 feet (6 m)**.

END OF SECTION

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SECTION 04 20 00
UNIT MASONRY

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Concrete masonry units.
2. Lintels.
3. Mortar and grout materials.
4. Reinforcement.
5. Ties and anchors.
6. Mortar and grout mixes.

B. Products Installed but not Furnished under This Section:
1. Steel lintels in unit masonry.
2. Steel shelf angles for supporting unit masonry.

C. Related Requirements:
1. Section 031000 "Concrete Forms and Accessories" for **installing** dovetail or channel slots for masonry-veneer anchors.
2. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).
B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:

1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Indicate bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315R.
3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type of the following:

1. Masonry units.
    a. Include **data on material properties**.
    b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
    c. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.
    d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing in accordance with ASTM C67/C67M
    e. For masonry units include data and calculations establishing average net-area compressive strength of units.
2. Cementitious materials. Include name of manufacturer, brand name, and type.
3. Mortar admixtures.
4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
5. Grout mixes. Include description of type and proportions of ingredients.
6. Reinforcing bars.
7. Joint reinforcement.
8. Anchors, ties, and metal accessories.

B. Mix Designs: For each type of mortar **and grout**. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

C. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined in accordance with TMS 602.

D. **Cold-Weather and Hot-Weather** Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Installers: All masonry flashing installers must complete the International Masonry Institute Flashing Upgrade training course.
2. Testing Agency Qualifications: Qualified in accordance with ASTM C1093 for testing indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches (610 mm) down both sides of walls, and hold cover securely in place.
   2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (610 mm) down face next to unconstructed wythe, and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For **exposed masonry units and cementitious mortar components**, obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
   1. Where fire-resistance-rated construction is indicated, **units are listed by UL or a qualified testing agency acceptable to authorities having jurisdiction**.

2.3 CONCRETE MASONRY UNITS

A. Verify CMU's are manufactured within 100 minles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site

B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
   1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
   2. Provide [**bullnose** units for outside corners unless otherwise indicated.

C. CMUs: ASTM C90, **normal weight**.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of **2800 psi (19.3 MPa)**.
   2. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less than nominal dimensions.
   3. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
   4. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

D. Concrete Building Brick: ASTM C55, **normal weight**.].

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of **2800 psi (19.3 MPa)**.
2. Size (Actual Dimensions): Manufactured to dimensions 3/8 inch less-than-nominal dimensions.

E. Decorative CMUs: ASTM C90, **normal weight**.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of **2800 psi**.
2. Size (Width): Manufactured to dimensions specified in "CMUs" Paragraph above.
3. Pattern and Texture:
   a. MSN-1: County Materials Decorative Concrete Masonry, Splitface texture, 8” x 16” running bond pattern.
   b. MSN-2: Arriscraft Thin-Clad Renaissance Units, Smooth texture, 12” x 24” running bond pattern.
4. Colors:
   a. MSN-1: 18-121C Bisque (Matched to Existing)
   b. MSN-2: Oak Ridge.
5. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of **2800 psi (19.3 MPa)**.
6. Size: Manufactured to dimensions specified in "CMUs" Paragraph above but with pre-faced surfaces having 1/16-inch- (1.6-mm-) wide returns of facing to create 1/4-inch- (6.2-mm-) wide mortar joints with modular coursing.

2.4 LINTELS

A. Solid Concrete Masonry Lintels: ASTM C1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated.
B. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 032000 "Concrete Reinforcing," and with reinforcing bars indicated.
C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
D. Offset Angle Supports: Steel plate brackets anchored to structure, allowing continuous insulation behind shelf angle supporting veneer. Component and anchor size and spacing engineered by manufacturer.

2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.
B. Hydrated Lime: ASTM C207, Type S.
C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
D. Masonry Cement: ASTM C91/C91M.
E. Mortar Cement: ASTM C1329/C1329M.
F. Aggregate for Mortar: ASTM C144.
1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch (6.4 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
G. Aggregate for Grout: ASTM C404.
H. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60 (Grade 420).
B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
C. Masonry-Joint Reinforcement, General: ASTM A951/A951M.
1. Interior Walls: Galvanized carbon steel.

2. Exterior Walls: **Hot-dip galvanized carbon**steel.
3. Wire Size for Side Rods: [**0.148-inch (3.77-mm)**] diameter.
4. Wire Size for Cross Rods: [**0.148-inch (3.77-mm)**] diameter.
5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (406 mm) o.c.
6. Provide in lengths of not less than 10 ft. (3 m).

D. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

E. Masonry-Joint Reinforcement for Multiwythe Masonry:

2.7 TIES AND ANCHORS

A. General: Ties and anchors extend at least 1-1/2 inches (38 mm) into veneer but with at least a 5/8-inch (16-mm) cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
1. Mill-Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A641/A641M, Class 1 coating.
2. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.4-mm-) diameter, **hot-dip galvanized steel** wire.
2. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**] diameter, [**hot-dip galvanized steel** wire.

D. Rigid Anchors: Fabricate from steel bars **1-1/2 inches (38 mm) wide by 1/4 inch (6.4 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated**.
1. Corrosion Protection: **Hot-dip galvanized to comply with ASTM A153/A153M** .

2.8 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
1. Do not use calcium chloride in mortar or grout.
2. Use **portland cement-lime** mortar unless otherwise indicated
3. For exterior masonry, use **portland cement-lime** mortar.
4. For reinforced masonry, use **portland cement-lime** mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, **Property** Specification. Provide the following types of mortar for applications stated unless another type is indicated.
1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use **Type S**.
3. For exterior, above-grade, load-bearing, nonload-bearing walls, and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
4. For interior nonload-bearing partitions, Type O may be used instead of Type N.

D. Grout for Unit Masonry: Comply with ASTM C476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476..
3. Provide grout with a slump of [**8 to 11 inches (203 to 279 mm)**] [**10 to 11 inches (254 to 279 mm)**] as measured in accordance with ASTM C143/C143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (13 mm) or minus 1/4 inch (6.4 mm).
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (13 mm).
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6.4 mm) in a story height or 1/2 inch (13 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 ft. (6.4 mm in 3 m), or 1/2-inch (13-mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 ft. (3.2 mm in 3 m), 1/4 inch in 20 ft. (6.4 mm in 6 m), or 1/2-inch (13-mm) maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft. (6.4 mm in 3 m), 3/8 inch in 20 ft. (10 mm in 6 m), or 1/2-inch (13-mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 ft. (3.2 mm in 3 m), 1/4 inch in 20 ft. (6.4 mm in 6 m), or 1/2-inch (13-mm) maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft. (6.4 mm in 3 m), 3/8 inch in 20 ft. (10 mm in 6 m), or 1/2-inch (13-mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 ft. (6.4 mm in 3 m), or 1/2-inch (13-mm) maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3.2 mm), with a maximum thickness limited to 1/2 inch (13 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3.2 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (10 mm) or minus 1/4 inch (6.4 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3.2 mm).
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.6 mm) from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in **running bond**; do not use units with less-than-nominal 4-inch (102-mm) horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than **4 inches (102 mm)**. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch (102-mm) horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches (610 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors, and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors **48 inches (1219 mm)** o.c. unless otherwise indicated.
2. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

A. Lay **CMUs**as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

1. For glazed masonry units, use a nonmetallic jointer 3/4 inch (19 mm) or more in width.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

E. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.6 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (152 mm).

1. Space reinforcement not more than 16 inches (406 mm) o.c.
2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings **in addition to continuous reinforcement**.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Cut and bend reinforcing units as directed by manufacturer for continuity at[**corners,**] returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry **using one of the following methods**:
   1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
   2. Install preformed control-joint gaskets designed to fit standard sash block.
   3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
   4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

3.8 LINTELS

A. Install steel lintels where indicated.
B. Provide **masonry**lintels where indicated and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are indicated without structural steel or other supporting lintels.
C. Provide minimum bearing of 8 inches (203 mm) at each jamb unless otherwise indicated.

3.9 REINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.
B. Placing Reinforcement: Comply with requirements in TMS 602.
C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than **60 inches (1524 mm)**

3.10 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
C. tion, where indicated.
D. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
E. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
   3. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
   4. Clean masonry with a proprietary acidic masonry cleaner applied according to manufacturer's written instructions.

3.11 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
   1. Crush masonry waste to less than 4 inches (102 mm) in each dimension.
   2. Do not dispose of masonry waste as fill within 18 inches (457 mm) of finished grade.
C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

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STRUCTURAL STEEL FRAMING

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Structural-steel materials.
   2. Shrinkage-resistant grout.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data:
   1. Structural-steel materials.
   2. High-strength, bolt-nut-washer assemblies.
   3. Anchor rods.
   4. Threaded rods.
   5. Forged-steel hardware.
   6. Shop primer.
   7. Shrinkage-resistant grout.

B. Shop Drawings: Show fabrication of structural-steel components.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment Drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
   5. Identify members not to be shop primed.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint, including the following:
   1. Power source (constant current or constant voltage).
   2. Electrode manufacturer and trade name, for demand-critical welds.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

C. Mill test reports for structural-steel materials, including chemical and physical properties.

D. Product Test Reports: For the following:
   1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
   2. Direct-tension indicators.
   3. Tension-control, high-strength, bolt-nut-washer assemblies.

E. Survey of existing conditions.

F. Source quality-control reports.

G. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
   1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
   1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
   2. Clean and relubricate bolts and nuts that become dry or rusty before use.
   3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:
   1. ANSI/AISC 303.

B. Connection Design Information:

1. Option 1: Connection designs have been completed and connections indicated on the Drawings.
2. Option 2: Fabricator's experienced steel detailer selects or completes connections in accordance with ANSI/AISC 303.
    a. Select and complete connections using schematic details indicated.
    b. Use Allowable Stress Design; data are given at service-load level.

C. Moment Connections: Type PR, partially restrained.

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A992/A992M.
B. Channels, Angles, M-Shapes: ASTM A36/A36M.
C. Channels, Angles, S-Shapes: ASTM A36/A36M.
D. Plate and Bar: ASTM A36/A36M.
E. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B structural tubing.
F. Steel Forgings: ASTM A668/A668M.
G. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
    1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with plain finish.

2.4 RODS

A. Headed Anchor Rods: ASTM F1554, Grade 36, straight.
    1. Nuts: ASTM A563 hex carbon steel.
    2. Plate Washers: ASTM A36/A36M carbon steel.
    3. Washers: ASTM F436, Type 1, hardened carbon steel.
    4. Finish: Plain.

2.5 PRIMER

A. Steel Primer:
    1. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.6 SHRINKAGE-RESISTANT GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
    1. Camber structural-steel members where indicated.
    2. Fabricate beams with rolling camber up.
    3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
    4. Mark and match-mark materials for field assembly.
    5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
    1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 1.
F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
    1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.

2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.8 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.9 SHOP PRIMING

A. Shop prime steel surfaces, except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:
1. SSPC-SP 2.
2. SSPC-SP 3.

C. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. **Snug-tighten** anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.
   1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
   2. Remove backing bars or runoff tabs **where indicated**, back gouge, and grind steel smooth.
   3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

3.5 REPAIR

A. Touchup Painting:
   1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
      a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.
   1. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
   2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.
      a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
         1) Liquid Penetrant Inspection: ASTM E165/E165M.
         2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
         3) Ultrasonic Inspection: ASTM E164.
         4) Radiographic Inspection: ASTM E94/E94M.

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SECTION 053100
STEEL DECKING

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof deck.
   2. Acoustical roof deck.

B. Related Requirements:
   1. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. Roof deck.
   2. Acoustical roof deck.

B. Shop Drawings:
   1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.
   1. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
      a. Acoustical roof deck.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:
   1. AWS D1.1/D1.1M.
   2. AWS D1.3/D1.3M.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
   1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.

2.2 ROOF DECK

A. Fabrication of Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:
   1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 33, G60 zinc coating.
   2. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 33, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
      a. Color: [Manufacturer's standard] [Gray] [White] [Gray top surface with white underside].
   3. Deck Profile: As indicated.
   4. Profile Depth: As indicated.
   5. Design Uncoated-Steel Thickness: As indicated.
   6. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated.
   7. Span Condition: Double span minimum.
   8. Side Laps: Interlocking seam.

2.3 ACOUSTICAL ROOF DECK

A. Fabrication of Acoustical Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:
   1. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 33, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
      a. Color: **[Manufacturer's standard] [Gray] [White] [Gray top surface with white underside].**
   2. Deck Profile: As indicated.
   3. Cellular Deck Profile: As indicated, with bottom plate.
   4. Profile Depth: As indicated.
   5. Design Uncoated-Steel Thickness: As indicated.
   6. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated.
   7. Span Condition: Double span minimum.
   8. Side Laps: Interlocking seam.
   9. Acoustical Perforations: **[Deck units with manufacturer's standard perforated vertical webs] [Cellular deck units with manufacturer's standard perforated flat-bottom plate welded to ribbed deck]**.
   10. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber. **<Insert actual physical properties and thicknesses of insulation>**.
      a. Factory install sound-absorbing insulation into cells of cellular deck.
      b. Installation of sound-absorbing insulation is specified in **<Insert Section number and title>**.
   11. Acoustical Performance: NRC **[0.65] [0.75] [0.80] [0.85] [0.90]**, tested in accordance with ASTM C423.

2.4 ACCESSORIES

A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

G. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inch minimum diameter.

H. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

I. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch-wide flanges and sloped recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

J. Galvanizing Repair Paint: ASTM A780/A780M.
K. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; manufacturer's written instructions; and requirements in this Section.
B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
C. Locate deck bundles to prevent overloading of supporting members.
D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
    1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
I. Retain paragraph below if mechanical fastening is permitted.
J. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with deck manufacturer's written instructions.

3.3 INSTALLATION OF ROOF DECK

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:
    1. Weld Diameter: 5/8 inch, nominal.
    2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.
    3. Weld Washers: Install weld washers at each weld location.
B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 18 inches, and as follows:
    1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
    2. Mechanically clinch or button punch.
    3. End Joints: Lapped 2 inches minimum or butted at Contractor's option.
C. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld or mechanically fasten flanges to top of deck. Space welds or mechanical fasteners not more than 12 inches apart with at least one weld or fastener at each corner.
    1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.
D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
    1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
E. Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in **<Insert Section number and title>**.

3.4 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.
B. Repair Painting:
    1. Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation and apply repair paint.

2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
3. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

END OF SECTION

SECTION 05 40 00
COLD-FORMED METAL FRAMING

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Exterior non-load-bearing wall framing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **Project site**.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Cold-formed steel framing materials.
   2. Exterior non-load-bearing wall framing.

B. Shop Drawings:
   1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
   2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated Design Submittal: For cold-formed steel framing.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of code-compliance certification for studs and tracks.

C. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.
   1. Steel sheet.
   2. Expansion anchors.
   3. Power-actuated anchors.
   4. Mechanical fasteners.
   5. Vertical deflection clips.

6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

D. Research Reports:
1. For nonstandard cold-formed steel framing **post-installed anchors and power-actuated fasteners**, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
2. For sill sealer gasket/termite barrier, showing compliance with ICC-ES AC380.

1.5 QUALITY ASSURANCE

A. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

B. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association.

C. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
1. Design Loads: As indicated on Drawings.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/360 of the wall height.
3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
a. Upward and downward movement of 1/2 inch.
5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing complies with AISI S100 and ASTM C955.

D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.2 COLD-FORMED STEEL FRAMING MATERIALS

A. Framing Members, General: Comply with ASTM C955 for conditions indicated.

B. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
1. Grade: As required by structural performance
2. Coating: G60, A60, AZ50, or GF30

C. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: As required by structural performance
2. Coating: G60

2.3 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0538 inch.
   2. Flange Width: 1-5/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0329 inch.
   2. Flange Width: 1-1/4 inches.

C. Vertical Deflection Clips, Exterior: Manufacturer's standard head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
   1. Minimum Base-Metal Thickness: 0.0428 inch.
   2. Flange Width: 1 inch plus the design gap for one-story structures.

E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.4 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   1. Supplementary framing.
   2. Bracing, bridging, and solid blocking.
   3. Web stiffeners.
   4. Anchor clips.
   5. End clips.
   6. Foundation clips.
   7. Gusset plates.
   8. Stud kickers and knee braces.
   9. Joist hangers and end closures.
   10. Hole-reinforcing plates.
   11. Backer plates.

2.5 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

B. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.
   1. Uses: Securing cold-formed steel framing to structure.
   2. Type: Torque-controlled expansion anchor.
   3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
   4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
   1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.6 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780/A780M.

B. Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.

D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

E. Sill Sealer Gasket: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

F. Sill Sealer Gasket/Termite Barrier: Minimum 68-mil nominal thickness, self-adhering sheet consisting of 64 mils of rubberized asphalt laminated on one side to a 4-mil- thick, polyethylene-film reinforcement, and with release liner on adhesive side.

1. Physical Properties:
   a. Peel Adhesion: 17.0 lb/in of width when tested in accordance with ASTM D412.
   b. Low-Temperature Flexibility: Pass at minus 25 deg F when tested in accordance with ASTM D146/D146M.
   c. Water Vapor Permeance: 0.05 perm maximum when tested in accordance with ASTM E96/E96M, Method B.
   d. Resistance to Termite Penetration: Comply with ICC-ES AC380.

2.7 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
   a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. Install sill sealer gasket/termite barrier in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
   a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF EXTERIOR NONLOADBEARING WALL FRAMING

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: 16 inches.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to infill studs and anchor to building structure.
4. Connect drift clips to cold-formed steel framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inche of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at centers indicated on Shop Drawings.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.

3.6 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 05 44 00
COLD-FORMED METAL TRUSSES

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. SECTION INCLUDES: Roof trusses.
B. RELATED REQUIREMENTS:
   1. Section 05 12 00 "Structural Steel Framing"
   2. Section 05 40 00 "Cold-Formed Metal Framing"

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site with the following attendees:
   1. Contractor’s Superintendent
   2. Architect
   3. DFD Construction Representative
   4. Cold Formed Metal Truss Supplier
   5. Cold Formed Metal Truss Subcontractor

1.4 ACTION SUBMITTALS

A. PRODUCT DATA:
   1. Cold-formed steel truss materials.
   2. Cold-formed steel truss clips and connectors.
   3. Anchor bolts.
   4. Post-installed anchors.
   5. Power-actuated fasteners.
   6. Mechanical fasteners.
B. SHOP DRAWINGS:
   1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel trusses; fabrication; and fastening and anchorage details, including mechanical fasteners.

2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
3. Delegated-Design Submittal: For cold-formed steel trusses.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.
B. Welding certificates.
C. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.
1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Miscellaneous structural clips and accessories.
6. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
C. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel trusses.
B. Structural Performance: Provide cold-formed steel trusses capable of withstanding design loads within limits and under conditions indicated.
1. Design Loads: As indicated on Drawings
2. Deflection Limits: Design trusses to withstand design loads without deflections greater than the following:
i. Roof Trusses: Vertical deflection of 1/240 of the span
3. Design trusses to provide for movement of truss members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
4. Cold-Formed Steel Truss Standards: Unless more stringent requirements are indicated, trusses shall comply with the following:
i. Floor and Roof Systems: AISI S210.
ii. Lateral Design: AISI S213.
iii. Roof Trusses: AISI S214.
C. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
D. Indicate design designations from UL or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.2 COLD-FORMED STEEL TRUSS MATERIALS

A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
1. Grade: As required by structural performance.
2. Coating: G60.

2.3 ROOF TRUSSES

A. Roof Truss Members: Manufacturer's standard steel sections.
   1. Connecting Flange Width: 1-5/8 inches, minimum at top and bottom chords connecting to sheathing or other directly fastened construction.
   2. Minimum Base-Metal Thickness: 0.0428 inch.
   3. Section Properties: As required by design.

2.4 TRUSS ACCESSORIES

A. Fabricate steel-truss accessories from steel sheet, ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for truss members.
B. Provide accessories of manufacturer's standard thickness and configuration unless otherwise indicated.

2.5 ANCHORS, CLIPS, AND FASTENERS

C. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.
D. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.
E. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC193, ICC-ES AC58 or ICC-ES AC308 as appropriate for the substrate.
   1. Uses: Securing cold-formed steel trusses to structure.
   2. Type: Torque-controlled expansion anchor, Torque-controlled adhesive anchor or adhesive anchor.
   3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
   4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1, or Group 2 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.
F. Power-Actuated Fasteners: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
G. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
   1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
H. Welding Electrodes: Comply with AWS standards.

2.6 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780/A780M, MIL-P-21035B or SSPC-Paint 20.
B. Shims: Load-bearing, high-density multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as truss members supported by shims.

2.7 FABRICATION

A. Fabricate cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
   1. Fabricate trusses using jigs or templates.
   2. Cut truss members by sawing or shearing; do not torch cut.
   3. Fasten cold-formed steel truss members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator.
      a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   4. Fasten other materials to cold-formed steel trusses by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
B. Reinforce, stiffen, and brace trusses to withstand handling, delivery, and erection stresses. Lift fabricated trusses by means that prevent damage or permanent distortion.
C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet (1:960) and as follows:
   a. Spacing: Space individual truss members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

b. Squareness: Fabricate each cold-formed steel truss to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting trusses and framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed steel trusses without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLATION

A. Install bridge, and brace cold-formed steel trusses according to AISI S200, AISI S202, AISI S214, and manufacturer's written instructions unless more stringent requirements are indicated.

1. Coordinate with wall framing to align webs of bottom chords and load-bearing studs or continuously reinforce track to transfer loads to structure.
2. Anchor trusses securely at all bearing points.
3. Install continuous bridging and permanently brace trusses as indicated on Shop Drawings and designed according to CFSEI's Technical Note 551e, "Design Guide: Permanent Bracing of Cold-Formed Steel Trusses.".

B. Install cold-formed steel trusses and accessories true to line and location, and with connections securely fastened.

1. Erect trusses with plane of truss webs plumb and parallel to each other. Align and accurately position trusses at required spacings.
2. Erect trusses without damaging truss members or connections.
3. Fasten cold-formed steel trusses by welding or mechanical fasteners.
    i. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    ii. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

C. Install temporary bracing and supports to secure trusses and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to trusses are secured.

D. Truss Spacing: 24 inches.

E. Do not alter, cut, or remove truss members or connections of trusses.

3.4 ERECTION TOLERANCES

A. Install cold-formed steel trusses level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Space individual trusses no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.5 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel trusses with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Cold-formed metal trusses will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

3.7 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, which ensure that cold-formed steel trusses are without damage or deterioration at time of Substantial Completion.

END OF SECTION

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SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rooftop equipment bases and support curbs.
   2. Wood blocking, cants, and nailers.
   3. Plywood backing panels.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. For each type of process and factory-fabricated product.
   2. For preservative-treated wood products.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates:
   1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
   2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

B. Evaluation Reports: For the following, from ICC-ES:
   1. Wood-preservative-treated wood.
   2. Fire-retardant-treated wood.
   3. Engineered wood products.
   4. Shear panels.
   5. Power-driven fasteners.
   6. Post-installed anchors.
   7. Metal framing anchors.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content:
   1. Boards: 15 percent.
   2. Dimension Lumber: 19 percent unless otherwise indicated.
   3. Timber: 19 percent.

C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
   1. Allowable design stresses, as published by manufacturer, are to meet or exceed those indicated. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 PRESERVATIVE TREATMENT

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:
   1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
   3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.

2.3 FIRE-RETARDANT-TREATMENT

A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
2. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat

1. Framing for raised platforms.
2. Framing for stages.
3. Concealed blocking.
4. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.
5. Furring.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

C. Concealed Boards: 15 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
2. Eastern softwoods; No. 2 Common grade; NeLMA.
3. Northern species; No. 2 Common grade; NLGA.
4. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC58, ICC-ES AC193, or ICC-ES AC308 as appropriate for the substrate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

C. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

D. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
   2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
   3. ICC-ES evaluation report for fastener.

END OF SECTION

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SECTION 06 20 23
INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Interior trim and plywood construction.
2. Fire-retardant-treated wood material.

1.2 DEFINITIONS

A. MDF: Medium-density fiberboard.
B. MDO: Plywood with a medium-density overlay on the face.
C. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.
B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 INTERIOR TRIM AND SHEET MATERIAL

A. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish):
1. Species and Grade: Birch.
a. Field verify to match existing plywood as noted in drawings.
2. Maximum Moisture Content: 13 percent.
3. Finger Jointing: Not allowed.
4. Gluing for Width: Allowed - Use for lumber trim wider than 6 inches.
5. Veneered Trim Material: Not allowed.
6. Plywood Core: Wood veneer.
a. Field verify core quantity to match existing plywood as noted in drawings.
7. Face Surface: Surfaced (smooth) and sanded.
8. Matching: Selected for compatible grain and color.

2.2 FIRE-RETARDANT-TREATED WOOD MATERIALS

A. Fire-Retardant-Treated Wood Materials: Where fire-retardant-treated materials are indicated – generally in buildings with "non-combustible" construction type - use materials complying with requirements that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products in accordance with test method indicated by a qualified testing agency.
1. Use treated materials that comply with requirements of the Architectural Woodwork Standards. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
2. For items indicated to receive a stained, transparent, or natural finish, use organic resin chemical formulation.
3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
4. Mill lumber before treatment, and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.

2.3 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Nailers: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
1. Fire-Retardant Treatment: Complying with requirements; provide where indicated.

B. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

C. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.

D. Multipurpose Construction Adhesive: Formulation, complying with ASTM D3498, that is recommended for indicated use by adhesive manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.2 INSTALLATION, GENERAL

A. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials.

1. Use concealed shims where necessary for alignment.
2. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
3. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
4. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
5. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.3 INSTALLATION OF STANDING AND RUNNING TRIM

A. Install trim with minimum number of joints as is practical, using full-length pieces from maximum lengths of lumber available.

1. Do not use pieces less than 24 inches long, except where necessary.
2. Stagger joints in adjacent and related standing and running trim.
3. Cope at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint.
4. Use scarf joints for end-to-end joints.
5. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
6. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
7. Install trim after gypsum-board joint finishing operations are completed.
8. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting.
9. Fasten to prevent movement or warping.
10. Countersink fastener heads on exposed carpentry work and fill holes.

3.4 INSTALLATION OF ITEMS MADE OF PLYWOOD AS NOTED IN DRAWINGS

A. Match detailing of existing.

B. Prepare for stain and clear coat as identified in Section 09 93 00 - Staining and Transparent Finishing.

END OF SECTION

SECTION 07 11 13
BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cold-applied, cut-back-asphalt dampproofing.
B. Related Section: 072100 - Thermal Insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. VOC Content: Products are to comply with VOC content limits of authorities having jurisdiction unless otherwise indicated.

2.2 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Henry Company; a Carlisle company.
   2. W. R. Meadows, Inc.
B. Trowel Coats: ASTM D4586/D4586M, Type I, Class 1, fibered.
C. Brush and Spray Coats: ASTM D4479/D4479M, Type I, fibered.

2.3 AUXILIARY MATERIALS

A. Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.
B. Cut-Back-Asphalt Primer: ASTM D41/D41M.
C. Asphalt-Coated Glass Fabric: ASTM D1668/D1668M, Type I.
D. Protection Course: Fan folded, with a core of extruded-polystyrene board insulation faced on one side or both sides with plastic film, nominal thickness 1/4 inch, with a compressive strength of not less than 8 psi per ASTM D1621, and maximum water absorption by volume of 0.6 percent per ASTM C272/C272M.

PART 3 - EXECUTION

3.1 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless otherwise indicated.
   1. Apply dampproofing to provide continuous plane of protection.
   2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.
B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches over outside face of footing.
   1. Extend dampproofing 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
   2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch-wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.
C. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1/4 inch onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.
   1. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe.
   2. Lap dampproofing at least 1/4 inch onto shelf angles supporting veneer.
D. Where dampproofing interior face of above-grade, exterior concrete and masonry single-wythe masonry walls, continue dampproofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by dampproofing wall before constructing intersecting walls.

3.2 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Concrete Foundations and Parged Masonry Foundation Walls: Apply two brush or spray coats at not less than 1.25 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat.
B. Unparged Masonry Foundation Walls: Apply primer and two brush or spray coats at not less than 1.25 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat.
C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft..
D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft..

3.3 PROTECTION COURSE INSTALLATION

A. Install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

B. Protection course is not required if drawings call for foundation insulation on exterior side of foundation wall.

END OF SECTION

SECTION 07 21 00
THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation.

B. Related Section:
1. See roofing membrane specification for roofing insulation.
2. See Section 09 29 00 SF - Gypsum Board for Sound Attenuating Blankets.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
1. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation.

1.3 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.
1. Sign, date, and post the certification in a conspicuous location on Project site.

B. Product test reports.

C. Research reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes less than 25 and 450 when tested in accordance with ASTM E84.

B. Fire-Resistance Ratings: Comply with ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.

C. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

D. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

E. Thermal-Resistance Value (R-Value) in accordance with ASTM C518:
1. Walls (above grade): R-20 min.
2. Foundation Walls: R-20 min.
3. Underslab: Not applicable.

2.2 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Atlas Polyiso Roof and Wall Insulation.
b. Carlisle Coatings & Waterproofing Inc.
c. DuPont de Nemours, Inc.
d. Johns Manville; a Berkshire Hathaway company.
e. Rmax, Inc.
f. The Dow Chemical Company.

B. Extruded Polystyrene Board Insulation, Type IV: ASTM C578, Type IV, 25-psi minimum compressive strength; unfaced – ***for foundation condition***.

2.3 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

A. For exterior walls (not foundation).

B. Polyisocyanurate Board Insulation, Foil Faced: ASTM C1289, foil faced, Type I, Class 1 or 2.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Atlas Polyiso Roof and Wall Insulation.
b. Carlisle Coatings & Waterproofing Inc.
c. DuPont de Nemours, Inc.
d. Johns Manville; a Berkshire Hathaway company.
e. Rmax, Inc.
f. The Dow Chemical Company.

2.4 ACCESSORIES

A. Insulation for Miscellaneous Voids:
1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.

2. Polyurethane Pour-In-Place Insulation: Closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84, specifically formulated for pour-in-place applications.

B. Insulation Anchors, Spindles, and Standoffs: As recommended by manufacturer.

a. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Install insulation with manufacturer's R-value label exposed after insulation is installed.

D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.2 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

C. If not otherwise indicated, extend insulation a minimum of 48 inches in from exterior walls.

3.3 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer.

1. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
2. Press units firmly against inside substrates.
3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose.

END OF SECTION

SECTION 07 27 26
FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vapor-retarding, fluid-applied air barriers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For air-barrier assemblies.

1. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to set quality standards for materials and execution.

1. Build integrated mockups of exterior wall assembly, 150 sq. ft., incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.

a. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.

b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction to be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested in accordance with ASTM E2357.

C. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. pressure difference; ASTM E2178.

D. Ultimate Elongation: Minimum 200 percent; ASTM D412, Die C.

E. Adhesion to Substrate: Minimum 16 lbf/sq. in. when tested in accordance with ASTM D4541.

F. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

G. UV Resistance: Can be exposed to sunlight for 60 days in accordance with manufacturer's written instructions.

2.1 HIGH-BUILD AIR BARRIERS, VAPOR RETARDING

A. High-Build, Vapor-Retarding Air Barrier Modified Bituminous Type: Modified bituminous membrane with an installed dry film thickness, according to manufacturer's written instructions, of 35 mils or thicker over smooth, void-free substrates.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carlisle Coatings & Waterproofing Inc.

b. Henry Company; a Carlisle company.

c. Tremco Incorporated.

d. W. R. Meadows, Inc.

B. Vapor Permeance: Maximum 0.1 perm; ASTM E96/E96M, Procedure A, Desiccant Method.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate in accordance with manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.

D. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

E. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

F. Bridge isolation joints, expansion joints, and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement in accordance with manufacturer's written instructions and details.

3.2 INSTALLATION

A. Install materials in accordance with air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.

1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
4. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.

B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

C. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames.

D. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

E. High-Build Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply air-barrier material in full contact around protrusions such as masonry ties.

1. Vapor-Retarding, High-Build Air Barrier: Total dry film thickness as recommended in writing by manufacturer to comply with performance requirements, but not less than 40 mils, applied in one or more equal coats.

F. Do not cover air barrier until it has been tested and inspected by testing agency.

G. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests: As determined by testing agency from among the following tests:

1. Air-barrier dry film thickness.
2. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage in accordance with ASTM E1186, chamber pressurization or depressurization with smoke tracers.
3. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate in accordance with ASTM E783 or ASTM E2357.

C. Air barriers will be considered defective if they do not pass tests and inspections.

1. Apply additional air-barrier material, in accordance with manufacturer's written instructions, where inspection results indicate insufficient thickness.
2. Remove and replace deficient air-barrier components for retesting as specified above.

D. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

E. Prepare test and inspection reports.

3.4 CLEANING AND PROTECTION

A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.

B. Remove masking materials after installation.

END OF SECTION

SECTION 07 41 13.16
STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vertical-rib, seamed-joint, standing-seam metal roof panels.
   2. Substrate board.
   3. Vapor retarder.
   4. Roof insulation.
   5. Cover board.
   6. Underlayment.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product data.
B. Shop Drawings:
   1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
   2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates for portable roll-forming equipment.
B. Product test reports.
C. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Roof Installer qualifications.
B. Portable Roll-Forming Equipment Certification: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of Work.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.
B. Special Warranty on Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E1592:
   1. Deflection Limits: For wind loads, no greater than 1/180 of the span.
B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested in accordance with ASTM E1680 or ASTM E283/E283M at the following test-pressure difference:
   1. Test-Pressure Difference: 1.57 lbf/sq. ft..
C. Water Penetration under Static Pressure: No water penetration when tested in accordance with ASTM E1646 or ASTM E331 at the following test-pressure difference:
   1. Test-Pressure Difference: 2.86 lbf/sq. ft..
D. Watertightness: No water penetration when tested in accordance with ASTM E2140 for hydrostatic-head resistance.
E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
   1. Uplift Rating: UL 90.
F. FM Approvals Listing: Provide metal roof panels and component materials that comply with requirements in FM Approvals 4471 as part of a panel roofing system and that are listed in FM's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   1. Fire/Windstorm Classification: Class 1A- 90.

2. Hail Resistance: SH.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

H. Energy Performance:
1. Provide roof panels in accordance with one of the following when tested in accordance with CRRC-1:
a. Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than 0.75.
b. Three-year, aged Solar Reflectance Index (SRI) of not less than 64 when calculated in accordance with ASTM E1980.

2.2 STANDING-SEAM METAL ROOF PANELS, GENERAL

A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.

2.3 VERTICAL-RIB, SEAMED-JOINT, STANDING-SEAM METAL ROOF PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ATAS International, Inc.
2. Berridge Manufacturing Company.
3. CENTRIA, a Nucor Brand.
4. PAC-CLAD; Petersen; a Carlisle company.

B. **Basis-of-Design**: Atas, 2 3/8" Field-Lok, 18" coverage with stiffening ribs.

C. Panels: Formed with vertical ribs at panel edges; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
1. Structural Support: Over solid deck.
2. Material: Metallic-coated steel.
3. Seam Type: Double folded.
4. Panel Profile: Intermediate stiffening ribs symmetrically spaced between ribs.
5. Panel Coverage: 18 inches.
6. Panel Height: 1.5 inches nominal.
7. Clips: Two piece, floating, designed to accommodate thermal movement.
a. Steel Clips: 0.028-inch-nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
b. Clip Spacing: 24 inches.

2.4 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. CertainTeed; SAINT-GOBAIN.
b. Georgia-Pacific Gypsum LLC.
c. USG Corporation.
2. Thickness: Type X, 5/8 inch.
3. Surface Finish: Factory primed.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions for fastening substrate panel to roof deck.

2.5 VAPOR RETARDER

A. **IF PROJECT HAS A SINGLE-PLY ROOFING MEMBRANE SPECIFICATION**, use vapor retarder specified for that system. Otherwise, use…

B. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

2.6 ROOF INSULATION

A. Roof insulation assembly must provide an overall average of R-35.

B. Insulation over Solid Deck:
1. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1) Atlas Polyiso Roof and Wall Insulation.

2) Carlisle Syntec Systems.
3) CertainTeed; SAINT-GOBAIN.
4) GAF.
5) Johns Manville; a Berkshire Hathaway company.
6) Rmax, A Business Unit of Sika Corporation.

b. Compressive Strength: 25 psi.
c. Size: 48 by 96 inches.
d. Thickness:
1) Base Layer: 1-1/2 inches.
2) Upper Layer: As needed to meet required R-value.

2.7 COVER BOARD

A. Oriented Strand Board or Plywood – as recommended by roof panel manufacturer: DOC PS 2, Exposure 1, 3/4 inch thick.

2.8 UNDERLAYMENT

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
1. Thermal Stability: Stable after testing at 240 deg F; ASTM D1970/D1970M.
2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D1970/D1970M.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ATAS International, Inc.
b. Carlisle WIP Products; a brand of Carlisle Construction Materials.
c. Henry Company; a Carlisle company.
d. Owens Corning.

B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.9 PANEL MATERIALS

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
1. Nominal Thickness: 0.028 inch.
2. Surface: Smooth, flat finish.

2.10 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, minimum ASTM A653/A653M, G90 hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 coating designation. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Gutters and Downspouts: See Section 07 62 00 - Sheet Metal Flashing and Trim.

E. Panel Fasteners: Self-tapping screws designed to withstand design loads.

F. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.11 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate in accordance with equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with manufacturer's recommendations.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not permitted on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
    a. Size: As recommended by metal panel manufacturer for application, but not less than thickness of metal being secured.

2.12 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel and Aluminum Panels and Accessories:

1. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.1 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and metal panel manufacturer's written installation instructions.

3.2 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.

1. At steel roof decks, install substrate board at right angle to flutes of deck.
    a. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board in accordance with roofing system manufacturers' written installation instructions.

3.3 INSTALLATION OF VAPOR RETARDER

A. Loosely lay vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 and 6 inches, respectively.
   1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
   2. Continuously seal side and end laps with tape.

3.4 INSTALLATION OF ROOF INSULATION

A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, in accordance with manufacturer's written installation instructions.
   1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.
   2. Tape joints and ruptures in vapor retarder and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.

3.5 INSTALLATION OF COVER BOARD

A. Install cover board over insulation in accordance with manufacturer's written installation instructions. Install with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.

3.6 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
   1. Apply over the entire roof surface.

B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.

C. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 07 62 00 "Sheet Metal Flashing and Trim."

3.7 INSTALLATION OF STANDING-SEAM METAL ROOF PANELS

A. Install metal panels in accordance with manufacturer's written installation instructions and approved Shop Drawings in orientation, sizes, and locations indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   1. Shim or otherwise plumb substrates receiving metal panels.
   2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
   3. Install screw fasteners in predrilled holes.
   4. Locate and space fastenings in uniform vertical and horizontal alignment.
   5. Install flashing and trim as metal panel work proceeds.
   6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
   7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
   8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:
   1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners in accordance with manufacturers' written installation instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
   1. Install clips to supports with self-tapping fasteners.
   2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
   3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
   4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

5. Watertight Installation:
   a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommended in writing by manufacturer as needed to make panels watertight.
   b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
   c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements and manufacturer's written installation instructions. Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 ft. with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

H. Pipe and Conduit Penetrations: Fasten and seal to metal roof panels as recommended by manufacturer.

3.8 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 42 13.13
FORMED METAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concealed-fastener, lap-seam metal wall panels.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

C. Samples: For each type of metal panel indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Warranties: Samples of special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft..

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 CONCEALED-FASTENER, LAP-SEAM METAL WALL PANELS

A. Provide factory-formed metal panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.

B. Flush-Profile, Concealed-Fastener Metal Wall Panels **MP-1-2-3**: Formed with vertical panel edges and a flat pan between panel edges; with flush joint between panels.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ATAS International, Inc.
      b. Berridge Manufacturing Company.
      c. CENTRIA, a Nucor Brand.
      d. Dri-Design.
      e. PAC-CLAD; Petersen; a Carlisle company.
   2. Basis-of-Design: Dri-Design, En-V, A80 Series.
   3. Aluminum Sheet: Coil-coated sheet, ASTM B209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
      a. Thickness: 0.040 inch.
      b. Surface: Smooth, flat finish.
      c. Exterior Finish: Three-coat fluoropolymer.
      d. Color: As indicated by manufacturer's designations in drawings.
   4. Panel Coverage: See drawings.
   5. Panel Height: 1.25 inch.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
   1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
   2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
   3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
   1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch wide and 1/8 inch thick.
   2. Joint Sealant: ASTM C920; as recommended in writing by metal panel manufacturer.
   3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.4 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.5 FINISHES

A. Panels and Accessories:

1. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat.
2. Concealed Finish: White or light-colored acrylic or polyester backer finish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.2 INSTALLATION

A. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.

1. Lap ribbed or fluted sheets one full rib. Apply panels and associated items true to line for neat and weathertight enclosure.
2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
5. Flash and seal panels with weather closures at perimeter of all openings.

B. Watertight Installation:

1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels; and elsewhere as needed to make panels watertight.
2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
3. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

3.3 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION

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SECTION 07 42 93
SOFFIT PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal soffit panels.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
C. Samples: For each type of metal panel indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.
B. Warranties: Samples of special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.
B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
   1. Deflection Limits: For wind loads, no greater than 1/180 of the span.
B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:
   1. Test-Pressure Difference: 1.57 lbf/sq. ft..
C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:
   1. Test-Pressure Difference: 2.86 lbf/sq. ft..
D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METAL SOFFIT PANELS

A. Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.
B. Flush-Profile Metal Soffit Panels: Solid panels formed with vertical panel edges and a flat pan between panel edges; with flush joint between panels.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ATAS International, Inc.
      b. Berridge Manufacturing Company.
      c. CENTRIA, a Nucor Brand.
      d. PAC-CLAD; Petersen; a Carlisle company.
   2. **Basis-of-Design**: Pac-Clad, Flush Soffit.
   3. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Nominal Thickness: 0.022 inch.
b. Exterior Finish: Two-coat fluoropolymer.
c. Color: As selected by Architect from manufacturer's full range.
4. Panel Coverage: 12 inches.
5. Panel Height: 1.0 inch.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/8 inch thick.
2. Joint Sealant: ASTM C920; as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.4 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.5 FINISHES

A. Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Concealed Finish: White or light-colored acrylic or polyester backer finish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

1. Soffit Framing: Wire tie or clip furring channels to supports.

3.2 INSTALLATION

A. Metal Soffit Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.

1. Apply panels and associated items true to line for neat and weathertight enclosure.
2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.

3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.

B. Watertight Installation:
1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels watertight.
2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
3. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

3.3 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION

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SECTION 07 53 23
ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Adhered ethylene-propylene-diene-terpolymer (EPDM) roofing system.
2. Vapor barrier.
3. Accessory roofing materials.
4. Substrate board.
5. Roof insulation.
6. Insulation accessories.
7. Asphalt materials.
8. Walkways.

1.2 PREINSTALLATION MEETINGS

A. Preliminary Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
1. Layout and thickness if insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation, thickness, and slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane and fastening spacings and patterns for mechanically fastened roofing system.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Tie-in with air barrier.

C. Samples: For the following products:
1. Roof membrane and flashings of color required.
2. Walkway pads or rolls, of color required.

D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:
1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
a. Submit evidence of complying with performance requirements.
2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For components of roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

C. Research reports.

D. Field Test Reports:
1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality-control reports.

F. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.6 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturers: A qualified manufacturer that is listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.
2. Installers: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 20 years from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.

B. Impact Resistance: Roof membrane to resist impact damage when tested in accordance with ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

C. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: Class 1A-90.
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 SH.

D. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

E. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.2 ETHYLENE-PROPYLENE-DIENE-TERPOLYMER (EPDM) ROOFING

A. EPDM Sheet: ASTM D4637/D4637M, Type I, nonreinforced, EPDM sheet with factory-applied seam tape.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Carlisle Syntec Systems.
   b. Johns Manville; a Berkshire Hathaway company.
   c. Versico Roofing Systems; Carlisle Construction Materials.
2. Thickness: 90 mils, nominal.
3. Exposed Face Color: Black.

2.3 VAPOR BARRIER

A. Composite Sheet *for wood or glass-mat sheathing or concrete*: Self-adhering 35-mil rubberized asphalt laminated to 5-mil polypropylene film.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Carlisle Syntec Systems.
      1) Basis-of-Design: VapAir Seal 725TR.
   b. Johns Manville; a Berkshire Hathaway company.
   c. Versico Roofing Systems; Carlisle Construction Materials.
2. Thickness: 40 mils, nominal.
3. Permeability: .015 perms per ASTM D1970 tested to E96 standards.
4. Air Permeance: .000 L*m^2@75 Pa per ASTM E2148.

B. Composite Sheet *for metal deck*: Reinforced aluminum foil with self-adhering SBS; 15-mil overall thickness.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Carlisle Syntec Systems.
      1) Basis-of-Design: VapAir Seal MD.
   b. Johns Manville; a Berkshire Hathaway company.
   c. Versico Roofing Systems; Carlisle Construction Materials.
2. Thickness: 40 mils, nominal.
3. Permeability: .030 perms per ASTM D1970 tested to E96 standards.
4. Air Permeance: .000 L*m^2@75 Pa per ASTM E2148.

2.4 ACCESSORY ROOFING MATERIALS

A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.

1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: 60-mil-thick EPDM, partially cured or cured, according to application.

C. Protection Sheet: Epichlorohydrin or neoprene nonreinforced flexible sheet, 55 to 60 mils thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil. *Install within 8'-0" of perimeter of kitchen exhaust duct*.

D. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

E. Bonding Adhesive: Manufacturer's standard.

F. Seaming Material: Use factory-applied seam tape, width as recommended by manufacturer to extent possible. Then use manufacturer's standard, synthetic-rubber polymer primer and 3-inch-wide minimum, butyl splice tape with release film Factory-applied seam tape, width as recommended by manufacturer.

G. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roofing.

H. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

I. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

J. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening components to substrate, and acceptable to roofing system manufacturer.

K. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, molded pipe boot flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

1. Provide white flashing accessories for white EPDM membrane roofing.

2.5 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CertainTeed; SAINT-GOBAIN.
   b. Georgia-Pacific Gypsum LLC.
   c. USG Corporation.
2. Thickness: Type X, 5/8 inch.
3. Surface Finish: Factory primed.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck.

2.6 ROOF INSULATION

A. Roof insulation assembly must provide an overall average of R-35.

B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1 felt facer on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Atlas Polyiso Roof and Wall Insulation.
   b. Carlisle Syntec Systems.
   c. CertainTeed; SAINT-GOBAIN.
   d. GAF.
   e. Hunter Panels; a Carlisle company.
   f. Insulfoam; a Carlisle Company.
   g. Johns Manville; a Berkshire Hathaway company.
   h. Rmax, A Business Unit of Sika Corporation.
2. Size: 48 by 96 inches.
3. Thickness:
   a. Base Layer: 1-1/2 inches.
   b. Upper Layer: As needed per tapered insulation plan to meet required R-value.

C. Tapered Insulation (if applicable): Provide factory-tapered insulation boards.

1. Material: Match roof insulation.
2. Minimum Thickness: 1/4 inch.
3. Slope:
   a. Roof Field: 1/4 inch per foot unless otherwise indicated on Drawings.
   b. Saddles and Crickets: 1/2 inch per foot unless otherwise indicated on Drawings.

2.7 INSULATION ACCESSORIES

A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:

1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.

C. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric; water permeable and resistant to UV degradation; type and weight as recommended by roofing system manufacturer for application.

2.8 ASPHALT MATERIALS

A. Roofing Asphalt: ASTM D312/D312M, Type III or Type IV.

B. Asphalt Primer: ASTM D41/D41M.

2.9 WALKWAYS

A. Flexible Walkways (if called for in drawings): Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick and acceptable to roofing system manufacturer.
   1. Size: Approximately 36 by 60 inches.
   2. Color: Contrasting with roof membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
   1. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
   2. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than 75 percent, or as recommended by roofing system manufacturer when tested in accordance with ASTM F2170.
      a. Test Frequency: One test probe per each 1000 sq. ft., or portion thereof, of roof deck, with not less than three test probes.
      b. Submit test reports within 24 hours of performing tests.
   3. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
   4. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.

3.2 PREPARATION

A. Perform fastener-pullout tests in accordance with roof system manufacturer's written instructions.
   1. Submit test result within 24 hours of performing tests.
      a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

3.3 INSTALLATION OF ROOFING, GENERAL

A. Install roofing system in accordance with roofing system manufacturer's written instructions, FM Approvals' RoofNav assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition (and to not void warranty for existing roofing system when applicable).

D. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under Section 07 27 26 "Fluid-Applied Membrane Air Barriers."

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install where identified in roofing details and/or roof assembly descriptions in the drawings.

B. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.
   1. At steel roof decks, install substrate board at right angle to flutes of deck.
      a. Locate end joints over crests of steel roof deck.
   2. At wood sheathing, install substrate board parallel to long axis of wood panels.
      a. Locate end joints over structural framing below but not over wood sheathing joints.
   3. Tightly butt substrate boards together.
   4. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   5. Fasten substrate board to top flanges of steel deck (or wood sheathing) in accordance with recommendations in FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29.
   6. Fasten substrate board to top flanges of steel deck (or wood sheathing) to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturers' written instructions.

3.5 INSTALLATION OF VAPOR BARRIER

A. See product description above for correct product for application.

B. Install self-adhering membrane per manufacturer’s written instructions.

3.6 INSTALLATION OF INSULATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Insulation installation intent:

1. Top-most course of insulation is to be adhered to course below with lower courses screwed to deck as a stack (i.e., lower courses are not screwed per course).

D. Installation Over Metal Decking (applies to decks with or without substrate board):
1. Install base *and subsequent layers* of insulation with joints staggered not less than 24 inches in adjacent rows, end joints staggered not less than 12 inches in adjacent rows, and with long joints continuous at right angle to flutes of decking.
a. Locate end joints over crests of decking.
b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
1) Trim insulation so that water flow is unrestricted.
f. Fill gaps exceeding 1/4 inch with insulation.
g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
h. Loosely lay base layer of insulation units over substrate.
i. Mechanically attach base layer of insulation (and substrate board when noted) using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
1) Fasten insulation in accordance with requirements in FM Approvals' RoofNav for specified Windstorm Resistance Classification.
2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
2. Install top layer of tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
1) Trim insulation so that water flow is unrestricted.
f. Fill gaps exceeding 1/4 inch with insulation.
g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
h. Adhere top layer of tapered insulation to layer below using adhesive in accordance with FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
1) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

E. Installation Over Wood Sheathing (applies to decks with or without substrate board):
1. Follow direction for “Installation Over Metal Decking” above, except that ends of insulation to be mechanically attached are to align with wood framing below.

3.7 ADHERED ROOFING INSTALLATION

A. Adhere roof membrane over area to receive roofing in accordance with roofing system manufacturer's written instructions.
B. Unroll membrane roof membrane and allow to relax before installing.
C. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.
F. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeters.
G. Apply roof membrane with side laps shingled with slope of roof deck where possible.
H. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape.

1. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
2. Apply lap sealant and seal exposed edges of roofing terminations.

I. Factory-Applied Seam Tape Installation: Clean and prime surface to receive tape.
1. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
2. Apply lap sealant and seal exposed edges of roofing terminations.

J. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

K. Adhere protection sheet over roof membrane at locations indicated.

3.8 INSTALLATION OF BASE FLASHING

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates in accordance with roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.9 INSTALLATION OF WALKWAYS

A. Flexible Walkways: Install walkway products in accordance with manufacturer's written instructions.
1. Install flexible walkways at the following locations:
a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roof membrane manufacturer's warranty requirements.
2. Provide 6-inch clearance between adjoining pads.
3. Adhere walkway products to substrate with compatible adhesive in accordance with roofing system manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.

B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

3.11 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: **Custom** units for the following applications:
1. Sheet metal materials.
2. Wall sheet metal fabrications – for through-wall flashing and drip edge.
3. Underlayment.
4. Miscellaneous materials.

B. Related Section: See Section 07 71 00 - Roof Specialties for **manufactured** units if required.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings: For sheet metal flashing and trim.
1. Plans, elevations, sections, and attachment details.
2. Fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Identification of material, thickness, weight, and finish for each item and location in Project.
4. Details for forming, including profiles, shapes, seams, and dimensions.
5. Details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Details of termination points and assemblies.
7. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Details of roof-penetration flashing.
9. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Details of special conditions.
11. Details of connections to adjoining work.
12. Formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.

C. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates: For each type of coping and roof edge flashing that is FM Approvals approved.

B. Product test reports.

C. Research reports.

D. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Entity that employs a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Architectural Metal Flashings and Accessories Installers.

B. For roof edge flashings and copings that are ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved, shop is to be listed as able to fabricate required details as tested and approved.

1.7 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
   b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. FM Approvals Listing: Manufacture and install roof edge flashings and copings that comply with requirements in FM Approvals 4471 as part of a roofing system and that are listed in FM Approvals' "Approval Guide" and approved for windstorm classification, Class 1A-90. Identify materials with name of fabricator and design approved by FM Approvals.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METAL MATERIALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

1. Nominal Thickness: 0.028 inch.
2. Surface: Smooth, flat.
3. Exposed Coil-Coated Finish:
   a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
4. Color: As selected by Architect from manufacturer's full range.
5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed.

1. Nominal Thickness:
   a. Unless noted otherwise: 0.0188 inch.
   b. Drip Edge: 0.0250 inch.
   c. Built-In Gutters: 0.0250 inch.
2. Surface: Smooth, flat.
3. Exterior Finish: ASTM A480/A480M, No. 2D (dull, cold rolled).
   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

2.3 UNDERLAYMENT

A. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F; ASTM D1970/D1970M.
2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F or lower; ASTM D1970/D1970M.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ATAS International, Inc.
   b. Carlisle WIP Products; a brand of Carlisle Construction Materials.
   c. Henry Company; a Carlisle company.
   d. Owens Corning.

B. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum, of type required for application.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
   a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
   b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
   c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
5. Fasteners for Copper Sheet: Copper, hardware bronze or passivated Series 300 stainless steel.

C. Solder:
1. For Zinc-Coated (Galvanized) Steel: ASTM B32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead with maximum lead content of 0.2 percent.
2. For Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

E. Elastomeric Sealant: ASTM C920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

H. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

I. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions and with interlocking counterflashing on exterior face, of same metal as reglet.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Fry Reglet Corporation.
b. Heckmann Building Products, Inc.
c. Hohmann & Barnard, Inc.
d. Metal-Era, Inc.
2. Material: Stainless steel, 0.0188 inch thick.
3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
4. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
5. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
6. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
7. Accessories:
a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.
8. Finish: With manufacturer's standard color coating.

2.5 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:
1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 ft. on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

G. Seams - Typical:
1. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

H. Seams – Concealed Gutters and Thru-Wall Scuppers:
1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters:
1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
2. Fabricate in minimum 96-inch-long sections.
3. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than twice the gutter thickness.
4. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
5. Gutters with Girth up to 15 Inches: Fabricate from the following materials:
a. Aluminum-Zinc Alloy-Coated Steel: See above.

B. Built-in Gutters:
1. Fabricate to cross section required, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required.
2. Fabricate in minimum 96-inch-long sections. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
3. Fabricate gutters with built-in expansion joints and gutter-end expansion joints at walls.
4. Fabricate from the following materials:
a. Stainless Steel: See above.

C. Downspouts: Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
1. Fabricate from the following materials:
a. Aluminum-Zinc Alloy-Coated Steel: See above.

D. Splash Pans: Fabricate to dimensions and shape required and from the following materials:
1. Stainless Steel: See above.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch-long, but not exceeding 12 ft. long sections. Furnish with 6-inch-wide, joint cover plates. Shop fabricate interior and exterior corners.
1. Fabricate from the following materials:
a. Stainless Steel: See above.

B. Copings: Fabricate in minimum 96-inch-long, but not exceeding 12 ft.- long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, fasten and seal watertight. Shop fabricate interior and exterior corners.
1. Fabricate from the following materials:
a. Aluminum-Zinc Alloy-Coated Steel: **0.040 inch thick**.

C. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. Aluminum-Zinc Alloy-Coated Steel: See above.

D. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: See above.

E. Roof-Penetration Flashing: Fabricate from the following materials:
1. Stainless Steel: See above.

F. Roof-Drain Flashing: Fabricate from the following materials:
1. Stainless Steel: See above.

2.8 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch-long, but not exceeding 12 ft. long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch-high, end dams. Fabricate from the following materials:
1. Stainless Steel Flexible Flashing (self-adhering): 0.012 inch thick including butyl adhesive.

B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch-high, end dams. Fabricate from the following materials:
1. Stainless Steel Flexible Flashing (self-adhering): 0.012 inch thick including butyl adhesive.

C. Basis-of-Design: York 304 SA.

D. Hemmed Drip-Edge: Manufactured from stainless steel sheet.
1. Thickness: See above.

E. Wall Expansion-Joint Cover: Fabricate from the following materials:
1. Aluminum-Zinc Alloy-Coated Steel: See above.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrates, and other conditions affecting performance of the Work.
1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering, High-Temperature Sheet Underlayment:
1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

B. Install slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.
1. Install in shingle fashion to shed water.
2. Lapp joints not less than 4 inches.

3.3 INSTALLATION OF SHEET METAL FLASHING AND TRIM, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
1. Install fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder and/orsealant.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
8. Do not field cut sheet metal flashing and trim by torch.
9. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
   1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
   2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
   1. Space movement joints at maximum of 10 ft. with no joints within 24 inches of corner or intersection.
   2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
   3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.
   1. Use sealant-filled joints unless otherwise indicated.
      a. Embed hooked flanges of joint members not less than 1 inch into sealant.
      b. Form joints to completely conceal sealant.
      c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
      d. Adjust setting proportionately for installation at higher ambient temperatures.
         1) Do not install sealant-type joints at temperatures below 40 deg F.
   2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
   1. Pretin edges of sheets with solder to width of 1-1/2 inches; however, reduce pretinning where pretinned surface would show in completed Work.
   2. Do not solder metallic-coated steel and aluminum sheet.
   3. Do not use torches for soldering.
   4. Heat surfaces to receive solder, and flow solder into joint.
      a. Fill joint completely.
      b. Completely remove flux and spatter from exposed surfaces.
   5. Stainless Steel Soldering:
      a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
      b. Promptly remove acid-flux residue from metal after tinning and soldering.
      c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

H. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.4 INSTALLATION OF ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters:
   1. Join sections with riveted joints sealed with sealant.
   2. Provide for thermal expansion.
   3. Attach gutters at eave or fascia to firmly anchor them in position.
   4. Provide end closures and seal watertight with sealant.
   5. Slope to downspouts.
   6. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 ft. apart. Install expansion-joint caps.

C. Built-in Gutters:
   1. Join sections with riveted and soldered joints.
   2. Provide for thermal expansion.
   3. Slope to downspouts.
   4. Provide end closures and seal watertight with sealant.
   5. Install underlayment layer in built-in gutter trough and extend to drip edge at eaves and under underlayment on roof sheathing.

a. Lap sides minimum of 2 inches over underlying course.
b. Lap ends minimum of 4 inches.
c. Stagger end laps between succeeding courses at least 72 inches.
d. Fasten with roofing nails.
e. Install slip sheet over underlayment.

6. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 ft. apart. Install expansion-joint caps.

D. Downspouts:
1. Join sections with 1-1/2-inch telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately 60 inches o.c.
4. Provide elbows at base of downspout to direct water away from building.
5. Connect downspouts to underground drainage system.

E. Splash Pans:
1. Install where downspouts discharge on low-slope roofs.
2. Set in asphalt roofing cement or elastomeric sealant compatible with the substrate.

3.5 INSTALLATION OF SLOPED ROOF SHEET METAL FABRICATIONS

A. Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard.
1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:
1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Copings:
1. Install copings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.
a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch centers.
b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
2. Extend counterflashing 4 inches over base flashing.
3. Lap counterflashing joints minimum of 4 inches.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.6 INSTALLATION OF WALL SHEET METAL FABRICATIONS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

C. Reglets: Installation of reglets is specified in Section 03 30 00 "Cast-in-Place Concrete" or Section 04 20 00 "Unit Masonry."

3.7 INSTALLATION TOLERANCES

A. Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 ft. on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.8 CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

3.9 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION

SECTION 07 72 53
SNOW GUARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pad-type, flat-mounted metal snow guards.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.
   1. Include details of rail-type snow guards.
C. Samples:
   1. Pad-Type Snow Guards: Full-size unit with installation hardware.
      a. For units with factory-applied finishes, submit manufacturer's standard color selections.
D. Delegated Design Submittals: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Include calculation of number and location of snow guards.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the state in which the Project is located.
B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design snow guards, including attachment to roofing material and roof deck, applicable for attachment method, based on the following:
   1. Roof snow load.
   2. Snow drifting
   3. Roof slope.
   4. Roof type.
   5. Roof dimensions.
   6. Roofing substrate type and thickness.
   7. Snow guard type.
   8. Snow guard fastening method and strength.
   9. Snow guard spacing.
   10. Coefficient of Friction Between Snow and Roof Surface: 0.
   11. Factor of Safety: 2.
B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
   1. Snow Loads: As indicated on Drawings.

2.2 PAD-TYPE SNOW GUARDS

A. Pad-Type, Flat-Mounted Metal Snow Guards:
   1. Material:
      a. ASTM A792/A792M, Class AZ50 aluminum-zinc alloy-coated steel sheet, Grade 40 but not less than 0.022 inch thick.
         1) Finish: High-performance organic two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.
            a) Color: As selected by Architect from manufacturer's full range.
   2. Attachment: Manufacturer's tested system, capable of resisting design loads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.
   1. Space rows as indicated on Shop Drawings.
B. Attachment for Standing-Seam Metal Roofing:

1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
2. Pad-Type, Flat-Mounted Snow Guards:
   a. Mechanically attach to metal roofing according to manufacturer's instructions.

END OF SECTION

SECTION 07 84 13
PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Penetration firestopping systems.
   2. Penetrations in fire-resistance-rated walls.
   3. Penetrations in horizontal assemblies.
   4. Penetrations in smoke barriers.
   5. Exposed penetration firestopping systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product data.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
   1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.4 INFORMATIONAL SUBMITTALS

A. Listed system designs.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Entity that has been approved by FM Approvals in accordance with FM Approvals 4991 or been evaluated by UL and found to comply with UL's "UL Solutions Qualified Firestop Contractor Program."

B. Manufacturer Qualifications: Entity that has received UL's "Firestop Movement Certification," which demonstrates that manufacturer's firestopping products designated with M-Ratings are based on exposure to cyclic movement and UL 1479 fire test evaluation when tested in accordance with ASTM E3037.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:
   1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
   2. Test in accordance with testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
      a. Penetration firestop systems installed with products bearing the classification marking of a qualified testing agency.
         1) UL in its online directory "Product iQ."
         2) Intertek Group in its "Directory of Building Products."
         3) FM Approvals in its "Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. 3M Building and Construction.
      b. Hilti, Inc.
      c. Tremco Incorporated.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
   1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
   2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.

3. M-Rating: Provide penetration firestopping systems meeting specified F-Rating after being tested in accordance with ASTM E3037.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor. The following floor penetrations do not require a T-rating:
a. Those within the cavity of a wall.
b. Floor, tub, or shower drains within a concealed space.
c. 4-inch or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.
3. W-Rating: Provide penetration firestopping systems with a Class 1 W-rating in accordance with UL 1479.
4. M-Rating: Provide penetration firestopping systems meeting specified F-Rating, T-Rating, and W-Rating after being tested in accordance with ASTM E3037.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined in accordance with UL 1479.
1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.
2. M-Rating: Provide penetration firestopping systems meeting specified L-Rating after being tested in accordance with ASTM E3037.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested in accordance with ASTM E84 or UL 723.

F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

D. Install fill materials by proven techniques to produce the following results:
1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.2 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. from end of wall and at intervals not exceeding 30 ft..

END OF SECTION

SECTION 07 84 43
JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Joints in or between fire-resistance-rated construction.
   2. Joints at exterior curtain-wall/floor intersections.
   3. Joints in smoke barriers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product data.

B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.
   1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an EJ or equivalent fire-resistance-rated assembly developed in accordance with current IFC guidelines.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written installation instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals in accordance with FM Approvals 4991 or been evaluated by UL and found to comply with UL's "UL Solutions Qualified Firestop Contractor Program."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:
   1. A qualified testing agency, acceptable to authorities having jurisdiction, will perform joint firestopping system tests.
   2. Test in accordance with testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
      a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
         1) UL in its online directory "Product iQ."
         2) Intertek Group in its "Directory of Building Products."

B. Rain/Water Resistance: For perimeter fire-barrier system applications, where inclement weather or greater-than-transient water exposure is expected, use products that dry rapidly and cure in the presence of atmospheric moisture sufficient to pass ASTM D6904 early rain-resistance test (24-hour exposure).

2.2 JOINT FIRESTOPPING SYSTEM TYPES

A. General: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
   1. Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.
   2. Provide products that, upon curing, do not re-emulsify, dissolve, leach, break down, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
   3. Provide firestop products that do not contain ethylene glycol.

B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined in accordance with ASTM E1966 or UL 2079, with published L-Ratings for ambient and elevated temperatures as evidence of the ability of the fire-resistive joint system to restrict the movement of smoke.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. 3M Building and Construction.
      b. Hilti, Inc.

c. Tremco Incorporated.

2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined in accordance with ASTM E2307.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. 3M Building and Construction.
   b. Hilti, Inc.
   c. Tremco Incorporated.
2. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.

D. Joints in Smoke Barriers: Provide joint firestopping systems with ratings determined in accordance with UL 2079 based on testing at a positive pressure differential of 0.30 inch wg.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. 3M Building and Construction.
   b. Hilti, Inc.
   c. Tremco Incorporated.
2. L-Rating: Not exceeding 5.0 cfm/ft. of joint at both ambient and elevated temperatures.

E. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined in accordance with ASTM E84.

2.3 ACCESSORIES

A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning: Before installing joint firestopping systems, clean joints in accordance with fire-resistive joint system manufacturer's written installation instructions and the following requirements:

1. Remove foreign materials from substrate surfaces that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates in accordance with joint firestopping system manufacturer's written installation instructions, using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Apply a suitable bond breaker to prevent three-sided adhesion in applications where condition occurs.

3.2 INSTALLATION

A. General: Install joint firestopping systems in accordance with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:

1. Apply elastomeric fill in voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.3 IDENTIFICATION

A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. from end of wall and at intervals not exceeding 30 ft..

3.4 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

END OF SECTION

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SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Silicone joint sealants.
   2. Nonstaining silicone joint sealants.
   3. Urethane joint sealants.
   4. Immersible joint sealants.
   5. Mildew-resistant joint sealants.
   6. Latex joint sealants.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product data.

B. Samples: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Joint-sealant schedule.

1.4 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Warranty Documentation:
   1. Manufacturers' special warranties.
   2. Installer's special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.7 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
   1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
   2. Disintegration of joint substrates from causes exceeding design specifications.
   3. Mechanical damage caused by individuals, tools, or other outside agents.
   4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.

B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. GE Construction Sealants; Momentive Performance Materials Inc.
      b. Sika Corporation - Building Components.
      c. The Dow Chemical Company.
      d. Tremco Incorporated.

2.3 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. PPG Paints; PPG Industries, Inc.
      b. Sherwin-Williams Company (The).
      c. Sika Corporation - Building Components.
      d. Tremco Incorporated.

B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Master Builders Solutions; brand of MBCC Group.
      b. Pecora Corporation.
      c. Sherwin-Williams Company (The).

C. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. LymTal International, Inc.

2.4 IMMERSIBLE JOINT SEALANTS

A. Immersible Joint Sealants. Suitable for immersion in liquids; ASTM C1247, Class 1; tested in deionized water unless otherwise indicated

B. Urethane, Immersible, S, P, 25, T, NT, I: Immersible, single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T, NT, and I.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Tremco Incorporated.
      b. W. R. Meadows, Inc.

2.5 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. GE Construction Sealants; Momentive Performance Materials Inc.
      b. PPG Paints; PPG Industries, Inc.
      c. Sika Corporation - Building Components.
      d. The Dow Chemical Company.
      e. Tremco Incorporated.

2.6 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. PPG Paints; PPG Industries, Inc.
      b. Sherwin-Williams Company (The).
      c. Tremco Incorporated.

2.7 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
    d. Exterior insulation and finish systems.
3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.

G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

H. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.3 JOINT-SEALANT SCHEDULE

A. Exterior joints in horizontal traffic surfaces:
   1. Joint Locations:
      a. Control and expansion joints in brick pavers.
      b. Isolation and contraction joints in cast-in-place concrete slabs.
      c. Joints between plant-precast architectural concrete paving units.
      d. Joints in stone paving units, including steps.
      e. Tile control and expansion joints.
      f. Joints between different materials listed above.
   2. Joint Sealant: **Urethane, M, P, 50, T, NT**.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Exterior joints in horizontal traffic surfaces subject to water immersion:
   1. Joint Locations:
      a. Joints in pedestrian plazas.
      b. Joints in swimming pool decks.
   2. Joint Sealant: **Urethane, immersible, S, P, 25, T, NT, I**.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Exterior joints in vertical surfaces and horizontal nontraffic surfaces:
   1. Joint Locations:
      a. Construction joints in cast-in-place concrete.
      b. Joints between plant-precast architectural concrete units.
      c. Control and expansion joints in unit masonry.
      d. Joints in dimension stone cladding.
      e. Joints in glass unit masonry assemblies.
      f. Joints in exterior insulation and finish systems.
      g. Joints between metal panels.
      h. Joints between different materials listed above.
      i. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
      j. Control and expansion joints in ceilings and other overhead surfaces.
   2. Joint Sealant: **Silicone, nonstaining, S, NS, 50, NT**.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

D. Interior joints in horizontal traffic surfaces:
   1. Joint Locations:
      a. Isolation joints in cast-in-place concrete slabs.
      b. Control and expansion joints in stone flooring.
      c. Control and expansion joints in brick flooring.
      d. Control and expansion joints in tile flooring.
   2. Joint Sealant: **Urethane, S, P, 25, T, NT**.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

E. Interior joints in vertical surfaces and horizontal nontraffic surfaces:
   1. Joint Locations:
      a. Control and expansion joints on exposed interior surfaces of exterior walls.
      b. Tile control and expansion joints.
      c. Vertical joints on exposed surfaces of unit masonry, concrete walls, and partitions.

d. Joints on underside of plant-precast structural concrete beams and planks.

2. Joint Sealant**: Urethane, S, NS, 25, NT**.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

F. Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement:

1. Joint Locations:

a. Control joints on exposed interior surfaces of exterior walls.

b. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.

2. Joint Sealant: **Acrylic latex or siliconized acrylic latex**.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

G. Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces:

1. Joint Locations:

a. Joints between plumbing fixtures and adjoining walls, floors, and counters.

b. Tile control and expansion joints where indicated.

2. Joint Sealant: **Silicone, mildew resistant, acid curing, S, NS, 25, NT**.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

H. Concealed mastics:

1. Joint Locations:

a. Aluminum thresholds.

b. Sill plates.

2. Joint Sealant: **Butyl-rubber based**.

END OF SECTION

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SECTION 07 92 19
ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Acoustical joint sealants.

1.2 ACTION SUBMITTALS

A. Product data.

B. Samples: Manufacturer's color charts consisting of strips of cured sealants, showing full range of available colors for each product exposed to view.

C. Acoustical joint-sealant schedule.

1.3 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product test reports.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Manufacturers' special warranties.
2. Installer's special warranties.

1.5 WARRANTY

A. Installer's Special Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ACOUSTICAL JOINT SEALANTS

A. Acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies in accordance with ASTM E90.

B. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hilti, Inc.
   b. OSI Sealants; Henkel Corporation.
   c. Pecora Corporation.
2. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

2.2 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by acoustical joint-sealant manufacturer where required for adhesion of sealant to joint substrates.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where recommended by acoustical joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.

B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C919, ASTM C1193, and manufacturer's written instructions for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

END OF SECTION

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior standard steel doors and frames.
   2. Exterior standard steel doors and frames.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: Include the following:
   1. Elevations of each door type.
   2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.
B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.5 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
   1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.
B. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies is to meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
   1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Ceco Door; AADG, Inc.; ASSA ABLOY.
   2. Curries, AADG, Inc.; ASSA ABLOY Group.
   3. LaForce, LLC.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
   1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
   2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.
C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.50 deg Btu/F x h x sq. ft. when tested in accordance with ASTM C1363 or ASTM E1423.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B..
   1. Doors:
      a. Type: As indicated in the Door and Frame Schedule on Drawings.
      b. Thickness: 1-3/4 inches.
      c. Face: Uncoated steel sheet, minimum thickness of 0.042 inch.

d. Edge Construction: Model 1, Full Flush.
e. Core: Polystyrene.
f. Fire-Rated Core: Manufacturer's standard vertical steel stiffener core for fire-rated and temperature-rise-rated doors.

2. Frames:
a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch.
b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: Full profile welded.

2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.

1. Doors:
a. Type: As indicated in the Door and Frame Schedule on Drawings.
b. Thickness: 1-3/4 inches.
c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum A40 coating.
d. Edge Construction: Model 1, Full Flush.
e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
h. Core: Polyisocyanurate.
i. Fire-Rated Core: Manufacturer's standard vertical steel stiffener with insulation core for fire-rated doors.

2. Frames:
a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
b. Construction: Full profile welded.

2.5 BORROWED LITES

A. Fabricate of uncoated steel sheet, minimum thickness of 0.053 inch.

B. Construction: Face welded.

C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.

D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.6 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
3. Postinstalled Expansion Anchor: Minimum 3/8-inch-diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.7 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

G. Glazing: Comply with requirements in Section 08 80 00 "Glazing."

2.8 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule on Drawings, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.9 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
    a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
    b. Install frames with removable stops located on secure side of opening.
2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.

a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

4. Solidly pack mineral-fiber insulation inside frames.

5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.

6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.

c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.

2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.

3. Smoke-Control Doors: Install doors in accordance with NFPA 105.

C. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 REPAIR

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint in accordance with manufacturer's written instructions.

END OF SECTION

SECTION 08 14 16
FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Five-ply flush wood veneer-faced doors for transparent finish.
2. Fire-rated wood door frames.
3. Factory priming and/or finishing flush wood doors and frames (if indicated in drawings).
4. Factory fitting flush wood doors to frames and factory machining for hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:
1. Door core materials and construction.
2. Door edge construction
3. Door face type and characteristics.
4. Door louvers.
5. Door trim for openings.
6. Door frame construction.
7. Factory-machining criteria.
8. Factory-priming and/or finishing specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
1. Door schedule indicating door location, type, size, fire protection rating, and swing.
2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
3. Details of frame for each frame type, including dimensions and profile.
4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
5. Dimensions and locations of blocking for hardware attachment.
6. Clearances and undercuts.
7. Requirements for veneer matching.

C. Samples: For factory-finished doors.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.
1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
3. Submit copy of DHI's Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.5 QUALITY ASSURANCE

A. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.

B. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies complies with qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.

C. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies complies with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with UL 10C or NFPA 252.
1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

B. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

2.2 FLUSH WOOD DOORS AND FRAMES, GENERAL

A. Quality Standard: In addition to requirements specified, comply with "Architectural Woodwork Standards."

2.3 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Oregon Door.
   b. Oshkosh Door Company.
   c. VT Industries, Inc.

2.4 SOLID-CORE, FIVE-PLY FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Doors, Solid-Core Five-Ply Veneer-Faced:
   1. Performance Grade by Location:
      a. ANSI/WDMA I.S. 1A Extra Heavy Duty: All locations but as noted for Standard Duty.
      b. ANSI/WDMA I.S. 1A Standard Duty: Closets (not including janitor's closets) and private toilets.
   2. Architectural Woodwork Standards Grade: Premium.
   3. Faces: Single-ply wood veneer not less than 1/50 inch thick.
      a. Species: Select white birch.
      b. Cut: Plain sliced (flat sliced).
      c. Match between Veneer Leaves: Book match.
      d. Assembly of Veneer Leaves on Door Faces: Center-balance match.
      e. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
      f. Room Match:
         1) Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet or more.
         2) Provide door faces of compatible color and grain within each separate room or area of building.
      g. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Section 06 42 16 "Flush Wood Paneling."
   4. Exposed Vertical Edges: Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A.
      a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
      b. Fire-Rated Pairs of Doors:
         1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
      c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
         1) Screw-Holding Capability: 550 lbf in accordance with WDMA T.M. 10.
   5. Core for Non-Fire-Rated Doors:
      a. ANSI A208.1, Grade LD-1 particleboard.
         1) Blocking: Provide wood blocking in particleboard-core doors as follows:
            a) 5-inch top-rail blocking, in doors indicated to have closers.
            b) 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
            c) 5-inch midrail blocking, in doors indicated to have exit devices.
         2) Provide doors with glued-wood-stave or WDMA I.S. 10 structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in Section 08 71 00 "Door Hardware."
   6. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.
      a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as follows:
         1) 5-inch top-rail blocking.
         2) 5-inch bottom-rail blocking, in doors indicated to have protection plates.
         3) 5-inch midrail blocking, in doors indicated to have armor plates.
         4) 5-inch midrail blocking, in doors indicated to have exit devices.
   7. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.5 LIGHT FRAMES AND LOUVERS

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.
   1. Wood Species: Same species as door faces.
   2. Profile: Manufacturer's standard shape.
   3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

B. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated on Drawings. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.

C. Wood Louvers: Door manufacturer's standard solid-wood louvers unless otherwise indicated.
   1. Wood Species: Same species as door faces.
   2. Profile: Flat.

D. Louvers for Fire-Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire-protection rating of 1-1/2 hours and less.
   1. Metal and Finish: Hot-dip galvanized steel, 0.040 inch thick, factory primed for paint finish.

2.6 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated.
   1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
   2. Comply with NFPA 80 requirements for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied.
   1. Locate hardware to comply with DHI-WDHS-3.
   2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
   3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
   4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
   5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Openings: Factory cut and trim openings through doors.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 08 80 00 "Glazing."
   3. Louvers: Factory install louvers in prepared openings.

D. Exterior Doors: Factory treat exterior doors with water repellent after fabrication has been completed but before factory priming or finishing.
   1. Flash top of outswinging doors with manufacturer's standard metal flashing.

2.7 FACTORY PRIMING

A. Doors for Opaque Finish: Factory prime faces, all four edges, edges of cutouts, and mortises with one coat of wood primer specified in Section 09 91 23" Interior Painting."

2.8 FACTORY FINISHING

A. Comply with referenced quality standard for factory finishing.
   1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
   2. Finish faces, all four edges, edges of cutouts, and mortises.
   3. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

B. Factory finish doors where indicated in schedules or on Drawings as factory finished.

C. Transparent Finish:
   1. Architectural Woodwork Standards System-5, Varnish, Conversion.
   2. Staining: Match Architect's sample (existing doors).
   3. Sheen: Satin.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hardware: For installation, see Section 08 71 00 "Door Hardware."

B. Install doors (and frames where noted) to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

C. Install frames level, plumb, true, and straight.
1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
2. Anchor frames to anchors or blocking built in or directly attached to substrates.
a. Secure with countersunk, concealed fasteners and blind nailing.
b. Use fine finishing nails for exposed fastening, countersunk and filled flush with woodwork.
1) For factory-finished items, use filler matching finish of items being installed.
3. Install fire-rated doors and frames in accordance with NFPA 80.
4. Install smoke- and draft-control doors in accordance with NFPA 105.

D. Job-Fitted Doors:
1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
2. Machine doors for hardware.
3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
4. Clearances:
a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
b. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
c. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
d. Comply with NFPA 80 for fire-rated doors.
5. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
6. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

F. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.2 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION

SECTION 08 31 13
ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Access doors and frames.
   2. Fire-rated access doors and frames.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Samples: For each type of access door and frame and for each finish specified.
C. Product Schedule: For access doors and frames.

1.3 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

1.4 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies meets the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
   1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, according to NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Concealed Flanges:
   1. Description: Face of door flush with frame, with exposed flange and concealed hinge.
   2. Optional Features: Gasketing, piano hinges, and masonry anchors (where relevant).
   3. Locations: Wall and ceiling.
   4. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch, 16 gage, factory primed.
   5. Frame Material: Same material, thickness, and finish as door.
   6. Latch and Lock: Cam latch, screwdriver operated for walls in non-public spaces and ceilings, and cam latch, hex-head wrench operated for walls with public access.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

A. Fire-Rated, Flush Access Doors with Concealed Flanges:
   1. Description: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal; with exposed flange, self-closing door, and concealed hinge.
   2. Optional Features: Gasketing, piano hinges, and masonry anchors (where relevant).
   3. Locations: Wall and ceiling.
   4. Fire-Resistance Rating: Not less than that of adjacent construction.
   5. Temperature-Rise Rating: 450 deg F at the end of 30 minutes.
   6. Metallic-Coated Steel Sheet for Door: Nominal 0.040 inch, 20 gage, factory primed.
   7. Frame Material: Same material, thickness, and finish as door.
   8. Latch and Lock: Self-closing and self-latching door hardware, operated by key.

2.4 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.
D. Frame Anchors: Same material as door face.
E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.5 FABRICATION

A. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
B. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
C. Latch and Lock Hardware:
   1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
   2. Keys: Furnish two keys per lock and key all locks alike.

2.6 FINISHES

A. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Adjust doors and hardware, after installation, for proper operation.

3.2 FIELD QUALITY CONTROL

A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated access door in accordance with NFPA 80, Section 5.2.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated access door indicating compliance with each item listed in NFPA 80 and NFPA 101.

END OF SECTION

SECTION 08 41 13
ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aluminum-framed entrance and storefront systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product data.
B. Shop Drawings:
   1. Plans, elevations, sections, full-size details, and attachments to other work.
   2. Connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
   3. Point-to-point wiring diagrams.
C. Samples: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.
D. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams.
E. Delegated Design Submittals: For aluminum-framed entrance and storefront systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.
B. Product test reports.
C. Source quality-control reports.
D. Field quality-control reports.
E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Fabricator of products.
   2. Entity that employs installers and supervisors who are trained and approved by manufacturer.
   3. Authorized representative who is trained and approved by manufacturer.
   4. Entity that is certified under the North American Contractor Certification Program (NACC) and that employs installers and supervisors who are trained and approved by manufacturer.
B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.
C. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and acceptable to Owner and Architect.
D. Egress Door Inspector Qualifications:
   1. Inspector for field quality-control inspections of egress door assemblies to comply with qualifications set forth in NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components," Article "Inspection of Door Openings."
   2. Inspector for field quality-control inspections of egress door assemblies to be certified under DHI's certification program as a Fire and Egress Door Assembly Inspector (FDAI) or a Certified Fire and Egress Door Assembly Inspector (CFDAI).
E. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.7 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace components of aluminum-framed entrance and storefront systems that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked-enamel, powder-coat, or organic finishes within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design aluminum-framed entrance and storefront systems.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrance and storefront systems representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Aluminum-framed entrance and storefront systems to withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   2. Failure also includes the following:
      a. Thermal stresses transferring to building structure.
      b. Glass breakage.
      c. Noise or vibration created by wind and thermal and structural movements.
      d. Loosening or weakening of fasteners, attachments, and other components.
      e. Failure of operating units.

C. Structural Loads:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
   1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches.
   2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
      a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
   3. Cantilever Deflection: Limited to 2L/175 at unsupported cantilevers.

E. Structural: Test in accordance with ASTM E330/E330M as follows:
   1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
   2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
   3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
   1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft..

G. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
   1. Thermal Transmittance (U-factor):
      a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.41 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
      b. Entrance Doors: U-factor of not more than 0.68 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
   2. Solar Heat-Gain Coefficient (SHGC):
      a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.26 as determined in accordance with NFRC 200.
      b. Entrance Doors: SHGC of not more than 0.22 as determined in accordance with NFRC 200.
   3. Air Leakage:

a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft. when tested in accordance with ASTM E283.
b. Entrance Doors: Air leakage of not more than 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..

4. Condensation Resistance Factor (CRF):
a. Fixed Glazing and Framing Areas: CRF for the system of not less than 55 as determined in accordance with AAMA 1503.
b. Entrance Doors: CRF of not less than 57 as determined in accordance with AAMA 1503.

H. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 1 for basic protection.
1. Large-Missile Test: For glazing located within 30 feet of grade.
2. Small-Missile Test: For glazing located between 30 feet and 60 feet above grade.

I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 ALUMINUM-FRAMED ENTRANCE AND STOREFRONT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. EFCO Corporation.
2. Kawneer Company, Inc.; Arconic Corporation.
3. OldCastle BuildingEnvelope (OBE).
4. Trulite Glass & Aluminum Solutions, LLC.
5. Tubelite Inc.

B. Basis-of-Design: Kawneer, Tri-Fab Versaglaze 601UT (2x6 framing).

C. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Exterior Framing Construction: Thermally broken.
2. Interior Vestibule Framing Construction: Nonthermal.
3. Glazing System: Retained mechanically with gaskets on four sides.
4. Finish: Color anodic finish.
5. Fabrication Method: Field-fabricated stick system.
6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
7. Steel Reinforcement: As required by manufacturer.

D. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

E. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

F. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
2. Door Design: As indicated.
3. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.
a. Provide nonremovable glazing stops on outside of door.

2.3 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 08 71 00 "Door Hardware."

B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door, to comply with requirements in this Section.
1. Opening-Force Requirements:
a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion and not more than 15 lbf to open the door to its minimum required width.
b. Accessible Interior Doors: Not more than 5 lbf to fully open door.

2.4 GLAZING

A. Glazing: Comply with Section 08 80 00 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: As recommended by manufacturer.

2.5 MATERIALS

A. Sheet and Plate: ASTM B209.

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.

C. Structural Profiles: ASTM B308/B308M.

D. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

2.6 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

H. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.7 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: As selected by Architect from full range of industry colors and color densities.

PART 3 - EXECUTION

3.1 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE AND STOREFRONT SYSTEMS

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Seal perimeter and other joints watertight unless otherwise indicated.

G. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

H. Set continuous sill members and flashing in full sealant bed, as specified in Section 07 92 00 "Joint Sealants," to produce weathertight installation.

I. Install joint filler behind sealant as recommended by sealant manufacturer.

J. Install components plumb and true in alignment with established lines and grades.

K. Install entrance doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware in accordance with entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

L. Install glazing as specified in Section 08 80 00 "Glazing."

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests.

B. Tests: Perform the following test on representative areas of aluminum-framed entrance and storefront systems.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect to be tested in accordance with **AAMA 501.2** and to not evidence **any** water penetration.
   a. Perform a minimum of two tests in areas as directed by Architect.
   b. Ensure that spray area includes perimeter condition.
2. Air Leakage: Follow **AAMA 503** per ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
   a. Perform a minimum of two tests in areas as directed by Architect.
3. Water Penetration: Follow **AAMA 503** per ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 1.00 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and to not evidence **any** water penetration.

C. Duration of Tests: Run all timed tests to end, and do not stop upon first evidence of minor failure. Intent is to understand if failure is due to window system or intersection of window system with adjacent wall (i.e., perimeter condition).

D. Aluminum-framed entrance and storefront systems will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

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SECTION 08 44 13
GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Glazed aluminum curtain wall systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: Include plans, elevations, sections, full-size details, and attachments to other work.
   1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
C. Samples: For each type of exposed finish required.
D. Delegated-Design Submittal: For glazed aluminum curtain walls, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Energy Performance Certificates: NFRC-certified energy performance values for each glazed aluminum curtain wall.
B. Product test reports.
C. Source quality-control reports.
D. Field quality-control reports.
E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AGM) contractors.
B. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and acceptable to Owner and Architect.
C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.7 WARRANTY

A. Special Assembly Warranty: Manufacturer agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.
B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.
C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazed aluminum curtain walls.
B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Glazed aluminum curtain walls shall withstand movements of supporting structure, including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   2. Failure also includes the following:
      a. Thermal stresses transferring to building structure.

b. Glass breakage.
c. Noise or vibration created by wind and thermal and structural movements.
d. Loosening or weakening of fasteners, attachments, and other components.
e. Failure of operating units.

C. Structural Loads:
1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans of greater than 13 feet 6 inches.
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
3. Cantilever Deflection: Limited to 2l/175 at unsupported cantilevers.

E. Structural: Test in accordance with ASTM E330/E330M as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft..

G. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:
1. Thermal Transmittance (U-factor):
a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.29 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
2. Solar Heat Gain Coefficient (SHGC):
a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.26 as determined in accordance with NFRC 200.
3. Air Leakage:
a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft. when tested in accordance with ASTM E283.
4. Condensation Resistance Factor (CRF):
a. Fixed Glazing and Framing Areas: CRF for the system of not less than 55 as determined in accordance with AAMA 1503.

H. Windborne-Debris Impact Resistance: Pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 1 for basic protection.
1. Large-Missile Test: For glazing located within 30 feet of grade.
2. Small-Missile Test: For glazing located between 30 feet and 60 feet above grade.

I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GLAZED ALUMINUM CURTAIN WALL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. EFCO Corporation.
2. Kawneer Company, Inc.; Arconic Corporation.
3. OldCastle BuildingEnvelope (OBE).
4. TRACO, a division of Kawneer.
5. Trulite Glass & Aluminum Solutions, LLC.
6. Tubelite Inc.

B. Basis-of-Design: Kawneer 1600 Wall System 1 (2x6 framing).

C. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken.

2. Glazing System: Retained mechanically with gaskets on four sides.
3. Glazing Plane: Front.
4. Finish: Color anodic finish.
5. System: Either stick or unitized system.
6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
7. Steel Reinforcement: As required by manufacturer.

D. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
1. Include snap-on aluminum trim that conceals fasteners.

E. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.3 GLAZING

A. Glazing: Comply with Section 08 80 00 "Glazing."

B. Glazing Gaskets: ASTM C509 or ASTM C864. Compression-type, replaceable EPDM.
1. Color: Black.

C. Glazing Sealants: As recommended by manufacturer.

2.4 MATERIALS

A. Sheet and Plate: ASTM B209.

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.

C. Structural Profiles: ASTM B308/B308M.

D. Steel Reinforcement:
1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

2.5 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Provisions for safety railings mounted between mullions at interior.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
8. Components curved to indicated radii.

D. Fabricate components to resist water penetration as follows:
1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

E. Curtain-Wall Framing: Fabricate components for assembly using manufacturer's standard assembly method.

F. Factory-Assembled Frame Units:
1. Rigidly secure nonmovement joints.
2. Prepare surfaces that are in contact with structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion.
3. Preparation includes, but is not limited to, cleaning and priming surfaces.
4. Seal joints watertight unless otherwise indicated.
5. Install glazing to comply with requirements in Section 08 80 00 "Glazing."

G. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.6 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
1. Color: As selected by Architect from full range of industry colors and color densities.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

G. Seal joints watertight unless otherwise indicated.

H. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

I. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

J. Install components plumb and true in alignment with established lines and grades.

3.2 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 08 80 00 "Glazing."

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Test Area: Perform tests on representative areas of glazed aluminum curtain walls.

C. Field Quality-Control Testing: Perform the following test on representative areas of glazed aluminum curtain walls.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested in accordance with **AAMA 501.2** and shall not evidence **any** water penetration.
   a. Perform a minimum of two tests in areas as directed by Architect.
   b. Ensure that spray area includes perimeter condition.

D. Duration of Tests: Run all timed tests to end, and do not stop upon first evidence of minor failure. Intent is to understand if failure is due to window system or intersection of window system with adjacent wall (i.e., perimeter condition).

E. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

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PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Commercial door hardware for aluminum entrances, wood and steel doors
   2. Coordination and interface with Owner’s Security System.
   3. Templates
   4. Keying System

1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish all hardware to Section 06200 for installation.

1.3 RELATED WORK

A. Section 08 11 00 - Metal Doors and Frames: Doors and Frames prepared for finish hardware.
B. Section 08 21 00 - Wood Doors: Wood doors: Doors and Frames prepared for finish hardware.
C. Division 26 - Electrical Power supply to electric hardware devices and low voltage control.

1.4 REFERENCES

A. ANSI A117.1 - Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.
B. ANSI/NFPA 80 - Fire Doors and Windows.
C. BHMA - Builders' Hardware Manufacturers Association.
D. DHI - Door and Hardware Institute.
E. NAAMM - National Association of Architectural Metal Manufacturers.
F. NFPA 101 - Life Safety Code.
G. SDI - Steel Door Institute.
H. ADA - The Americans with Disabilities Act.

1.5 COORDINATION

A. Coordinate work of this Section with other directly affected Sections involving manufacturer of any internal reinforcement for hardware.

B. Furnish template for application to doors and jambs with machine or wood screws or through-bolts as required. Templates or hardware or both shall be delivered to factory or building as required by those furnishing items to which hardware is to be applied. Refer to other Sections of Specifications for this information. Locksets for metal doors shall have beveled faces to correspond with bevel or doors. Strikes shall be ASA Standard dimension. Locks having bolts or latches engaging with mullions or jambs of hollow metal shall have box type strikes with curved lips.

C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

D. Cooperate with installing contractor and others with regard to application of hardware. Make occasional inspections to verify that items are properly used, installed, in correct location and master-key system is maintained. Report improper application of hardware.

E. Prior to preparing shop drawing submittal, contact Architect to set up a meeting with the Owner to review door functions.

1.6 QUALITY ASSURANCE

A. Manufacturers: Companies specializing in manufacturing door hardware with minimum three years experience.

B. Hardware Supplier: Company specializing in supplying commercial and institutional door hardware with five years experience.

C. Each type of hardware shall be furnished from only one manufacturer.

D. No hardware shall be attached to metal frames with self-tapping or sheet metal screws.

E. Furnish thru bolts for fastening overhead holders and closers on composite core doors.

1.7 REGULATORY REQUIREMENTS

A. Conform to NFPA Standard No. 80 requirements applicable to fire rated doors and frames.

B. Provide only hardware which has been tested and listed by U.L. for types and sizes of doors required and complies with requirements of door and door frame labels.

1.8 CERTIFICATIONS

A. Architectural Hardware Vendor shall inspect complete installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified herein.

B. Provide two copies of certifications to Architect.

1.9 SUBMITTALS

A. Before ordering material, prepare and submit complete vertical hardware schedule for all hardware materials to Architect for review. Approval of schedule does not relieve Contractor of any responsibility for furnishing material in accordance with requirements of work.

B. Schedule shall be specific and conclusive with respect to catalog numbers, finishes, template requirements, brackets, type of fasteners and locations. Incomplete schedule will not be checked.

C. Include in schedule, installation dimensions, hardware locations and mounting heights of each type of hardware.

D. Prepare detailed keying schedule after obtaining Owner's instructions and requirements, and submit for approval.

E. Samples, if requested shall be submitted to Architect for approval. Approved samples, if of proper finish, will be delivered to job for ultimate use; otherwise samples will be returned to Contractor upon completion.

F. Submit certificate that hardware to be furnished meets or exceed specified requirements.

G. Submit catalog cut sheets describing all hardware items.

H. Coordinate with Electrical Contractor and Owner’s Security Design Vendor installation requirements for locksets that have electric strikes, door position switches and other line or low voltage requirements.

I. Operation and Maintenance data.

1.10 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data for all hardware items provided.

B. Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

C. Include one copy of final approved hardware and keying schedule.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Send duplicate list of hardware in each shipment to Contractor. Original list shall accompany shipment. Hardware vendor shall pay shipping and delivery charges.

B. Deliver hardware to Carpenter (Section 06200) or to respective shops of other Contractors as required. Consult with named Contractors and follow their directions regarding manner, sequence and time of delivery and obtain receipt.

C. Responsibility for safekeeping after delivery rests with trade to whom hardware was delivered.

D. Hardware shall be sorted and delivered to jobsite plainly marked to correspond with item numbers of vendor's approved schedule and be specific as to exact openings and other locations for which items are packaged. Each door opening shall receive separate item number on Hardware Schedule.

E. Plainly mark packages of hardware so that locations of their use may be ascertained without breaking package. Where several packages are needed to complete schedule for one location, securely tie together or box.

F. Pack hardware by building area unless Contractor receiving hardware orders otherwise.

G. Hardware Supplier shall check all shipments to insure proper accessories and templates.

H. Deliver hardware only after detailed schedule, keying diagrams, and samples have been approved.

I. Provide secure lock-up for hardware delivered to the project. Control handling and installation of hardware items which are not immediately replaceable so that the completion of the work will not be delayed by hardware losses.

1.12 MAINTENANCE MATERIALS

A. Provide three each special wrenches and tools applicable to each difference or special hardware component.

B. Provide three each maintenance tools and accessories supplied by hardware component manufacturer.

1.13 WARRANTY

A. Provide manufacturer's standard warranty.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of door hardware from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

B. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

D. Accessibility Requirements: For door hardware on doors in an accessible route, comply with **ICC A117.1**.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).
2. Comply with the following maximum opening-force requirements:
   a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
   b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.
5. Adjust spring hinges so that, from an open position of 70 degrees, the door will take at least 1.5 seconds to move to the closed position.

2.3 MATERIALS

A. Locks, Latches, Cylinders, and Dead Locks

1. Shall be Schlage L series as noted in hardware sets. Backset shall be 2-3/4" for all locks, latches and dead locks, unless otherwise required to match existing door prep's. No substitutions.
2. All locks and latches shall be of one manufacturer.
3. Included construction cores for all cylinders.
4. All cylinder cores shall be Schlage Primus brand cores. No substitutions. Primus cores are to be supplied by owner.

B. Exit Devices

1. Devices shall be as manufactured by Von Duprin as noted in hardware sets. No substitutions.
2. Function shall be as noted in schedule.
3. Mount exit devices to match mullions at adjacent doors and frames wherever possible.

C. Butt Hinges

1. Shall be Best, Hager, or Ives ball bearing, nonrising loose pin, flat button tip, unless specified to the contrary.
2. Number of butts required:
   a. Doors up to 7' – 4" - 3 butts
   b. Doors 7'- 4" up to 10' – 4 butts

3. Butt size requirements
   a. Interior doors up to 36” wide 4-1/2 x 4-1/2 standard weight.
   b. Interior doors over 36" wide 4-1/2 x 4-1/2 heavy weight.
   c. Exterior doors 4-1/2 x 4-1/2 heavy weight.
4. Door butt legend: (unless otherwise noted in Schedule)
   a. Exterior doors and interior doors exposed to garage/wet areas –stainless steel-NRP.
   b. All other doors steel based.
5. Furnish UL approved butts on labeled doors.
6. Provide non-removable pins (NRP) on all exterior and lockable outswinging doors.
7. Continuous Gear Hinges: Hager, Ives, or Select.

D. Door Closers
1. Shall be LCN 4040XP series unless otherwise specified in hardware groups. No substitutions.
2. Closers shall have key adjusting device.
3. Mount to provide maximum opening permitted by building construction or equipment. Note on schedule the maximum swing per location for other trades involved in reinforcement or installation.
4. All door closers shall be similar in design and appearance to those listed in the schedule, so far as possible, of one manufacturer. Furnish special arms and applications as indicated in hardware schedule or as dictated by structural conditions or local code requirements. Provide appropriate brackets for doors with transoms.
5. Door closers at labeled fire doors shall bear UL approval. Provide thru-bolts for mineral core doors unless otherwise specified in door specifications.

E. Pushes, Pulls, and Kickplates
1. Shall be as manufactured by Hager, Ives, Rockwood, or Trimco..
2. All plates shall be 16 gauge (0.50), beveled sides and with countersunk screw holes at intervals of not over 6" on all four sides. Screws shall be stainless steel oval head, finish to match plates.

F. Stops and Bumpers
1. Shall be Hager, Ives, Rixson, Rockwood, or Trimco..
2. Install bumper behind each door.
3. Overhead stops and holder types as specified in hardware groups.
4. Apply with expansion shield and machine screws only.
5. Provide special templates as required for proper coordination of door closers and overhead door holders.

G. Manual and Automatic flushbolts.
1. Shall be Hager, Ives, Rockwood, or Trimco.

H. Low Energy Openers
1. ADA Automatic Openers: Stanley Magic Force, Horton 4000LE or Motion Access Condor Swing as specified in hardware groups. Automatic operators are to be included as supply and install. Coordinate installation and operation of opener and switches with electrical contractor.

I. Thresholds, Weatherstripping, Sound Seals
1. National Guard, Hager, or Pemko.

J. Door Silencers or Mutes
1. Furnish three for each pressed steel frame for single doors, two for each pressed steel frame for pairs of doors.

K. Other Materials
1. Provide other materials not specifically described but required for a complete and proper installation, as selected by the Contractor and approved by the Architect.

2.4 KEYING

A. Keying is by owner.

2.5 FABRICATION

A. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and ANSI/BHMA A156.18.

B. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended; however, aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.

2.6 FINISHES

A. Provide finishes complying with ANSI/BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames in accordance with ANSI/SDI A250.6.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights **to comply with the following** unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Custom Steel Doors and Frames: HMMA 831.

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (760 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room. Verify location with Architect.

1. Configuration: Provide one power supply for each door opening or least number of power supplies required to adequately serve doors with electrified door hardware.

E. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

F. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

1. Do not notch perimeter gasketing to install other surface-applied hardware.

3.4 INSPECTION AND ADJUSTMENTS

A. Hardware vendor shall, before substantial completion of project, and/or as directed by Architect, inspect all locks that are part of this project to see that keys pass proper locks as required.

B. Check that all locks and latches are properly lubricated, as recommended by manufacturer, with lock lubricant and that all moving parts are adjusted correctly to insure free, smooth operation.

C. Door closers and holders shall be checked for proper lubrication. After building is in use, arrange with factory representative of closer manufacturer to make final adjustments to closers to meet building conditions.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

SCHEDULE

Check specified schedule against latest revised plans when making up schedule for approval. Schedule each door separately and, where practical, item numbers shall be same as door numbers and in consecutive sequence.

If hardware is not scheduled for a particular door, furnish hardware of types specified for similar locations as far as practical.

Include accessories required to fully equip in satisfactory manner, doors and the like as shown and specified. Include necessary screws, nuts, bolts, expansion shields and other devices necessary for proper application.]

Items of hardware herein described shall be considered as standard and, unless otherwise specifically mentioned, all hardware used throughout work shall be equal thereto in size, weight, material and workmanship. Revision of standard hardware, which may be necessary to conform to details shall be provided. Items not specifically mentioned but necessary for completion of work shall be of most suitable type matching in quality and finish items which are described.

SET 01

	EA	HINGES	AS SPECIFIED	640	IVES
1	EA	CLASSROOM LOCK	L9070T X 03A	613	SCHLAGE
1	EA	PRIMUS CORE	AS REQUIRED	613	SCHLAGE
2	EA	CLOSER	4040XP-H	695	LCN
2	EA	OVERHEAD STOP	GJ100 SERIES	613	GLYNN-JOHNSON
1	SET	AUTO FLUSHBOLTS	FB31P/FB41P	613	IVES
1	EA	DUSTPROOF STRIKE	DP2	613	IVES
1	EA	COORDINATOR	COR X FL	711	IVES
2	EA	KICKPLATE	10” X 1” LDW	613	IVES

**PROVIDE LCN SPECIAL TEMPLATE ST1630 AND 4040XP-18TJ PLATE AS REQUIRED FOR CLOSER AND OVERHEAD STOP INSTALLATION.

SET 02

	EA	HINGES	AS SPECIFIED	640	IVES
1	EA	CLASSROOM LOCK	L9070T X 03A	613	SCHLAGE
1	EA	PRIMUS CORE	AS REQUIRED	613	SCHLAGE
1	EA	CLOSER	4040XP-H	695	LCN
1	EA	OVERHEAD STOP	GJ100 SERIES	613	GLYNN-JOHNSON
1	EA	KICKPLATE	10” X 2” LDW	613	IVES

SET 03

	EA	HINGES	AS SPECIFIED	640	IVES
1	EA	PRIVACY	L9040 X 03A X L283-722	613	SCHLAGE
1	EA	CLOSER	4040XP	695	LCN
1	EA	WALL STOP	409	613	ROCKWOOD
1	EA	KICKPLATE	10” X 2” LDW	613	IVES

SET 04

	EA	HINGES	AS SPECIFIED	640	IVES
1	EA	EXIT DEVICE	9927NL X LBR	613	VON DUPRIN
1	EA	EXIT DEVICE	9927DT X LBR	613	VON DUPRIN
1	EA	I/C CYLINDER	AS REQUIRED	613	SCHLAGE
1	EA	PRIMUS CORE	AS REQUIRED	613	SCHLAGE
2	EA	CLOSER	4040XP	695	LCN

2	EA	OVERHEAD HOLDER	GJ100H SERIES	613	GLYNN-JOHNSON
2	EA	KICKPLATE	10" X 1" LDW	613	IVES

**PREP DOORS WITH RACEWAYS FOR FUTURE ELECTRIC LATCH RETRACTION KITS AND ELECTRIC HINGES FOR FUTURE CARD ACCESS.

SET 05

	EA	HINGES	AS SPECIFIED	640	IVES
2	EA	EXIT DEVICE	9927DT X LBR	613	VON DUPRIN
2	EA	CLOSER	4040XP	695	LCN
2	EA	OVERHEAD HOLDER	GJ100H SERIES	613	GLYNN-JOHNSON
2	EA	KICKPLATE	10" X 1" LDW	613	IVES

**PREP DOORS WITH RACEWAYS FOR FUTURE ELECTRIC LATCH RETRACTION KITS AND ELECTRIC HINGES FOR FUTURE CARD ACCESS.

SET 06

	EA	HINGES	224HD	640	IVES
1	EA	EXIT DEVICE	99EO	613	VON DUPRIN
1	EA	CLOSER	4040XP	695	LCN
1	EA	OVERHEAD STOP	GJ100 SERIES	613	GLYNN-JOHNSON
1	SET	WEATHERSTRIP	700SDKB	DKB	NGP
1	EA	SWEEP	200NDKB	DKB	NGP
1	EA	THRESHOLD	8425	AL	NGP

SET 07

1	EA	CONTINUOUS HINGE	112HD	DKB	IVES
1	EA	EXIT DEVICE	99EO	613	VON DUPRIN
1	EA	CLOSER	4040XP	695	LCN
1	EA	OVERHEAD STOP	GJ100 SERIES	613	GLYNN-JOHNSON
1	EA	SWEEP	200NDKB	DKB	NGP
1	EA	THRESHOLD	8425	AL	NGP

**SEALS BY DOOR SUPPLIER.
**PROVIDE DROP PLATE AND BLADE STOP SPACER AS REQUIRED FOR CLOSER INSTALLATION.

SET 08

	EA	HINGES	AS SPECIFIED	640	IVES
1	EA	STOREROOM LOCK	L9080T X 03A	613	SCHLAGE
1	EA	PRIMUS CORE	AS REQUIRED	613	SCHLAGE
2	EA	CLOSER	4040XP-SCUSH	695	LCN
1	SET	AUTO FLUSHBOLTS	FB31P/FB41P	613	IVES
1	EA	DUSTPROOF STRIKE	DP2	613	IVES
1	EA	COORDINATOR	COR X FL	711	IVES
2	EA	MNTG BRACKETS	AS REQUIRED	BLK	IVES
2	EA	KICKPLATE	10" X 1" LDW	613	IVES
1	SET	SEALS	5050C	BLK	NGP
1	SET	ASTRAGAL	115N	DKB	NGP
2	EA	AUTO DR BOTTOM	320N	AL	NGP

SET 09

	EA	HINGES	AS SPECIFIED	640	IVES
1	EA	STOREROOM LOCK	L9080T X 03A	613	SCHLAGE

1	EA	PRIMUS CORE	AS REQUIRED	613	SCHLAGE
2	EA	CLOSER	4040XP	695	LCN
2	EA	OVERHEAD HOLDER	GJ100H SERIES	613	GLYNN-JOHNSON
1	SET	AUTO FLUSHBOLTS	FB31P/FB41P	613	IVES
1	EA	DUSTPROOF STRIKE	DP2	613	IVES
1	EA	COORDINATOR	COR X FL	711	IVES
2	EA	MNTG BRACKETS	AS REQUIRED	BLK	IVES
2	EA	KICKPLATE	10” X 1” LDW	613	IVES
1	SET	SEALS	5050C	BLK	NGP
1	SET	ASTRAGAL	115N	DKB	NGP
2	EA	AUTO DR BOTTOM	320N	AL	NGP

SET 10

	EA	HINGES	AS SPECIFIED	640	IVES
1	EA	STOREROOM LOCK	L9080T X 03A	613	SCHLAGE
1	EA	PRIMUS CORE	AS REQUIRED	613	SCHLAGE
1	EA	CLOSER	4040XP	695	LCN
1	EA	WALL STOP	409	613E	ROCKWOOD
1	EA	KICKPLATE	10” X 2” LDW	613	IVES
1	EA	DEADBOLT FILLER PLATE	AS REQUIRED		

**GC TO CUT NEW 4 7/8” ANSI STRIKE PREP IN FRAME FOR NEW LOCK.
**PROVIDE NEW FILLER FOR EXISTING DEADBOLT STRIKE. FIELD VERIFY.

SET 11

	EA	HINGES	AS SPECIFIED	640	IVES
1	EA	PUSH	70C	613	ROCKWOOD
1	EA	PULL	BF111 X 70C	613	ROCKWOOD
1	EA	CLOSER	4040XP	695	LCN
1	EA	WALL STOP	409	613E	ROCKWOOD
1	EA	KICKPLATE	10” X 2” LDW	613	IVES
1	EA	FOOT PULL	FP1230	613E	ROCKWOOD

END OF SECTION

SECTION 08 80 00
GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Glass products.
2. Laminated glass.
3. Insulating glass.
4. Glazing sealants.
5. Glazing tapes.
6. Miscellaneous glazing materials.

1.2 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.
C. Delegated Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For glass.
B. Product test reports.
C. Preconstruction adhesion and compatibility test report.
D. Sample warranties.

1.6 QUALITY ASSURANCE

A. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.7 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
1. Warranty Period: 10 years from date of Substantial Completion.
B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
1. Warranty Period: 10 years from date of Substantial Completion.
C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.
1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazing.
B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:
1. Design Wind Pressures: As indicated on Drawings.
2. Design Snow Loads: As indicated on Drawings.

3. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.

C. Windborne-Debris-Impact Resistance: Exterior glazing shall pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 1 for basic protection.
1. Large-Missile Test: For glazing located within 30 feet of grade.
2. Small-Missile Test: For glazing located between 30 feet and 60 feet above grade.

D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F.
2. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
3. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

F. Acoustic Performance:
1. Exterior Glazing: 28 OITC min.
2. Interior Glazing: 35 STC min.

2.2 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. NGA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.3 GLASS PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Cardinal Glass Industries, Inc.
b. Guardian Glass LLC.
c. Pilkington North America; NSG Group.
d. Saint-Gobain Glass Corp.
e. Viracon.

B. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.

C. Low-Iron Annealed Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.

D. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.

E. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

F. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

G. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.

H. Ceramic-Coated Vision Glass: ASTM C1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in NGA's "Engineering Standards Manual."

I. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.
J. Silicone-Coated Spandrel Glass: ASTM C1048, Type I, Condition C, Quality-Q3.
K. Reflective- and Low-E-Coated Spandrel Glass: ASTM C1376, Kind CS.

2.4 LAMINATED GLASS

A. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
1. Construction: Laminate glass with polyvinyl butyral interlayer, ionoplast interlayer, or cast-in-place and cured-transparent-resin interlayer to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.

2.5 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
2. Perimeter Spacer: Manufacturer's standard spacer material and construction.
3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.6 GLAZING SEALANTS

A. General:
1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range of industry colors.

B. Neutral-Curing Silicone Glazing Sealant, Class 100/50: Complying with ASTM C920, Type S, Grade NS, Use NT.

2.7 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.8 MISCELLANEOUS GLAZING MATERIALS

A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
B. Setting Blocks:
1. Type recommended in writing by sealant or glass manufacturer.
C. Spacers:
1. Type recommended in writing by sealant or glass manufacturer.
D. Edge Blocks:
1. Type recommended in writing by sealant or glass manufacturer.
E. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
F. Provide spacers for glass lites where length plus width is larger than 50 inches.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

3.2 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Apply heel bead of elastomeric sealant.

F. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.3 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.4 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.5 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

3.6 MONOLITHIC GLASS SCHEDULE

A. Clear Glass Type **GL-4**:

1. Annealed float glass. Provide fully tempered where safety glazing is required as noted in drawings.
2. Minimum Thickness: 6 mm.

3.7 LAMINATED GLASS SCHEDULE

A. Clear Laminated Glass Type **GL-3**:

1. Two plies of annealed float glass.
2. Minimum Thickness of Each Glass Ply: 3 mm.
3. Interlayer Thickness: 0.030 inch min.

4. Safety glazing required.

3.8 INSULATING GLASS SCHEDULE

A. Clear With Applied Membrane Insulating Glass Type **GL-2**:
1. Provide fully tempered where safety glazing is required as noted in drawings.
2. Basis-of-Design Product: Solera, Solera S R5+Aerogel.
3. Applied Membrane: Light Diffusing Veil (by Solera).
4. Overall Unit Thickness: 1 inch.
5. Minimum Thickness of Each Glass Lite: 6 mm.
6. Outdoor Lite: Annealed float glass.
7. Interspace Content: Aerogel.
8. Indoor Lite: Annealed float glass.
9. Safety glazing required.
10. Panel Characteristics:
    a. SHGC: 0.37 max.
    b. VLT: 0.40 min.
    c. U-factor: 0.20 max.

B. Low-E&Ceramic-Coated, Insulating Vision Glass Type **GL-1**:
1. Provide fully tempered where safety glazing is required as noted in drawings.
2. Basis-of-Design Product: Viracon, 51767 Bird Friendly glass.
3. Ceramic Coating Color and Pattern: 1% coverage, 1/4” dot, 2x2, staggered in warm grey.
4. Overall Unit Thickness: 1 inch.
5. Minimum Thickness of Each Glass Lite: 6 mm.
6. Outdoor Lite: Clear heat-strengthened float glass.
7. Interspace Content: Argon.
8. Indoor Lite: Clear heat-strengthened float glass.
9. Ceramic Coating Location: Second surface.
10. Low-E Coating: Pyrolytic or sputtered on third surface.
11. Panel Characteristics:
    a. SHGC: 0.25 max.
    b. VLT: 0.60 min.
    c. U-factor: 0.20 max.

END OF SECTION

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SECTION 08 83 00
MIRRORS

PART 1 - GENERAL

1.1 SUMMARY

A. This section does NOT apply to those tagged as Toilet Accessories in drawings.

B. Section Includes:

1. Silvered flat glass mirrors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.

C. Samples: For each type of the following:

1. Mirrors: 12 inches square, including edge treatment on two adjoining edges.
2. Mirror Clips: Full size.
3. Mirror Trim: 12 inches long.

1.3 INFORMATIONAL SUBMITTALS

A. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing and substrates on which mirrors are installed.

B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For mirrors to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer, who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing.

1. Testing is not required if data are submitted based on previous testing of mirror mastic products and mirror backing matching those submitted.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SILVERED FLAT GLASS MIRRORS

A. Mirrors, General: ASTM C1503.

B. Annealed Monolithic Glass Mirrors: Mirror Select Quality, clear.

1. Nominal Thickness: 4.0 mm.

2.2 MISCELLANEOUS MATERIALS

A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors.

D. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.3 MIRROR HARDWARE

A. Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.

1. Aluminum J-Channel Bottom Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch in height, respectively, and a thickness of not less than 0.04 inch.
2. Aluminum J-Channel Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch in height, respectively, and a thickness of not less than 0.04 inch.
3. Finish: Clear bright anodized.

B. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

2.4 FABRICATION

A. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts, so they fit closely around penetrations in mirrors.

B. Mirror Edge Treatment: Flat polished.

1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.

C. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint, as recommended in writing by film-backing manufacturer, to produce a surface free of bubbles, blisters, and other imperfections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.

B. Verify compatibility with and suitability of substrates, including compatibility of existing finishes or primers with mirror mastic.

C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION

A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced National Glass Association (NGA) publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

B. Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.

1. Aluminum J-Channels: Provide setting blocks 1/8 inch thick by 4 inches long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch wide by 3/8 inch long at bottom channel.
2. Install mastic as follows:
   a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
   b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
   c. After mastic is applied, align mirrors and press into place while maintaining a minimum airspace of 1/8 inch between back of mirrors and mounting surface.

C. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer and NGA's publication "Proper Procedures for Cleaning Flat Glass Mirrors."

END OF SECTION

SECTION 08 91 19
FIXED LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fixed extruded-aluminum louvers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

C. Samples: For each type of metal finish required.

D. Delegated Design Submittal: For louvers indicated to comply with structural performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on tests performed according to AMCA 500-L.

B. Sample warranties.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
   3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.5 WARRANTY

A. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.

B. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures are considered to act normal to the face of the building.
   1. Wind Loads:
      a. Determine loads based on a uniform pressure of 20 lbf/sq. ft., acting inward or outward.

C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

2.2 FIXED EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Wind-Driven-Rain-Resistant Louver, Extruded Aluminum:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Greenheck Fan Corporation.
      b. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
   2. Louver Depth: 6 inches.
   3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
   4. Louver Performance Ratings:
      a. Free Area: **See Mechanical for requirement**.
      b. Air Performance: Not more than **X-inch wg** static pressure drop at **Y-fpm** free-area exhaust and/or intake velocity. **See Mechanical for values**.
      c. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a core-area intake velocity of 300 fpm.
   5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

B. Vertical, Wind-Driven-Rain-Resistant Louver, Extruded Aluminum:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Greenheck Fan Corporation.
      b. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
   2. Louver Depth: 6 inches.

3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
4. Louver Performance Ratings:
   a. Free Area: **See Mechanical for requirement**.
   b. Air Performance: Not more than **X-inch wg** static pressure drop at **Y-fpm** free-area exhaust and/or intake velocity. **See Mechanical for values**.
   c. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a core-area intake velocity of 300 fpm.
5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.3 LOUVER SCREENS

A. General: Provide screen at each exterior louver.
   1. Screen Location for Fixed Louvers: Interior face.
   2. Screening Type: Bird screening.
B. Louver Screen Frames: Same type and form of metal as indicated for louver to which screens are attached.
C. Louver Screening for Aluminum Louvers:
   1. Bird Screening, Stainless Steel: 1/2-inch-square mesh, 0.047-inch wire.

2.4 MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
C. Galvanized-Steel Sheet: ASTM A653/A653M, G60 zinc coating, mill phosphatized.
D. Stainless Steel Sheet: ASTM A240/A240M, Type 304, No. 2B finish.
E. Fasteners: Use types and sizes to suit unit installation conditions.
   1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
   2. For fastening aluminum, use aluminum or 300 series stainless steel fasteners.
   3. For fastening galvanized steel, use hot-dip-galvanized-steel or 300 series stainless steel fasteners.
   4. For fastening stainless steel, use 300 series stainless steel fasteners.
   5. For color-finished louvers, use fasteners with heads that match color of louvers.
F. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless steel components, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing according to ASTM E488/E488M conducted by a qualified testing agency.
G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.5 FABRICATION

A. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
B. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.6 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
   1. Color: As selected by Architect from full range of industry colors and color densities.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
D. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

3.2 ADJUSTING

A. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

END OF SECTION

SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Framing systems.
   2. Suspension systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation reports for high-strength steel studs and tracks, firestop tracks, post-installed anchors, and power-actuated fasteners.

1.4 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association, the Steel Stud Manufacturers Association, or the Supreme Steel Framing System Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, in accordance with ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C645 for conditions indicated.
   1. Steel Sheet Components: Comply with ASTM C645 requirements for metal unless otherwise indicated
   2. Protective Coating: Comply with ASTM C645; ASTM A653/A653M, G40; or coating with equivalent corrosion resistance. Galvannealed products are unacceptable.
      a. Coating demonstrates equivalent corrosion resistance with an evaluation report acceptable to authorities having jurisdiction.

B. Studs and Track: ASTM C645.
   1. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection.
   2. Depth: As indicated on Drawings.

C. High-Strength Steel Studs and Tracks: Roll-formed with surface deformations to stiffen the framing members.
   1. Minimum Base-Steel Thickness: As required by horizontal deflection performance requirements.
   2. Depth: As indicated on Drawings.

D. Slip-Type Head Joints: Where indicated, provide one of the following:
   1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing 2-inch minimum vertical movement.
   2. Single Long-Leg Track System: Top track with 2-inch-deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
   3. Double-Track System: Top outer tracks, inside track with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
   4. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

E. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Base-Steel Thickness: 0.0296 inch.

G. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch-wide flanges.
   1. Depth: 1-1/2 inches.
   2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.

H. Hat-Shaped, Rigid Furring Channels:
1. Minimum Base-Steel Thickness: 0.0296 inch.
2. Depth: As indicated on Drawings.

I. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.
1. Configuration: Asymmetrical or hat shaped.

J. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges.
1. Depth: As indicated on Drawings.
2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.
3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

K. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 3/4 inch, minimum uncoated-steel thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

B. Hanger Attachments to Concrete:
1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, AC193, AC58, or AC308 as appropriate for the substrate.
a. Uses: Securing hangers to structure.
b. Type: Torque-controlled, expansion anchor torque-controlled, adhesive.
c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.

E. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch-wide flanges.
1. Depth: 2-1/2 inches.

F. Furring Channels (Furring Members):
1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
2. Steel Studs and Tracks: Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
a. Minimum Base-Steel Thickness: 0.0269 inch.
b. Depth: As indicated on Drawings.
3. High-Strength Steel Studs and Tracks:
a. Minimum Base-Steel Thickness: 0.0180 inch.
b. Depth: As indicated on Drawings.
4. Hat-Shaped, Rigid Furring Channels: 7/8 inch deep.
a. Minimum Base-Steel Thickness: 0.0296 inch.
5. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound transmission.
a. Configuration: Asymmetrical or hat shaped.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:
1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.
1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.

3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.2 INSTALLATION OF FRAMING SYSTEMS

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
    a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:
    a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
    b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Z-Shaped Furring Members:

1. Erect insulation, specified in Section 07 21 00 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.3 INSTALLATION OF SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
    a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

3.4 FIELD QUALITY CONTROL

A. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

SECTION 09 29 00
GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Interior gypsum board.
2. Tile backing panels.
3. Sound attenuating blankets.

1.2 ACTION SUBMITTALS

A. Product data.
B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.
C. Samples: For each texture finish indicated on same backing indicated for Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated in accordance with ASTM E119 by an independent testing agency.
B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Gypsum Board, Type X: ASTM C1396/C1396M.
1. Thickness: 5/8 inch.
2. Long Edges: Tapered.
3. **Typical wall and ceiling board unless noted otherwise**.
B. Abuse-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested in accordance with ASTM C1629/C1629M.
1. Core: 5/8 inch, Type X.
2. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds Level 1 requirements.
3. Indentation: ASTM C1629/C1629M, meets or exceeds Level 1 requirements.
4. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 1 requirements.
5. Long Edges: Tapered.
6. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
7. **Used where called for in drawings**.
C. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
4. **Except surfaces to receive tile, used at wet walls and all walls/ceilings of restrooms and shower/locker rooms**.

2.4 SPECIALTY GYPSUM BOARD

A. Gypsum Board, Type C: ASTM C1396/C1396M. Manufactured to have increased fire-resistive capability.
1. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
2. Long Edges: Tapered.
3. **Used where required by UL design. See wall types**.

2.5 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.
1. Thickness: 1/2 inch unless noted/detailed otherwise in drawings.
2. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
3. **Used behind any wall or ceiling tile**.

2.6 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.
1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
2. Shapes:

a. Cornerbead.
b. Bullnose bead.
c. LC-Bead: J-shaped; exposed long flange receives joint compound.
d. L-Bead: L-shaped; exposed long flange receives joint compound.
e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
f. Expansion (control) joint.
g. Curved-Edge Cornerbead: With notched or flexible flanges.

2.7 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.
B. Joint Tape:
1. Interior Gypsum Board: Paper.
2. Exterior Gypsum Soffit Board: Paper.
3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
4. Tile Backing Panels: As recommended by panel manufacturer.
C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.
D. Joint Compound for Tile Backing Panels:
1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.8 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
E. Acoustical Sealant: As specified in Section 07 92 19 "Acoustical Joint Sealants."
F. Thermal Insulation: As specified in Section 07 21 00 "Thermal Insulation."
G. Vapor Retarder: As specified in Section 07 26 00 "Vapor Retarders" if used.

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELS

A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
B. Comply with ASTM C840.
C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
D. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

3.2 FINISHING OF GYPSUM BOARD

A. Prefill open joints, rounded or beveled edges, and damaged surface areas.
B. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
C. Gypsum Board Finish Levels: Finish panels to levels indicated below and in accordance with ASTM C840:
1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile or for acoustical tile.
3. Level 3: N/A.

4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated – most common situation.
    a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
5. Level 5: At panel surfaces that will be exposed to view with gloss or high gloss painted finish, or where indicated on Drawings.
    a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."

D. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.

E. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

F. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.3 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION

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SECTION 09 30 13
CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Porcelain tile.
   2. Glazed wall tile.
   3. Waterproof membranes.
   4. Crack isolation membranes.
   5. Setting material.
   6. Grout materials.

B. See Section 09 29 00 SF - Gypsum Board for tile backing panels.

1.2 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings: Show locations, plans, and elevations, of each type of tile and tile pattern. Show widths, details, and locations of movement joints in tile substrates and finished tile surfaces.

C. Samples:
   1. Full-size units of each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend. For tile with aesthetic classification V3 or V4, provide 12 tiles from same production run.
   2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
   3. Full-size units of each type of trim and accessory for each color and finish required.
   4. Stone thresholds in 6-inch lengths.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Tile and Trim Units: Furnish quantity of full-size units equal to ONE box for each type, composition, color, pattern, and size indicated.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer employs at least one installer for Project that has completed the Advanced Certification for Tile Installers (ACT) certification for installation of mud floors, mud walls, membranes, shower receptors, and large format tile.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.2 PORCELAIN TILE

A. Porcelain Tile Type:
   1. See Finish Schedule and Finish Key in drawings for selected tiles.
   2. Certification: Tile certified by the Porcelain Tile Certification Agency.
   3. Face Size Variation: Rectified.
   4. Tile Color, Glaze, and Pattern: Per Finish Key.
   5. Grout Color: As selected by Architect from manufacturer's full range if not identified in Finish Key.
   6. Precoat with temporary protective coating.
   7. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
      a. Base Cap: Surface bullnose, module size same as adjoining flat tile.
      b. Wainscot Cap: Surface bullnose, module size same as adjoining flat tile.

c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
d. External Corners: Surface bullnose, module size same as adjoining flat tile.
e. Internal Corners: Field-butted square corners.
f. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch across nominal 4-inch dimension.

2.3 GLAZED WALL TILE

A. Glazed Wall Tile Type:
1. See Finish Schedule and Finish Key in drawings for selected tiles.
2. Face Size Variation: Rectified.
3. Tile Color and Pattern: Per Finish Key.
4. Grout Color: As selected by Architect from manufacturer's full range if not identified in Finish Key.
5. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
a. Base: Straight, module size per Finish Key.
b. Wainscot Cap: Surface bullnose, module size per Finish Key.
c. External Corners: Surface bullnose; same size as adjoining flat tile.
d. Internal Corners: Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

2.4 WATERPROOF MEMBRANES

A. General: Manufacturer's standard product that complies with ANSI A118.10 and ANSI A118.12 and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.
B. Waterproof Membrane, Sheet: Polyethylene sheet faced on one or both sides with polyester fabric.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ARDEX Americas.
b. Laticrete International, Inc.
c. MAPEI Corporation.
d. Schluter Systems L.P.
2. Nominal Thickness: 0.008 inch.

2.5 CRACK ISOLATION MEMBRANES

A. General: Manufacturer's standard product that complies with ANSI A118.12 for standard performance and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.
B. Crack Isolation Membrane, Polyethylene Sheet: Polyethylene faced on both sides with polyester fabric.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Custom Building Products.
b. Laticrete International, Inc.
c. MAPEI Corporation.
d. Schluter Systems L.P.

2.6 SETTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
1. Cleavage Membrane: Installer's option of material that complies with ANSI A108.02, paragraph 3.8.
2. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A1064/A1064M except for minimum wire size.
3. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C847.
4. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
B. Improved Modified Dry-Set Mortar (Thinset): ANSI A118.15.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ARDEX Americas.
b. Custom Building Products.
c. H.B. Fuller Construction Products Inc. / TEC.
d. Laticrete International, Inc.
e. MAPEI Corporation.

2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.15.

2.7 GROUT MATERIALS

A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.

B. High-Performance Tile Grout: ANSI A118.7.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ARDEX Americas.
   b. Custom Building Products.
   c. H.B. Fuller Construction Products Inc. / TEC.
   d. Laticrete International, Inc.
   e. MAPEI Corporation.

2.8 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting and adhesive materials for installations indicated.

B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D4397, 4.0 mils thick.

C. Metal Flooring Transitions: Profile designed specifically for flooring applications; height to match tile and setting-bed thickness.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Schluter Systems L.P.
2. Description: L-shaped unless noted otherwise in the drawings.
3. Material and Finish: Metallic; exposed-edge material.
   a. Color: See finish schedule and key.

D. Temporary Protective Coating: Formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products and easily removable after grouting is completed without damaging grout or tile.

E. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

F. Grout Sealer: Grout manufacturer's standard product for sealing grout joints that does not change color or appearance of grout.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with adhesives, bonded mortar bed, or thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove coatings, including curing compounds or other coatings, that are incompatible with tile-setting materials.

B. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with adhesives or thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

C. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1 and is sloped 1/4 inch per foot toward drains.

D. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

E. Substrate Flatness:

1. For tile shorter than 15 inches, confirm that structure or substrate is limited to variation of 1/4 inch in 10 ft. from the required plane, and no more than 1/16 inch in 12 inches when measured from tile surface high points.

2. For large format tile, tile with at least one edge 15 inches or longer, confirm that structure or substrate is limited to 1/8 inch in 10 ft. from the required plane, and no more than 1/16 inch in 24 inches when measured from tile surface high points.

F. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 INSTALLATION OF CERAMIC TILE SYSTEM

A. Install tile backing panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

B. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

1. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

C. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

1. Allow crack isolation membrane to cure before installing tile or setting materials over it.

D. Install tile in accordance with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 series that are referenced in TCNA installation methods and specified in tile installation schedules, and apply to types of setting and grouting materials used.

E. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

F. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

G. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

H. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

I. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

J. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

K. Movement Joints: Provide movement joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated on Drawings. Form joints during installation of setting materials, mortar beds, and tile. Keep joints free of dirt, debris, and setting materials prior to filling with sealants. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

L. Metal Flooring Transitions: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.

M. Grout Sealer: Apply grout sealer to cementitious grout joints in tile floors in accordance with manufacturer's written instructions. As soon as sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

END OF SECTION

SECTION 09 65 13
RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Thermoset-rubber base.
   2. Rubber stair accessories.
   3. Rubber molding accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 THERMOSET-RUBBER BASE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Johnsonite; a Tarkett company.
   2. Nora by Interface.
   3. Roppe Corporation; Roppe Holding Company.
B. Product Standard: ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
   1. Style and Location: As selected in the Finish Key in the drawings.
C. Thickness: 0.125 inch.
D. Height: As selected in the Finish Key in the drawings.
E. Lengths: Coils in manufacturer's standard length.
F. Outside Corners: Preformed.
G. Inside Corners: Job formed.
H. Colors: As selected in the Finish Key in the drawings.

2.2 RUBBER MOLDING ACCESSORY

A. Manufacturer: To match adjacent resilient floor finish or stair accessory or as noted in Finish Key.
B. Profile and Dimensions: Provide rubber molding accessories at all transitions between floor finishes and where otherwise noted in drawings.
C. Colors and Patterns: See Finish Key for selections.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
   1. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
   4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
      a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
      b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
D. Do not install resilient products until materials are the same temperature as space where they are to be installed.
E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
E. Do not stretch resilient base during installation.
F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
G. Preformed Corners: Install preformed corners before installing straight pieces.
H. Job-Formed Corners:
1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 18 inches in length.
a. Form without producing discoloration (whitening) at bends.
2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 18 inches in length.
a. Cope corners to minimize open joints.

3.3 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.
B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
B. Floor Polish (when required by flooring manufacturer): Remove soil, adhesive, and blemishes from resilient stair treads before applying liquid floor polish.
1. Apply two coat(s).
C. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION

SECTION 09 65 16
RESILIENT SHEET FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vinyl sheet flooring with backing.
   2. Rubber sheet flooring with backing.
   3. Resilient sports flooring.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Samples: For each exposed product and for each color, texture, and pattern specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for resilient sheet flooring installation and seaming method indicated.
   1. Engage an installer who employs workers for this Project who are trained or certified by resilient sheet flooring manufacturer for installation techniques required.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient sheet flooring, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
   1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
B. Product Standard: ASTM F1303.
   1. Type (Binder Content): Type I, minimum binder content of 90 percent.
   2. Wear-Layer Thickness: Grade 1.
   3. Overall Thickness: As standard with manufacturer.
   4. Backing Class: Class A (fibrous).
C. Sheet Width: As standard with manufacturer.
D. Seamless-Installation Method: Heat welded.
E. Other Requirements: See Finish Schedule and Finish Key for selected products.

2.2 RUBBER SHEET FLOORING WITH BACKING

A. Product Standard: ASTM F1860.
   1. Type: Type I, homogeneous rubber sheet floor covering with backing.
   2. Backing: Fibrous.
   3. Hardness: Manufacturer's standard hardness, measured using Shore, Type A durometer per ASTM D2240.
B. Sheet Width: As standard with manufacturer.
C. Seamless-Installation Method: Heat welded.
D. Other Requirements: See Finish Schedule and Finish Key for selected products.

2.3 RESILIENT SPORTS FLOOR

1. Provide flooring material and all associated and installation materials by or recommended by the manufacturer as identified in the Finish Schedule and Finish Key. This includes all sports/field lines as identified in Finish Plan.

2.4 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient sheet flooring manufacturer for applications indicated.
B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient sheet flooring and substrate conditions indicated.
C. Seamless-Installation Accessories:
   1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
      a. Colors: As selected by Architect from manufacturer's full range.
D. Integral-Flash-Cove-Base Accessories:
   1. Cove Strip: 1-inch radius provided or approved by resilient sheet flooring manufacturer.
   2. Cap Strip: Square metal cap provided or approved by resilient sheet flooring manufacturer.
   3. Corners: Metal inside and outside corners and end stops provided or approved by resilient sheet flooring manufacturer.
E. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient sheet flooring manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to resilient sheet flooring manufacturer's written instructions to ensure adhesion of resilient sheet flooring.

B. Concrete Substrates: Prepare according to ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient sheet flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient sheet flooring until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient sheet flooring.

3.2 RESILIENT SHEET FLOORING INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient sheet flooring.

B. Unroll resilient sheet flooring and allow it to stabilize before cutting and fitting.

C. Lay out resilient sheet flooring as follows:

1. Maintain uniformity of flooring direction.
2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in flooring substrates.
3. Match edges of flooring for color shading at seams.
4. Avoid cross seams.

D. Scribe and cut resilient sheet flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend resilient sheet flooring into toe spaces, door reveals, closets, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient sheet flooring as marked on substrates. Use chalk or other nonpermanent marking device.

G. Install resilient sheet flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.

H. Adhere resilient sheet flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

I. Seamless Installation:

1. Heat-Welded Seams: Comply with ASTM F1516. Rout joints and heat weld with welding bead to fuse sections permanently into a seamless flooring installation. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.

J. Integral-Flash-Cove Base: Cove resilient sheet flooring 6 inches (unless indicated otherwise in drawings) up vertical surfaces. Support flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.

1. Install metal corners at inside and outside corners.

K. Floor Polish: Remove soil, adhesive, and blemishes from flooring surfaces before applying liquid floor polish.

1. Apply two coats if recommended by manufacturer.

3.3 RESILIENT SPORTS FLOORING INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient sheet flooring.

END OF SECTION

SECTION 09 66 23
RESINOUS MATRIX TERRAZZO FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes thin-set, epoxy-resin terrazzo flooring **and base** (if noted in drawings) – a system that is to be *ground*.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include terrazzo installation requirements. Include plans, sections, component details, and relationship to other work.

C. Samples: For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material certificates.

C. Preinstallation moisture-testing reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Engage an installer who is a contractor member of NTMA.
2. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer's products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NTMA Standards: Comply with NTMA's written recommendations for terrazzo type indicated unless more stringent requirements are specified.

2.2 EPOXY-RESIN TERRAZZO

A. Epoxy-Resin Terrazzo: Comply with manufacturer's written instructions for matrix and aggregate proportions and mixing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Key Resin Company.
   b. Terrazzo & Marble Supply Companies.

B. Mix Color and Pattern: Match Architect's sample. See Finish Key for basis-of-design.

a. Note: ***Bidder is responsible for determining aggregate type and mix of sample prior to bid. A change order for aggregate will not be entertained unless Architect changes sample***.

C. Materials:

1. Moisture-Vapor-Emission-Control Membrane: Two-component, high-solids, high-density, low-odor, epoxy-based membrane-forming product produced by epoxy terrazzo manufacturer that reduces moisture emission from concrete substrate to not more than 3 lb of water/1000 sq. ft. in 24 hours.
2. Substrate-Crack-Suppression Membrane: Product of terrazzo-resin manufacturer, having minimum 120 percent elongation potential according to ASTM D412.
   a. Reinforcement: Fiberglass scrim.
   b. Note: ***Bidder to assume membrane will cover 20 percent of terrazzo floor finish area***.
3. Primer: Manufacturer's product recommended for substrate and use indicated.
4. Epoxy-Resin Matrix: Manufacturer's standard recommended for use indicated and in color required for mix indicated.
5. Finishing Grout: Resin based.

2.3 STRIP MATERIALS

A. Thin-Set Divider Strips: L-type angle in depth required for topping thickness indicated.

1. Material: Match Heavy-Top strips.
2. Top Width: 1/8 inch.
3. Application: Curved design.

B. Heavy-Top Divider Strips: L-type angle in depth required for topping thickness indicated.

1. Bottom-Section Material: Matching top-section material.
2. Top-Section Material: Brass.
3. Top-Section Width: 1/8 inch.

4. Application: All straight lines.

C. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material and color of divider strips and in depth required for topping thickness indicated.

D. Accessory Strips: Match divider-strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
1. Base-bead strips for exposed top edge of terrazzo base.
2. Edge-bead strips for exposed edges of terrazzo.
3. Nosings for terrazzo stair treads and landings.

E. Abrasive Strips: Three-line abrasive inserts at nosings. Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.
1. Width: 1/2 inch.
2. Depth: As required by terrazzo thickness.
3. Length: 4 inches less than stair width.
4. Color: As selected by Architect from full range of industry colors.

2.4 MISCELLANEOUS ACCESSORIES

A. Strip Adhesive: Epoxy-resin adhesive recommended by adhesive manufacturer for this use.

B. Anchoring Devices: Provide mechanical anchoring devices or adhesives for strip materials as recommended by manufacturer and as required for secure attachment to substrate.

C. Patching and Fill Material: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.

D. Joint Compound: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.

E. Resinous Matrix Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by sealer manufacturer for use on terrazzo type indicated.

F. Sealer: Slip- and stain-resistant, penetrating-type sealer that is chemically neutral; does not affect terrazzo color or physical properties; and is recommended by sealer manufacturer for application.
1. Surface Friction: Not less than 0.6 according to ASTM D2047.
2. Acid-Base Properties: With pH factor between 7 and 10.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Johnson Diversey, Plaza Plus.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.

B. Concrete Slabs:
1. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with terrazzo.
2. Prepare *existing* concrete slabs as follows:
a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup. Surface preparation results should achieve a CSP3- CSP5 profile according to International Concrete Repair Institute Guideline No. 03732. Grinding is preferred if acceptable in writing from manufacturer.
b. Repair damaged and deteriorated concrete according to terrazzo manufacturer's written instructions.
c. Use patching and fill material to fill holes and depressions in substrates according to terrazzo manufacturer's written instructions.

C. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

D. Preinstallation Moisture Testing:
1. Testing Agency: Engage a qualified testing agency to perform tests.
2. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
a. Relative Humidity Test: Maximum 80 percent relative humidity measurement when tested according to ASTM F2170 using in-situ probes.
3. Proceed with terrazzo installation only after concrete substrates pass moisture testing or after installation of moisture-vapor-emission-control membrane on substrate areas that fail testing.

E. Moisture-Vapor-Emission-Control Membrane: Install according to manufacturer's written instructions.
1. Install on concrete substrates that incorporate lightweight aggregates.

2. Install concrete substrates that fail preinstallation moisture testing.

F. Substrate-Crack-Suppression Membrane: Install to isolate and suppress substrate cracks according to manufacturer's written instructions.
1. Prepare and prefill substrate cracks with membrane material.
2. Install membrane at substrate cracks in areas to receive terrazzo.
3. Reinforce membrane with fiberglass scrim.

G. Protect other work from water and dust generated by grinding operations. Control water and dust to comply with environmental protection regulations.
1. Erect and maintain temporary enclosures and other suitable methods to limit water damage and dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

3.2 EPOXY-RESIN TERRAZZO INSTALLATION

A. Comply with NTMA's written recommendations for terrazzo and accessory installation.

B. Strip Materials:
1. Divider and Control-Joint Strips:
a. Locate divider strips in locations indicated.
b. Install control-joint strips back to back and directly above concrete-slab control joints.
c. Install control-joint strips with 1/4-inch gap between strips, and install sealant in gap.
d. Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.
2. Accessory Strips: Install as required to provide a complete installation.
3. Abrasive Strips: Install with surface of abrasive strip positioned 1/16 inch higher than terrazzo surface.

C. Apply primer to terrazzo substrates according to manufacturer's written instructions.

D. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer's written instructions.
1. Installed Thickness: 3/8 inch nominal.
2. Terrazzo Finishing: Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.
a. Rough Grinding: Grind with 24-grit or finer stones or with comparable diamond abrasives. Follow initial grind with 60/80-grit stones or with comparable diamond abrasives.
b. Grouting: Before grouting, clean terrazzo with water, rinse, and allow to dry. Apply and cure epoxy grout.
c. Fine Grinding/Polishing: Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted. Grind with 200-grit stones or with comparable diamond abrasives until grout is removed from surface.
3. Installation Tolerance: Limit variation in terrazzo surface from level to 1/4 inch in 10 feet; noncumulative.

E. Install and finish poured-in-place terrazzo stairs at the same time the adjacent terrazzo flooring is installed.

F. Install and finish poured-in-place terrazzo base at the same time the adjacent terrazzo flooring is installed.

G. Cut out and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by Architect.

H. Cleaning:
1. Remove grinding dust from installation and adjacent areas.
2. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow them to dry thoroughly.

I. Sealing:
1. Seal surfaces according to NTMA's written recommendations.
2. Apply sealer according to sealer manufacturer's written instructions.

END OF SECTION

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SECTION 09 68 13
TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Modular carpet tile.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For carpet tile installation, plans showing the following:
1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
2. Carpet tile type, color, and dye lot.
3. Type of subfloor.
4. Type of installation.
5. Pattern of installation.
6. Pattern type, location, and direction.
7. Pile direction.
8. Type, color, and location of insets and borders.
9. Type, color, and location of edge, transition, and other accessory strips.
10. Transition details to other flooring materials.
C. Samples: For each exposed product and for each color and texture required.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.
B. Sample warranty.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Full-size units equal to ONE box for each type indicated.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.8 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

A. Applied Treatments:
1. Soil-Resistance Treatment: Manufacturer's standard treatment.
2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
B. Performance Characteristics:
1. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D7330.
2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm according to NFPA 253.
3. Dry Breaking Strength: Not less than 100 lbf according to ASTM D2646.
4. Tuft Bind: Not less than 5 lbf according to ASTM D1335.
5. Delamination: Not less than 4 lbf/in. according to ASTM D3936.
6. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
7. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
8. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
9. Colorfastness to Light: Not less than 4 after 40 AFU (AATCC fading units) according to AATCC 16, Option E.
10. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Concrete Slabs:

1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
   a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
   b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
   c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

B. Wood Subfloors: Verify that underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

C. Metal Subfloors: Verify that underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

D. Painted Subfloors: Perform bond test recommended in writing by adhesive manufacturer.

1. Access Flooring Systems: Verify access floor substrate is compatible with carpet tile and adhesive, if any, and underlayment surface is gaps greater than 1/8 inch and protrusions more than 1/32 inch.

3.2 PREPARATION

A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Metal Substrates: Clean grease, oil, soil and rust, and prime if recommended in writing by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.

E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer unless noted otherwise in drawings.

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns recommended in writing by carpet tile manufacturer.

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

H. Install pattern parallel to walls and borders unless indicated otherwise in drawings.

I. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

J. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION

SECTION 09 91 23
INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Primers.
2. Water-based finish coatings.
3. Solvent-based finish coatings.
4. Floor sealers and paints.
5. Dry fall coatings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Samples: For each type of topcoat product.
C. Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Benjamin Moore & Co.
2. PPG Paints; PPG Industries, Inc.
3. Sherwin-Williams Company (The).

2.2 PAINT PRODUCTS, GENERAL

A. Material Compatibility:
1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

B. Colors: As indicated in a color schedule.

2.3 PRIMERS – see 'Interior Paint Schedule' article below for direction for each substrate

A. Items to be shipped "primed" are to use applicable primer from this list.
B. Interior/Exterior Latex Block Filler: Water-based, high-solids, emulsion coating formulated to bridge and fill porous surfaces of exterior concrete masonry units in preparation for specified subsequent coatings.
C. Alkali-Resistant, Water-Based Primer: Water-based primer formulated for use on alkaline surfaces, such as plaster, vertical concrete, and masonry.
D. Interior, Institutional Low-Odor/VOC Primer Sealer: Water-based primer sealer with low-odor characteristics and a VOC of less than 10 grams per liter for use on new interior plaster, concrete, and gypsum wallboard surfaces that are subsequently to be painted with latex finish coats.
E. Interior Alkyd Primer Sealer: Solvent-based, alkyd-type, primer/sealer for new interior wood, plaster, and porous surfaces,
F. Alkyd Quick-Dry Primer for Metal: Corrosion-resistant, solvent-based, modified-alkyd primer; lead and chromate free; formulated for quick-drying capabilities and for use on cleaned, interior steel surfaces.
G. Surface-Tolerant Metal Primer: Corrosion-resistant, solvent-based metal primer formulated for use on structural steel and metal fabrications that have been minimally prepared.
H. Cementitious Galvanized Primer: Solvent-based primer composed of linseed oil/alkyd resin and portland cement for cleaned galvanized metal prior to finish coating.
I. Quick-Drying Aluminum Primer: Corrosion-resistant, solvent-based, alkyd or modified-alkyd primer formulated for quick-drying capabilities and for use on prepared exterior aluminum.

2.4 WATER-BASED FINISH COATS - see 'Interior Paint Schedule' article below for direction for each substrate

A. Interior, Latex, Institutional Low Odor/VOC: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.
B. Interior, Latex, Institutional Low Odor/VOC: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.

2.5 SOLVENT-BASED FINISH COATS - see 'Interior Paint Schedule' article below for direction for each substrate

A. Interior, Alkyd: Pigmented, solvent-based alkyd paint for use on primed/sealed interior plaster, gypsum, wood, and metal walls primarily in residential and moderate traffic commercial environments.

2.6 FLOOR SEALERS AND PAINTS

A. Water-Based Concrete Floor Sealer: Clear, water-based, acrylic-copolymer-emulsion sealer formulated for oil, gasoline, alkali, and water resistance and for use on concrete traffic surfaces.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.
    b. Hempel (USA), Inc.
    c. PPG Paints; PPG Industries, Inc.
    d. Rust-Oleum Corporation; a subsidiary of RPM International, Inc.
    e. Sherwin-Williams Company (The).

2.7 DRY FALL COATINGS

A. Dry Fall, Latex, Flat: Pigmented, water-based, emulsion-type, fast-drying coating for use on interior plaster, concrete, gypsum board, primed wood, and metal ceilings.

1. Gloss and Sheen Level: Manufacturer's standard flat finish.

B. Water Based, Dry Fall for Galvanized Steel, Flat: Pigmented, water-based coating for direct application to cleaned, interior galvanized-metal ceiling surfaces and adjacent primed metals.

1. Gloss and Sheen Level: Manufacturer's standard flat finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

B. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

C. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 INSTALLATION

A. Apply paints according to manufacturer's written instructions.

B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

C. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in all **but** mechanical or electrical rooms:
    a. Equipment, including panelboards and switch gear.
    b. Uninsulated metal piping.
    c. Uninsulated plastic piping.
    d. Pipe hangers and supports.
    e. Metal conduit.
    f. Plastic conduit.
    g. Tanks that do not have factory-applied final finishes.
    h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 CLEANING AND PROTECTION

A. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

B. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE – all systems might not apply

A. Concrete Substrates, Nontraffic Surfaces:

1. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex, institutional low odor/VOC, low sheen.

B. Concrete Substrates, Traffic Surfaces:
1. See 033543 - Polished Concrete Finishing if called for in Finish Schedule.
2. See 071800 - Traffic Coatings if called for in Finish Schedule.
3. Water-Based Concrete Floor Sealer System if called for in Finish Schedule:
a. First Coat: Matching topcoat.
b. Topcoat: Water-based concrete floor sealer.

C. CMU Substrates:
1. Institutional Low-Odor/VOC Latex System:
a. Block Filler: Interior/exterior latex block filler.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low odor/VOC, low sheen.

D. Steel Substrates:
1. Institutional Low-Odor/VOC Latex over Shop-Applied Quick-Drying Shop Primer System:
a. Prime Coat: Pre-primed.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low odor/VOC, satin.
d. For pre-primed elements like hollow metal doors/frames.
2. Institutional Low-Odor/VOC Latex over Alkyd Primer System:
a. Prime Coat: Alkyd Quick-Dry Primer for Metal.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low odor/VOC, satin.
d. For unprimed/uncoated elements.
3. Water-Based Dry Fall over Shop-Applied Shop Primer System:
a. Prime Coat: Shop primer specified in Section where substrate is specified.
b. Topcoat: Dry fall, latex, flat.
c. For non-galvanized ceiling elements.

E. Galvanized-Metal Substrates:
1. Institutional Low-Odor/VOC Latex System:
a. Prime Coat: Water-based galvanized primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low odor/VOC, satin.
d. For galvanized elements.
2. Water-based Dry Fall for Galvanized Steel System:
a. Prime Coat: Water-based dry fall for galvanized steel.
b. Topcoat: Dry fall, latex, flat.
c. For galvanized ceiling elements.

F. **Finish Carpentry & Architectural Woodwork**: Wood trim, Doors, Windows, and Wood board paneling.
1. Institutional Low-Odor/VOC Latex over Alkyd Primer System:
a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low odor/VOC, satin.
d. For wood trim, doors, windows, wood paneling, and casework.

G. Gypsum Board Substrates:
1. Institutional Low-Odor/VOC Latex System:
a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low odor/VOC, flat (ceilings/soffits) and eggshell (walls).
d. For walls, ceilings, and soffits.

END OF SECTION

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SECTION 09 93 00
STAINING AND TRANSPARENT FINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wood stains.
   2. Transparent finishes.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Samples: For each type of finish system and in each color and gloss of finish required.
C. Product List: Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Benjamin Moore & Co.
   2. Penofin.
   3. PPG Paints; PPG Industries, Inc.
   4. Sherwin-Williams Company (The).
   5. Sikkens.

2.2 MATERIALS, GENERAL

A. Material Compatibility:
   1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2.3 WOOD STAINS

A. Stain, Interior, Semitransparent, for Interior Wood: Solvent-based, oil or oil/alkyd, semitransparent, pigmented stain for new interior wood surfaces that are to be finished with a clear varnish.

2.4 TRANSPARENT FINISHES

A. Varnish, Interior, Polyurethane, Oil Modified: Solvent-based, one-component, oil-modified polyurethane clear satin varnish for new or previously varnished or stained interior wood surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.
B. Maximum Moisture Content of Interior Wood Substrates: 15 percent, when measured with an electronic moisture meter.

3.2 PREPARATION

A. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
   1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
B. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate condition and as specified.
   1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
   2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.

3.3 APPLICATION

A. Apply finishes according to manufacturer's written instructions.
B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

A. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 INTERIOR WOOD-FINISH-SYSTEM SCHEDULE

A. Wood Substrates, Wood Trim, Architectural Woodwork, Doors, Windows, and/or Wood Board Paneling:

1. Polyurethane Varnish over Stain System:
    a. Stain Coat: Stain, semitransparent, for interior wood – color to match existing.
    b. First Intermediate Coat: Polyurethane varnish matching topcoat.
    c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
    d. Topcoat: Varnish, interior, polyurethane, oil modified, satin.

END OF SECTION

SECTION 10 14 23
PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Panel signs – for interior, wall-mounted applications.

1.2 ACTION SUBMITTALS

A. Product Data: For panel signs.
B. Shop Drawings: For panel signs.
1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
4. Show locations of electrical service connections.
5. Include diagrams for power, signal, and control wiring.
C. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design," the ABA standards of the Federal agency having jurisdiction, and ICC A117.1.

2.2 PANEL SIGNS

A. Panel Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
1. Integral Tactile Plaque: Graphics and Plaque materials are one piece. Tactile Photopolymer Inserts are .080" phenolic photopolymer with raised copy and fully domed Grade 2 Braille dots etched to 1/32". Background color is painted in acrylic lacquer in the specified Insert color. Top surface of copy characters is then added by roller printing in specified copy color using Silkscreen inks.
2. Sign-Panel Perimeter: Finish edges smooth.
a. Edge Condition:
1) Vertical Edges: Square cut.
2) Horizontal Edges: Square cut.
b. Corner Condition in Elevation: Square.
3. Mounting: Surface mounted to wall with adhesive and/or two-face tape.
4. Color as selected by Architect from full range of industry colors.
a. Painted Finish and Graphics: Manufacturer's standard, factory-applied acrylic lacquer, in color as selected by Architect from manufacturer's full range.
5. Text and Typeface: Accessible raised characters and Braille. Typeface matching Architect's schedule. Finish raised characters to contrast with background color, and finish Braille to match background color.
6. Flatness Tolerance: Sign is to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner.

2.3 PANEL-SIGN MATERIALS

A. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated. Fade resistant to 5 years.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:
1. Use concealed fasteners and anchors unless indicated to be exposed.
B. Adhesive: As recommended by sign manufacturer.
C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

B. Design components allow for expansion and contraction for a minimum material temperature range of 100 degrees F, without causing buckling or over stressing of adhesives and fasteners.

C. Form work to required shapes and sizes, with true lines and angles. Provide necessary rebates, lugs, and brackets for assembly of units.

D. Contact surfaces of connected members must be true. Assembled so joints will be tight and practically unnoticeable, without use of filling compound.

E. Signs shall have fine, even texture and be flat and sound. Lines and miters sharp, arises unbroken, profiles accurate and ornament true to pattern. Plane surfaces should be smooth, flat and without oil-canning, free of rack and twist. Maximum variation from plane of surface plus or minus .032". Restore texture to filled or cut areas.

F. Level or straighten wrought work. Members shall have sharp lines and angels and smooth surfaces.

G. All painted surfaces properly primed. Finish coating of paint to have complete coverage with no light or thin applications allowing substrate or primer to show. Parts are checked for approval against the color match master chip. Finished surface smooth, free of scratches, gouges, drips, bubbles, thickness variations, foreign matter, and other imperfections.

2.6 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Accessible Signage: Install in locations on walls as indicated on Drawings and according to the accessibility standard.

C. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.
3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
4. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
5. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

3.2 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION

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SECTION 10 21 13.19
PLASTIC TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Solid-plastic toilet compartments.

B. Related Requirements:
1. Section 06 10 00 "Rough Carpentry" for blocking.
2. Section 09 22 16 "Non-Structural Metal Framing" for blocking.
3. Section 10 28 00 "Toilet, Bath, and Laundry Accessories" for accessories mounted on toilet compartments.

1.2 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings: Plans, elevations, sections, details, and attachment details.

C. Samples: Manufacturer's standard color sheets, showing full range of available colors for each type of toilet compartment.

D. Delegated Design Submittals: For grab bars mounted on toilet compartment panels, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire Performance: Tested in accordance with, and pass the acceptance criteria of, NFPA 286.

B. Structural Performance: Where grab bars are mounted on toilet compartments, design panels to comply with the following requirements:
1. Panels are able to withstand a concentrated load on grab bar of at least 250 lbf applied at any direction and at any point, without deformation of panel.

C. Regulatory Requirements: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1 for toilet compartments designated as accessible.

2.2 SOLID-PLASTIC TOILET COMPARTMENTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. ASI Global Partitions.
2. Scranton Products.

B. Basis-of-Design: Scranton Products.

C. Toilet-Enclosure Style: Overhead braced.

D. Entrance-Screen Style: Overhead braced.

E. Urinal-Screen Style: Wall hung.

F. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) material, not less than 1 inch thick, seamless, with eased edges, and with homogenous color throughout thickness of material. Provide with no-sightline system consisting of door and pilaster lapped edges on strike side of door and door and pilaster lapped edges on hinge side of door (unless continuous hinge is used).
1. Heat-Sink Strip: Manufacturer's continuous, extruded-aluminum or stainless steel strip fastened to exposed bottom edges of solid-plastic components to hinder malicious combustion.
2. Color: One color in each room as selected by Architect from manufacturer's full range.

G. Entrance-Screen Construction: Matching panel construction.

H. Urinal-Screen Construction: Matching panel construction.

I. Pilaster Sleeves (Caps): Manufacturer's standard design; solid plastic or stainless steel.
1. Plastic Color: Matching pilaster.

J. Urinal-Screen Post: 1-3/4-inch-square aluminum tube with satin finish; with sleeve (cap) matching that on the pilaster (i.e., not to floor)

K. Brackets (Fittings):
1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

2.3 HARDWARE AND ACCESSORIES

A. Door Hardware and Accessories: Manufacturer's operating hardware and accessories. Mount with through bolts.
1. Hinges:

a. Manufacturer's continuous, cam type that swings to a closed or partially open position, allowing emergency access by lifting door.
1) Material, Continuous Hinge: Stainless steel.

2. Latch and Keeper: Manufacturer's surface-mounted latch unit, designed for emergency access, and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible.
a. Material: Stainless steel.

3. Coat Hook: As identified in Toilet Accessory section.

4. Door Bumper: Manufacturer's rubber-tipped bumper at outswinging doors UNLESS specified in Toilet Accessory section.
a. Material: Stainless steel.

5. Door Pull: Manufacturer's unit at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible.
a. Material: Stainless steel.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.4 MATERIALS

A. Aluminum Castings: ASTM B26/B26M.

B. Aluminum Extrusions: ASTM B221.

C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

D. Stainless Steel Castings: ASTM A743/A743M.

E. Zamac: ASTM B86, commercial zinc-alloy die castings.

2.5 FABRICATION

A. Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.

B. Overhead-Braced Units: Manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

C. Urinal-Screen Posts: Manufacturer's standard corrosion-resistant anchoring assemblies at posts and walls, with leveling adjustment nuts at tops and bottoms of posts. Provide sleeves (caps) at posts to conceal anchorage.

D. Door Size and Swings: Unless otherwise indicated, provide 24-inch-wide, inswinging doors for standard toilet enclosures and 36-inch-wide, outswinging doors with a minimum 32-inch-wide, clear opening for toilet enclosures designated as accessible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:
a. Pilasters and Panels or Screens: 1/2 inch.
b. Panels or Screens and Walls: 1 inch.

2. Full-Height (Continuous) Brackets: Secure panels or screens to walls and to pilasters with full-height brackets.
a. Locate bracket fasteners, so holes for wall anchors occur in masonry or tile joints.
b. Align brackets at pilasters with brackets at walls.

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels and adjust, so tops of doors are parallel with overhead brace when doors are in closed position.

C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.2 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware in accordance with hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors to return doors to fully closed position.

END OF SECTION

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SECTION 10 28 00
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Public&Private-use washroom accessories.
2. Public-use shower room accessories.
3. Childcare accessories.
4. Needle disposal cabinet.
5. Sanitary Napkin Dispenser.

1.2 ACTION SUBMITTALS

A. Product data.
B. Samples: For each exposed product and for each finish specified, full size.
1. Approved full-size Samples will be returned and may be used in the Work.
C. Delegated Design Submittals: For grab bars and shower seats.
1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
1. Warranty Period: 10 years from date of Substantial Completion.
B. Manufacturer's Special Warranty for Hand Dryers: Manufacturer agrees to repair or replace hand dryers that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Structural Performance: Design accessories and fasteners to comply with the following requirements:
1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.
2. Shower Seats: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.

2.2 MANUFACTURER

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ASI-American Specialties, Inc.
b. Bobrick Washroom Equipment, Inc.
c. Bradley Corporation.
d. Gamco Commercial Restroom Accessories.
2. Style: Unless noted otherwise, all accessories to be the same style from the same manufacturer.
3. Basis-of-Design unless noted otherwise: **Bobrick Washroom Equipment**.

2.3 PUBLIC&PRIVATE-USE WASHROOM ACCESSORIES

A. Toilet Tissue (Roll) Dispenser **TA-03**:
1. Owner furnished; Contractor installed.
B. Grab Bar **TA-02**:
1. Basis-of-Design: B-6806.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch thick.
a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin).
4. OD: 1-1/4 inches.
5. Configuration and Length: As indicated on Drawings.
C. Sanitary-Napkin Disposal Unit **TA-04**:
1. Owner furnished; Contractor installed.
D. Hook **TA-09**:

1. Basis-of-Design: B-672.
2. Description: Coat hook.
3. Mounting: Concealed.
4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

E. Shelf **TA-07**:
1. Basis-of-Design: B-298.
2. Description: 5”x24” shelf with integral end brackets.
3. Mounting: Surface mounted.
4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

2.4 PUBLIC-USE SHOWER ROOM ACCESSORIES

A. Shower Curtain Rod **TA-10**:
1. Basis-of-Design: B-6047.
2. Description: 1.25-inch-OD, straight rod.
3. Configuration: As indicated on Drawings.
4. Mounting Flanges: Concealed fasteners; in material and finish matching rod.
5. Rod Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

B. Shower Curtain **TA-10**:
1. Size: Minimum 6 inches wider than opening by 72 inches high.
2. Material: Nylon-reinforced vinyl, minimum 9 oz. or 0.008-inch-thick vinyl, with integral antibacterial and flame-retardant agents.
3. Color: As selected from manufacturer's full range.
4. Grommets: Corrosion resistant at minimum 6 inches o.c. through top hem.
5. Shower Curtain Hooks: Stainless steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

C. Folding Shower Seat **TA-06**:
1. Basis-of-Design: B-5181.
2. Configuration: As indicated on Drawings.
3. Seat: Per basis-of-design.
4. Mounting Mechanism: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
5. Dimensions: As indicated on Drawings.

2.5 CHILDCARE ACCESSORIES

A. Diaper-Changing Station **TA-05**:
1. Basis-of-Design: KB300-SS.
2. Description: Horizontal and/or vertical (as indicated in drawings) unit that opens by folding down from stored position and with child-protection strap.
   a. Engineered to support minimum of 250 lb static load when opened.
3. Mounting: Surface mounted, with unit projecting not more than 4 inches from wall when closed.
4. Operation: By pneumatic shock-absorbing mechanism.
5. Material and Finish: Stainless steel cladding over steel and polypropylene frame.
6. Liner Dispenser: Provide built-in dispenser for disposable sanitary liners.
7. Bag Hook: Independently mounted, stainless steel bag hook.

2.6 NEEDLE DISPOSAL CABINET

A. Needle Disposal Cabinet **TA-11**:
1. Owner furnished; Contractor installed.

2.7 SANITARY NAPKIN DISPENSER

A. Sanitary Napkin Dispenser **TA-08**:
1. Owner furnished; Contractor installed.

2.8 FABRICATION

A. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
1. Remove temporary labels and protective coatings.

B. Grab Bars: Install to comply with specified structural-performance requirements.

C. Shower Seats: Install to comply with specified structural-performance requirements.

1 **END OF SECTION**

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SECTION 10 44 13
FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire-protection cabinets for portable fire extinguishers.
      a. FEC-1 & FEC-2.

1.2 PREINSTALLATION CONFERENCE

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For fire-protection cabinets.
C. Samples: For each type of exposed finish required.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

2.2 FIRE-PROTECTION CABINET

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Larsen's Manufacturing Company.
      a. Models listed below are basis-of-design.
B. Cabinet Type: Suitable for fire extinguisher.
C. Cabinet Construction: Rated according to wall cabinet is recessed within.
   1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch-thick cold-rolled steel sheet lined with minimum 5/8-inch-thick fire-barrier material. Provide factory-drilled mounting holes.
D. Cabinet Material: Cold-rolled steel sheet.
E. Fully-recessed or Semi-recessed Cabinet – **FEC-1**: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend). **Model 2409 series.**
   1. *Intent is for all public locations to have fully-recessed cabinets; semi-recessed only when wall depth does not permit fully-recessed*.
   2. Square-Edge Trim: 1-1/4- to 1-1/2-inch backbend depth.
   3. Rolled-Edge Trim: 2-1/2-inch backbend depth.
F. Surface-Mounted Cabinet – **FEC-2**: Cabinet box fully exposed and mounted directly on wall with no trim. **Model 2409 series.**
G. Cabinet Trim Material: Same material and finish as door.
H. Door Material: Stainless steel sheet.
I. Door Style: Solid.
J. Door Glazing: N/A.
K. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
L. Accessories:
   1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.
      a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
         1) Location: Applied to cabinet door.
         2) Application Process: Silk-screened.

3) Lettering Color: Red.
4) Orientation: Vertical.

M. Materials:

1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
   a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
   b. Color: As selected by Architect from manufacturer's full range.
2. Aluminum: ASTM B221 for extruded shapes and aluminum sheet, with strength and durability characteristics of not less than Alloy 6063-T5 for aluminum sheet.
   a. Finish: Clear anodic.
3. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304.
   a. Finish: ASTM A480/A480M No. 4 directional satin finish,.
4. Tempered Break Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 1.5 mm thick.

2.3 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Prepare recesses for recessed and semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

B. Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

C. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

D. Identification: Apply decals and/or vinyl lettering at locations indicated.

E. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

END OF SECTION

SECTION 10 44 16
FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers.
   1. FE-1 & FE-2.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Larsen's Manufacturing Company.
         1) Models listed below are basis-of-design.
   2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose/ABC Dry-Chemical Type – **FE-1**: UL-rated UL-rated 4A-80B:C, 10 pound nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard red enameled container. **Model MP-10**.

C. Wet chemical class K Type (for use in commercial kitchen) **– FE-2**: UL-rated 2A:K, 2.5 gallon nominal capacity, with pressure-indicating gage. **Model WC2 1/2**.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

C. Mounting Brackets (where noted in drawings): Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
   1. Mounting Height: Top of fire extinguisher to be at 42 inches above finished floor.

END OF SECTION

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SECTION 105100
PLASTIC LOCKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Lockers.

1.2 REFERENCES

A. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.

1.3 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

B. Shop Drawings: Drawings shall be submitted showing individual locker size and overall dimensions.

C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A company regularly engaged in manufacture of products specified in this section, and whose products have been in satisfactory use under similar service conditions for not less than 5 years.

B. Installer Qualifications: A company regularly engaged in installation of products specified in this Section, with a minimum of 5 years experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Locker components shall be stored flat until assembly. All finishes shall be protected from soiling and damage during handling.

1.6 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.7 WARRANTY

A. Warranty: Manufacturer guarantees its plastic against breakage, corrosion, and delamination under normal conditions for 15 years from the date of receipt by the customer. If materials are found to be defective during that period for reasons listed above, the materials will be replaced free of charge. (Labor not included in warranty.)

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire Performance: Tested in accordance with, and pass the acceptance criteria of, NFPA 286.

B. Regulatory Requirements: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1 for toilet compartments designated as accessible.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Scranton Products.

B. Basis-of-Design: Scranton Products, DuraLife Plastic School Lockers.

2.3 LOCKERS

A. Design: Solid plastic storage locker.
   1. See drawings for configuration.

B. Size: Individual and stack height as indicated on drawings.
   1. Locker Depth: 18 inches.

2. Locker Width: 15 inches.

C. Hardware:

1. Plastic Coat Hook: Top-mounted, two-pronged plastic coat hook.
2. Padlock hasp.
3. Horizontal venting.
4. Continuous hinge.
5. Top: Slope top.
6. End panel.

2.4 CONSTRUCTION

A. Locker Doors and Frames: Made from high impact, high density polyethylene (HDPE) formed under high pressure into solid plastic components 1/2 inch thick with homogeneous color throughout.

B. Sides, Tops, Bottoms, Backs, and Shelves: Made from high impact, high density, polyethylene (HDPE) formed under pressure into solid plastic components 3/8 inch thick with homogenous natural color throughout. Vertical back, outside, inside panels, horizontal top, bottom, divider, and shelves will be grey in color.

C. End Panels: Filler panels of plastic material in color of locker unless noted otherwise as an accent color.

D. Continuous Latch: Made from high impact HDPE plastic and capable of accepting various locking mechanisms. The spring-loaded latch shall be securely fastened to the entire length of the door providing a quiet positive latching function.

E. Door Hinge: Heavy duty zinc-plated steel. Full length, assembled onto door and locker front.

F. Assembly Profile: To be full height of lockers. Profile to be tongue-and-groove joint construction using 3/8 inch thick HDPE.

G. Coat Hooks: Two-prong, high impact plastic. Mounted to bottom of shelf or divider. One each per door opening.

2.5 MATERIALS

A. Lockers to be constructed from High Density Polyethylene (HDPE) resins.

1. Resins compounded under high pressure, forming a single component which is waterproof, nonabsorbent and has a self-lubricating surface that resists marks from pens, pencils, markers and other writing instruments.

B. HDPE Components: To have a smooth "orange peel" finish. Locker doors and door frames to be the same color.

1. Color: As selected from manufacturer's standard colors.

2.6 FABRICATION

A. Locker Components: Fabricated square and rigid with a finish free of scratches and chips.

B. Solid Plastic Locker Components: Snap together at profile connections or slide together at dovetail connections for easy assembly and provide a solid and secure anti-racking bookcase component construction for clean lines and precise reveals. Adjacent lockers share a common side panel. Locker units are manufactured for assembly in a group of no more than three adjacent lockers.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Report discrepancies to the Architect.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install lockers at the location shown in accordance with the manufacturers' instructions for plumb, level, rigid and flush installations.

C. Anchor the units to the wall studs through the locker back and to the floor using 1-1/2 inch Tapcon screws.

D. Lockers shall be installed on a concrete base as indicated in drawings.

3.4 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware in accordance with manufacturer's written instructions for proper operation.

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

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SECTION 11 66 23
GYMNASIUM EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basketball equipment.
   2. Volleyball equipment.
   3. Safety pads.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For gymnasium equipment.
   1. Include plans, elevations, sections, and attachment details.
   2. Include diagrams for power, signal, and control wiring.
C. Samples: For each exposed product and for each item and color specified.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Court layout plans, reflected ceiling plans, and other details, drawn to scale, and coordinated with ceiling-suspended gymnasium equipment, floor inserts, game lines, and markers applied to finished flooring, and coordinated with each other, using input from installers of the items involved.
B. Product Certificates: For each type of gymnasium equipment.
C. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of gymnasium equipment that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BASKETBALL EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Porter – basis-of-design.
B. Standard Rules: Provide equipment according to the requirements of NFHS's "Basketball Rules Book."
C. Connections: Manufacturer's standard connections or connections recommended in writing by manufacturer and complying with Section 05 50 00 "Metal Fabrications" of size and type required to transfer loads to building structure.
D. Overhead-Supported Backstops:
   1. Folding Type: Manufacturer's standard assembly for side-folding backstop, with hardware and fittings to permit folding.
   2. Goal Height Adjuster: Adjustable from 8 to 10 feet to top of ring with gear-drive mechanism, locking in any position within adjustment range, with visible height scale attached to side of framing.
      a. Operation:
         1) Electrical: Electric operation with integral gear-drive motor, with limit switches preset to goal heights.
E. Winch: Hoist consisting of heavy-duty, fully enclosed worm-gear; brake; cable drum; cable; and fittings, for mounting on wall with equipment-mounting board; designed to move and hold backboard in any raised or lowered position.
F. Backstop Electric Operator: Provide operating machine of size and capacity recommended in writing by manufacturer for equipment specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, and remote controls. Coordinate wiring requirements and electrical characteristics with building electrical system.
   1. Electrical Components, Devices, and Accessories: Listed and labeled according to NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Motor Electrical Characteristics:

a. Horsepower: 3/4 hp.
b. Voltage: 115 V ac, single phase, 60 hertz.

3. Remote-Control Station(s): NEMA ICS 6, Type 1 enclosure for recessed or flush mounting and momentary-contact, three-position, switch-operated control with up, down, and off functions.
   a. Keys: Provide [**one key**] [**two keys**] [**one set of dual keys**] [**two sets of dual keys**] [**dual keys, one key for up and one for down**] per station.

4. Limit Switches: Adjustable switches at each backstop, interlocked with motor controls and set to automatically stop backstop at fully retracted and fully lowered positions.

G. Basketball Backboards:
1. **Basis-of-Design**: Bison.
   a. Model: BA42XL – See Drawings for location(s).
   b. Model: BA48XL – See Drawings for location(s).
   c. Other manufacturers will be considered if they substantially match the basis-of-design models.

H. Goal-Mounting Assembly: Compatible with goal, backboard, and backstop.

I. Basketball Goals: Basket ring complete with flanges, braces, attachment plate, and evenly spaced loops welded around underside of ring.
1. Single-rim basket ring competition goal.
2. Double-rim basket ring.
3. Type:
   a. Fixed: Nonmovable.
   b. Movable: pressure-release design with manufacturer's standard breakaway mechanism and rebound characteristics identical to those of fixed, nonmovable ring.
4. Finish: Manufacturer's standard finish.

J. Basketball Nets: 12-loop-mesh net, between 15 and 18 inches long, sized to fit ring diameter, and as follows:
1. Cord: Made from white cotton.

K. Backboard Safety Pads: Designed for backboard thickness and extending continuously along bottom and up sides of backboard and over backstop according to manufacturer's standard design.
1. Color: As selected by Architect from manufacturer's full range.

L. Basketball Shot Clock:
1. **Basis-of-Design**: Bison.
   a. Model: In-Time Wireless with all necessary mounting hardware and accessories to be a fully-functional system.
   b. Other manufacturers will be considered if they substantially match the basis-of-design model.

2.2 VOLLEYBALL EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Porter – basis-of-design.

B. Standard Rules: Provide equipment according to the requirements of NFHS's "Volleyball Rules Book".

C. Floor Insert: Solid-brass floor plate and steel pipe sleeve, concealed by floor plate, with capped bottom end, 3 inch diameter, minimum 12 inches long, to securely anchor pipe sleeve as indicated on Drawings; with anchors designed for securing floor insert to floor substrate indicated; quantity as indicated on Drawings.
1. Flush Floor Plate: Manufacturer's standard hinged access cover, designed to be flush with adjacent flooring. Provide one tool(s) for unlocking access covers.
2. Floor Plate: 5 inch diameter brass.

2.3 SAFETY PADS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Porter Supersafe.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Pad Coverings: Provide safety pad fabric covering that is fabricated from puncture- and tear-resistant, PVC-coated polyester or nylon-reinforced PVC fabric, minimum 14-oz./sq. yd. and treated with fungicide for mildew resistance; with surface-burning characteristics indicated, and lined with fire-retardant liner.

D. Wall Safety Pads: Padded wall wainscot panels designed to be attached in a continuous row; each panel section consisting of fill laminated to backer board, with visible surfaces fully covered by seamless fabric covering, free of sag and wrinkles and firmly attached to back of backer board.

1. Backer Board: Minimum 7/16-inch-thick wood board.
2. Fire-Resistive Fill: Multiple-impact-resistant foam minimum 2-inch-thick, fire-resistive neoprene, 6.0-lb/cu. ft. density.
3. Size: Each panel section 24 inches wide by minimum 72 inches long.
4. Number of Modular Panel Sections: As indicated on Drawings.
5. Installation Method: Manufacturer's standard.

E. Fabric Covering Color(s): As selected by Architect from manufacturer's full range for one color(s).

F. Cutout Trim: Manufacturer's standard flanged cutout trim kits for fitting pads around switches, receptacles, and other obstructions.

1. Color: Gray.

2.4 MATERIALS

A. Support Cable: Manufacturer's standard galvanized-stranded-steel wire rope. Provide fittings according to the wire rope manufacturer's written instructions for size, number, and installation method.

B. Support Chain and Fittings: For chains used for overhead lifting, provide Grade 80 heat-treated alloy-steel chains, according to ASTM A391/A391M, with commercial-quality, hot-dip galvanized steel connectors and hangars.

C. General-Purpose Chain: For chains not used for overhead lifting, provide carbon steel chain, according to ASTM A413/A413M (Grade 30 proof coil chain or higher grade recommended by gymnasium equipment manufacturer). Provide coating type, chain size, number, and installation method according to manufacturer's written instructions.

D. Castings and Hangers: Malleable iron, according to ASTM A47/A47M; grade as required for structural loading.

E. Softwood Plywood: DOC PS 1, exterior.

F. Particleboard: ANSI A208.1.

G. Equipment-Mounting Board: Wood, transparent or neutral-color-painted finish; size and quantity as required to mount gymnasium equipment according to manufacturer's written instructions.

H. Anchors, Fasteners, Fittings, and Hardware: Gymnasium equipment manufacturer's standard corrosion-resistant or noncorrodible units; concealed.

I. Grout: Nonshrink, nonmetallic, premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout, according to ASTM C1107/C1107M, with minimum strength recommended in writing by gymnasium-equipment manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with manufacturer's written installation instructions.

B. Permanently Placed Gymnasium Equipment and Components: Install rigid, level, plumb, square, and true; anchored securely to supporting structure; positioned at locations and elevations indicated; in proper relationship to adjacent construction; and aligned with court layout.

C. Connections: Connect electric operators to building electrical system.

D. Removable Gymnasium-Equipment Components: Assemble in place to verify that equipment and components are complete and in proper working order. Disassemble removable gymnasium equipment after assembled configuration is approved by Owner, and store units in location indicated on Drawings.

E. Adjust movable components of gymnasium equipment to operate safely, smoothly, easily, and quietly; free from binding, warp, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range; and lubricate as recommended in writing by manufacturer.

3.2 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain gymnasium equipment.

END OF SECTION

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SECTION 11 66 53
GYMNASIUM DIVIDERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Electric operators.
   2. Divider curtains.
   3. Divider system accessories.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For gymnasium dividers.
   1. Include diagrams for power, signal, and control wiring.
C. Samples: For each exposed product and for each item and color specified.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans with divider-curtain layouts, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
B. Product Certificates: For each type of gymnasium divider.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 TOP-ROLL DIVIDER SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Porter.
      a. Basis-of-Design: 92085000 2
      b. Other manufacturers will be considered if they substantially match the basis-of-design model.
B. Divider-Curtain System: Electrically operated, belt-guided, top/center-roll drive pipe, and as follows:
   1. Outer Edge Hems: Double turned and welded.
   2. Supports and Fittings: Corrosion-resistant steel clamps and hangers.
   3. Drive Pipe and Curtain Battens: Steel pipe or tubing.

2.2

2.3 ELECTRIC OPERATORS

A. Provide factory-assembled electric operation system of size and capacity recommended in writing and provided by gymnasium divider manufacturer for gymnasium dividers specified, with electric motors and factory-prewired motor controls, control devices, and accessories required for proper operation.
   1. Include wiring from control stations to motors and between synchronizer and dual motors for long curtains. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
B. Electrical Components, Devices, and Accessories: Listed and labeled according to NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Motor Electrical Characteristics:
   1. Horsepower: 1 hp.
   2. Voltage: 115 V ac, single phase, 60 hertz.
D. Limit Switches: Adjustable switches at each divider curtain, interlocked with motor controls and set to automatically stop divider curtain at fully extended and fully retracted positions.
E. Control System:
   1. Key-Switch Operation: NEMA ICS 6, Type 1 enclosure, momentary-contact, three-position switch-operated control with up, down, and off functions.
      a. Keys: Provide key(s) per station.

2.4 DIVIDER CURTAINS

A. Upper Curtain, Mesh: Woven mesh of polyester yarn double-coated with vinyl, weighing not less than 19 oz./sq. yd..
   1. Mesh Color: As selected by Architect from full range of industry colors and color densities.
B. Lower Curtain, Solid: Woven polyester fabric double-coated with vinyl, 19 oz./sq. yd., 8-foot height above floor.

1. Fabric Color(s): One color(s), as selected by Architect from full range of industry colors and color densities.

C. Hems: Folded and electronically welded.

D. Seams: Electronically welded.

E. Overall Curtain Height: 20 feet.

F. Bottom of Curtain: Approximately 2 inches above finished floor.

G. Divider-Curtain Flame-Resistance Rating: Passes NFPA 701 Test 2.

2.5 DIVIDER SYSTEM ACCESSORIES

A. Safety Lock: Locks drive system when speed exceeds manufacturer's recommended speed.

B. Audible Motion Alarm: Provide alarm with intermittent warning tone when curtain is raised or lowered.

2.6 SUPPORT MATERIALS AND FASTENERS

A. Support Chain and Fittings: For chains used for overhead lifting, provide Grade 80, heat-treated alloy-steel chains, according to ASTM A391/A391M, with commercial-quality, hot-dip galvanized or zinc-plated steel connectors and hangers.

B. General-Purpose Chain: For chains not used for overhead lifting, provide carbon steel chain, according to ASTM A413/A413M, Grade 30 proof coil chain or higher grade recommended by gymnasium divider manufacturer. Provide coating type, chain size, number, and installation method according to manufacturer's written instructions.

C. Anchors, Fasteners, Fittings, and Hardware: Manufacturer's standard corrosion-resistant or noncorrodible units; concealed.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with manufacturer's written installation instructions.

B. Install gymnasium dividers level, plumb, square, and true; anchored securely to supporting structure; positioned at locations and elevations indicated; in proper relation to adjacent construction; and aligned with sport-court layout.

C. Connections: Connect electric operators to building electrical system.

D. Adjust movable components of gymnasium dividers to operate safely, smoothly, easily, and quietly, free from binding, warp, distortion, uneven tension, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range; and lubricate as recommended in writing by manufacturer.

E. Limit Switch Adjustment: Set and adjust upper and lower limit controls.

3.2 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain gymnasium dividers.

END OF SECTION

SECTION 12 36 61.16
SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Solid surface material countertops.
2. Solid surface material backsplashes – if identified in drawings.
3. Solid surface material end splashes – if identified in drawings.
4. Solid surface material apron fronts – if identified in drawings.

1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials and sinks.
B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
C. Samples: For each type of material exposed to view.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ISFA 2-01.
1. Manufacturers, Colors, and Patterns: As identified in the finish schedule and key in the drawings.
2. Type: Provide Standard type unless Special Purpose type is indicated.
3. Integral Sink Bowls: Comply with CSA B45.5/IAPMO Z124.
B. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
C. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 FABRICATION

A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
1. Grade: Premium.
B. Configuration:
1. Front: See cabinet details in drawings.
2. Backsplash: Straight, slightly eased at corner.
3. End Splash: Matching backsplash.
C. Countertops:
1. 3/4-inch-thick, solid surface material with front edge built up with same material.
D. Backsplashes: 3/4-inch-thick, solid surface material.
E. Joints:
1. Fabricate countertops without joints to greatest extent possible.
F. Cutouts and Holes:
1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by solid surface material manufacturer.
B. Sealant for Countertops: Comply with applicable requirements in Section 07 92 00 "Joint Sealants."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer.
B. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
C. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions.
D. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
E. Install backsplashes and end splashes by adhering to wall and countertops with adhesive.
F. Install aprons to backing and countertops with adhesive.
G. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
H. Apply sealant to gaps at walls; comply with Section 07 92 00 "Joint Sealants."

END OF SECTION

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SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE-SUPPRESSION

PART 1 - GENERAL

SCOPE

This section includes information common to two or more technical fire protection specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Related Documents
- Regulatory Requirements
- Reference Standards
- Quality Assurance
- Abbreviations and Symbols
- Definitions
- Coordination
- Continuity of Existing Services
- Protection of Finished Surfaces
- Sleeves and Openings
- Sealing and Firestopping
- Equipment Furnished By Others
- Provisions for Future
- Off Site Storage
- Submittals
- Operating and Maintenance Instructions
- Record Drawings
- Training of Owner Personnel
- Testing
- Cleaning
- Warranty
- Certified Startup Reports

PART 2 - PRODUCTS
- Access Panels and Doors
- Pipe Penetrations
- Sealing and Firestopping

PART 3 - EXECUTION
- Demolition
- Concrete Work
- Openings, Cutting and Patching
- Building Access
- Equipment Access
- Coordination of Work
- Pipe Penetrations
- Identification
- Lubrication and Maintenance
- Sleeves

RELATED WORK

Provisions of Division 01 shall govern work under this Section.

This section applies to all Division 21 Sections of Fire Suppression.

REGULATORY REQUIREMENTS

Refer to Division 01 of the Project Manual.

Codes and Standards:

Fire Protection work shall conform to the requirements of Wisconsin Building Code (COMM), NFPA Standards, and local regulations regarding design, materials and installation.

Materials and workmanship shall comply with applicable Codes, local ordinances, industry standards and utility regulations. In case of differences between Codes, and the Contract Documents, the most stringent shall govern.

Non-Compliance:
Should the Contractor perform any work that does not comply with the above requirements, he shall bear all costs necessary to correct the deficiencies.

Permits, Inspections, and Fees:
Request and obtain permits and inspection appointments.

Provide fees and charges for approvals, reviews, or other inspections.

Include copies of the certificates in the Operating and Maintenance Instructions.

Fees and charges assessed by local utilities for water or other services shall be included in the bid.

REFERENCE STANDARDS
Abbreviations of standards organizations referenced in this and other sections are as follows:

AGA	American Gas Association
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
CGA	Compressed Gas Association
CS	Commercial Standards, Products Standards Sections, Office of Engineering Standards Service, NBS
DSPS	State of Wisconsin Department of Professional Services
EPA	Environmental Protection Agency
FM	Factory Mutual System
FS	Federal Specifications, Superintendent of Documents, U.S.Government Printing Office
IAPMO	International Association of Plumbing & Mechanical Officials
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
MCA	Mechanical Contractors Association
MICA	Midwest Insulation Contractors Association
MSS	Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
NBS	National Bureau of Standards
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
STI	Steel Tank Institute
UL	Underwriters Laboratories Inc.

QUALITY ASSURANCE
Substitution of Materials: Refer to Division 01 of the Project Manual.

All products and materials used are to be new, undamaged, clean and in good condition. Existing products and materials are not to be reused unless specifically indicated.

Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the intended performance from the system into which these items are placed.

ABBREVIATIONS AND SYMBOLS
Key to abbreviations and symbols shall be on the Drawings.

The following are additional abbreviations used in the Specifications:

A/E	Architect/Engineer
GC	General Contractor

PC	Plumbing Contractor
FPC	Fire Protection Contractor
HC	Heating Ventilating and Air Conditioning Contractor
EC	Electrical Contractor
KEC	Kitchen Equipment Contractor
LEC	Lab Equipment Contractor

DEFINITIONS

Furnish:

Supply and deliver to Project site ready for unpacking, assembly and installation

Install:

Operations at Site including unpacking, assembling, erecting, placing, anchoring, applying, finishing, cleaning, and connecting related devices required for product fully functional for intended use after installation.

Provide:

Furnish and install, such that product is fully functional for intended use.

COORDINATION

The Drawings show the general arrangement of piping and equipment and shall be followed as closely as actual building construction and the work of other trades permits. Architectural and Structural Drawings shall take precedence. Because of the scale of the Drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate conditions affecting the Work and arrange accordingly, providing offsets, fittings and accessories as may be required to meet conditions.

CONTINUITY OF EXISTING SERVICES

Refer to Division 01 of the Project Manual.

Do not interrupt or change existing services without prior written approval from the Owner's Project Representative. When interruption is required, coordinate scheduling of down-time with the Owner to minimize disruption to his activities. Unless specifically stated, all work involved in interrupting or changing existing services is to be done during normal working hours.

PROTECTION OF FINISHED SURFACES

Refer to Division 01, of the Project Manual.

SEALING AND FIRESTOPPING

Sealing and firestopping of sleeves/openings between piping, etc. and the sleeve or structural opening shall be the responsibility of the contractor whose work penetrates the opening. The contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.

EQUIPMENT FURNISHED BY OTHERS

None.

PROVISIONS FOR FUTURE

None.

OFF SITE STORAGE

Refer to Division 01 of the Project Manual.

SUBMITTALS

Refer to Division 01, of the Project Manual.

Submit shop drawings with space for approval stamps of GC and A/E.

Refer to Division 01, of the Project Manual.

Not more than two weeks after award of contract but before any shop drawings are submitted, contractor to submit the following fire protection system data sheet. List piping material types, ASTM number, schedule or pressure class, joint type, manufacturer and model number where appropriate. List valves, specialties and equipment with manufacturer and model number. The approved fire protection system data sheet(s) will be made available to the Owners Project Representative for their use on this project.

FIRE PROTECTION SYSTEM DATA SHEET

Item	Pipe Service/Sizes	Manufacturer/Model No.	Remarks
Pipe			
Fittings			
Hangers & Supports			
Sprinkler Heads			
Valves			
Specialty Valves			
Pipe Specialties			
Fire Protection Specialties			
Fire Protection Equipment			

Shop drawing submittals are to be bound in a three ring binder, labeled, contain the project manual cover page and a material index list page showing item designation, manufacturer and additional items supplied with the installation. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Include wiring diagrams of electrically powered equipment.

Submittals shall be sent to the local Fire Chief or Fire Marshal for review prior to the Architect/Engineer. Include copy of approval letter in submission to Architect/Engineer.

Submit plans indicating water supply location and size, piping layout and size, sprinkler locations and type, hanger locations and type, equipment locations and type, valve locations and type, occupancy classes, hydraulic reference points, design areas and discharge densities.

Submit hydraulic calculations for water supply and sprinkler systems. Include summary sheet and detailed work sheets. Describe characteristics of water supply and location of effective point used in calculations. Include graph illustration of water supply, hose demand, sprinkler demand.

Submit sufficient quantities of data sheets and shop drawings to allow the following distribution:

- Operating and Maintenance Manuals 2 copies
- Architect/Engineer 2 copies
- Local Fire Chief or Marshal 1 copy

Firestop Systems:
Contractor shall submit product data for each firestop system. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgement can be based upon.

OPERATING AND MAINTENANCE INSTRUCTIONS
Refer to Division 01 of the Project Manual.

Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:

- Copies of all approved submittals along with approval letters.
- Manufacturer's wiring diagrams for electrically powered equipment.
- Records of tests performed to certify compliance with system requirements.
- Certificates of inspection by regulatory agencies.
- Parts lists for equipment and specialties.
- Manufacturer’s installation, operation and maintenance recommendations for equipment and specialties.
- Valve schedules
- Lubrication instructions, including list/frequency of lubrication
- Warranties
- Additional information as indicated in the technical specification sections

RECORD DRAWINGS
Refer to Division 01 of the Project Manual.

In addition to the data indicated in the General Requirements, maintain fire protection layout record drawings and hydraulic calculations on originals prepared by the installing contractor/subcontractor. Include copies of these record drawings and calculations with the Operating and Maintenance manuals.

TRAINING OF OWNER PERSONNEL
Instruct Owner's personnel in the proper operation, maintenance and testing of systems and equipment provided as part of this project. Include not less than 2 hours of instruction, using the Operating and Maintenance manuals and record drawings during this instruction.

TESTING
Equipment, material and labor required for testing, shall be provided by the Contractor.

Contractor shall notify Inspector(s) one day prior to the time when the test is ready to be performed. Contractor shall notify the A/E of date and time for tests.

After the test, indicate in writing the time, date, name and title of the person approving the test. This shall also include the description and what portion of the system has been tested. The person approving the test shall sign the certification.

Records shall be maintained of testing that has been completed, and shall be made available at the job site to authorities.

Upon completion of the work, records and certifications approving testing requirements shall be submitted.

Defective work or material shall be replaced or repaired, and the test repeated. Repairs shall be made with new materials.

CLEANING
Contractor shall keep the premises broom clean and free of all surplus materials, rubbish and debris which is caused by his employees or resulting from his work.

Foreign matter shall be blown out, or flushed out, of pipes, tanks, pumps, strainers, motors, devices, switches, and panels.

Identification plates on equipment shall be free of paint and dirt.

The Contractor shall leave his portion of the work ready for operation.

WARRANTY
Warrant that work functions for one year following acceptance of the system(s).

The Contractor shall keep the system in good working order at no expense, unless defects are clearly the result of improper or abnormal usage.

The Contractor shall submit to the A/E upon request for acceptance of the work, written certification that the entire system has been installed and adjusted for operation in accordance with the Contract Documents.

PART 2 - PRODUCTS

ELECTRICAL REQUIREMENTS
General:
Work shall conform to requirements of Division 26.

Provide wiring diagrams.

ACCESS PANELS AND DOORS
Provide access panels at locations requiring access to mechanical equipment. Locations include, but are not limited to areas above drywall ceilings, shaft enclosures and other furred-in spaces concealing valves, ducts or equipment. Provide UL listed, fire rated access panels when penetrating fire rated chase or shaft areas.

Access panels shall be of size required to provide adequate access to equipment. Minimum size shall be 12 inch by 12 inch for hand access and 24 inch by 24 inch for body access.

Panels shall be Milcor brand or equivalent.

Panels shall include concealed hinges, cam type locking devices, and have frame/border type necessary for particular wall or ceiling construction they are installed. Access panels shall be flush mounted, recessed frame type units. Access panels shall be prime coated steel, able to accept field painting for general applications and stainless steel for use in toilet rooms, shower rooms and similar wet areas.

Refer to Architectural Room Finish Schedule for wall and ceiling surfaces and finishes.

For non-security applications, panel construction shall utilize 16 gauge frame with not less than 18 gauge hinged door panel. Door locks shall be screwdriver operated for panels in general location applications and shall be key locked for public area applications.

PIPE PENETRATIONS
Refer to Division 01 requirements as well as the following.

Fire, Smoke And Fire/Smoke Rated Surfaces:
3M CP 25N/S or CP 25S/L caulk, 3M FS 195 wrap/strip with restricting collar, 3M CS 195 composite sheet, Pipe Shields Inc. Series F fire barrier kits, Proset Systems fire rated floor and wall penetrations, Insta-Foam Products Insta-Fire Seal Firestop Foam or Dow Corning Fire Stop System.

All fire stopping systems shall be provided by the same manufacturer.

UL listed or tested by independent testing laboratory, approved by State and Local Code jurisdictions.

Use product that has a rating not less than rating of wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.

Sleeves in concrete to be Schedule 40 steel pipe with integral water stop unless fire stop material used includes a sleeve that is an integral part of rated assembly.

Use firestop putty, caulk sealant, intumescent wrapstrips, intumescent firestop collars, firestop blocks, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.

Non-Rated Surfaces:
Stamped steel, chrome plated, hinged, split ring escutcheons or floor/ceiling plates for covering openings in occupied spaces.

In exterior wall openings below grade, use modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the un-insulated pipe and cored opening or a water-stop type wall sleeve.

At interior partitions where pipe penetrations are sealed, use Tremco Dymonic, Sika Corp. Sikaflex 1a, Sonneborn Sonolastic NPI, or Mameco Vulken 116 urethane caulk to effectively seal. Use galvanized sheet metal sleeves in hollow wall penetrations.

PART 3 - EXECUTION

GENERAL
Coordination Of Work:
Review the complete set of Drawings and Specifications and report discrepancies to the A/E. Obtain written instructions for changes necessary. Coordinate with each trade prior to beginning installation and make provisions to avoid interferences. Changes required caused by neglect to coordinate shall be made without expense to the project.

Piping shall not be located above electrical panels.

Anchor Bolts, Sleeves, and Supports:
These items required for the Work shall be furnished by the FPC for proper installation of his work. They shall be installed (except as otherwise specified) by the trade furnishing and installing the material in which they are to be located. Location of anchor bolts, sleeves, inserts and supports shall be directed by the trade requiring them. Expense resulting from the improper location or installation of anchor bolts, sleeves, inserts and supports shall be paid for by the Contractor for the trade with responsibility for directing their proper location.

Adjustments In Locations:
Locations of pipes and equipment, shall be adjusted to accommodate the work interferences anticipated and encountered. Prior to fabrication determine the exact route and location of each pipe (subject to A/E's approval).

Right Of Way:
New lines which pitch shall have the right-of-way over those which do not pitch. For example: Gravity drains shall normally have right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed. Notify A/E and other trades of conflicts.

Offsets, transitions and changes in direction of electrical raceways, pipes, and ducts shall be made to maintain proper room and pitch of sloping lines whether or not indicated on the Drawings.

DEMOLITION

Perform all demolition as indicated on the drawings to accomplish new work. Where demolition work is to be performed adjacent to existing work that remains in an occupied area, construct temporary dust partition to minimize the amount of contamination of the occupied space. Where pipe is removed and not reconnected with new work, cap ends of existing services as if they were new work. Coordinate work with the Owner to minimize disruption to the existing building occupants.

All pipe, sprinklers, equipment, wiring, associated conduit and similar items demolished, abandoned, or deactivated are to be removed from the site by the Contractor except as specifically noted otherwise. All designated equipment is to be turned over to the Owner for his use at a place and time he so designates. Maintain the condition of material and/or equipment that is indicated to be reused equal to that existing before work began.

CONCRETE WORK

Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for support or installation of plumbing piping, fixtures, specialties and equipment. Coordinate locations of equipment, pipe penetrations in wet areas, etc. with the Division 03 Contractor.

Plumbing related cast-in-place concrete on the exterior of the building to be provided by this Contractor in conformance with requirements of Division 03. This includes piping thrust restraints, pipe supports, hydrant supports, manholes, catch basins, grease traps, septic tanks, distribution boxes, valve pits, meter pits, cleanout cover pads, yard hydrant pads, etc.

OPENINGS, CUTTING AND PATCHING

Refer to Division 01 requirements.

Provisions for openings including chases, holes and clearances through walls, floors, and roof, ceilings and partitions shall be made in advance of construction of each part of the building. Openings shall (except for pipe sleeves) be provided by the GC for the respective materials in which openings occur, during the construction of the building with the exception of pipe sleeves. Furnish required opening dimensions and locations.

If the FPC neglects to inform the GC of his opening requirements before that portion of the building is complete, the FPC shall cut the openings, provide framing and lintels. In the event holes must be cut through reinforced concrete, drill so as to avoid spalling and unnecessary damage or weakening of structural members. No chopping or breaking out is permitted. Before cutting or drilling, the Contractor shall obtain permission from the A/E. Patch adjacent materials and repair damage resulting from the cutting.

The FPC may perform core drilling for openings in existing walls and floors at the direction of the A/E. Framed openings shall be by the GC.

BUILDING ACCESS

Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

EQUIPMENT ACCESS

Install all piping, valves, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Where access is required in plaster walls or ceilings, furnish the access doors to the General Contractor.

Accessible ceilings, (i.e. lay-in ceilings) do not require access panels. Provide color coded thumb tacks or screws, depending on surface, for use in accessible ceilings.

COORDINATION OF WORK

Install systems, equipment and piping in cooperation with other trades. Locations of pipes, equipment, fixtures, etc., shall be adjusted to accommodate the work interferences anticipated and encountered. Prior to fabrication determine the exact route and location of each pipe (subject to A/E's approval).

Any work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

Verify that all devices are compatible for the type of construction and surfaces on which they will be used.

Offsets, transitions and changes in direction of electrical raceways, pipes and ducts shall be made as required whether or not indicated on the Drawings.

Provide appropriate sections of work with required wall, roof and floor opening locations and dimensions. If Contractor neglects to coordinate information, openings shall be the responsibility of Contractor.

PIPING INSTALLATION

Installation Arrangement:

Install work to permit removal (without damage to other parts) of parts requiring replacement or maintenance. Arrange pipes and equipment to permit ready access to valves, cocks, traps, starters, motors, and control components and to clear the openings of swinging and overhead doors and of access panels.

Connections Different From Those Shown:

Where equipment requiring different arrangement or connections from those shown is used, install the equipment to operate properly and in harmony with the intent of the Drawings and Specifications. When requested by the A/E, submit drawings showing the proposed installation.

Upon approval of the revisions, make changes in piping, ductwork, supports, insulation, wiring, and panelboards. Provide additional valves, fittings and other additional equipment required for the proper operation of the system resulting from the selection of equipment, including required changes in affected trades. The Contractor shall be responsible for the proper location of rough-in and connections by other trades.

Changes shall be made at no increase in the Contract amount or additional cost to the other trades.

LUBRICATION AND MAINTENANCE

Lubricate bearings with lubricant as recommended by manufacturer before equipment is operated for any reason. Once equipment has been run, maintain lubrication in accordance with the manufacturer's instructions until the work is accepted by the Owner. Maintain log of all lubricants used and frequency of lubrication. Include information in Operating and Maintenance Manuals at completion of project.

SLEEVES

Provide galvanized sheet metal sleeves for fire rated pipe penetrations through interior and exterior walls to provide a backing for sealant or firestopping. Patch wall around sleeve to match adjacent wall construction and finish. Grout area around sleeve in masonry construction. In finished spaces where pipe penetration through wall is exposed to view, sheet metal sleeve shall be installed flush with face of wall. In existing poured concrete walls where penetration is core drilled, pipe sleeve is not required. Grout holes directly around steel pipe.

In all piping floor penetrations, fire rated and non-fire rated, top of sleeve shall extend 3/4 inch above the adjacent finished floor. In existing floor penetrations, core drill sleeve opening large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting, non-shrink grout. If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve that will transfer weight to existing floor structure.

PIPE PENETRATIONS

General:

Coordinate location of building surface penetrations with appropriate contractors. Furnish sleeves, inserts, and devices to be built into structure to contractor performing Work. Prepare Shop Drawings for approval for penetrations of structural elements, including floor slabs, shear walls, and bearing walls. Do not allow penetrations to be made until Shop Drawings are approved.

Fire Rated Surfaces:

Install products in accordance with the manufacturer's instructions where pipe penetrates a fire rated surface. When pipe is insulated, use product that maintains integrity of insulation and vapor barrier. Where sleeve must be installed in existing floor, grout area around sleeve to restore floor integrity. In wet area floor penetration, top surface of penetration to be 2 inches above adjacent floor with additional height obtained by means of concrete pad poured integral with floor.

Non-Rated Surfaces:

Install escutcheons or floor/ceiling plates where pipe penetrates non-fire rated surfaces in occupied spaces. Size units to accommodate insulation, where applicable. Escutcheons are not required when insulation completely covers wall opening and insulation end is trimmed in a neat manner. Occupied spaces for this Paragraph include only those rooms with finished ceilings and penetration occurs below ceiling.

In exterior wall openings below grade, place water-stop type wall sleeve before concrete pour or core drill opening after pour. Assemble rubber links to proper size for pipe and tighten in place in accordance with manufacturer's instructions.

Install galvanized sheet metal sleeve in hollow wall penetrations to provide backing for sealant. Apply sealant to both sides of penetration in a manner that annular space between pipe sleeve and pipe or insulation is completely blocked.

Completely seal (or caulk) around pipe penetrations through non-rated, smoke tight corridor walls in healthcare facilities. Refer to architectural drawings for additional information.

ESCUTCHEON PLATES

Provide plates on pipes passing through finished floors, walls and ceilings, with outside diameter to cover sleeve opening and inside diameter to fit snugly around pipe. Set tight to building surface. Escutcheon plates shall be chromium plated metal.

PAINTING

Refer to Division 09.

IDENTIFICATION

Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion.

Where stenciling is not appropriate for equipment identification, engraved name plates may be used.

Identify interior piping mains not less than once every 25 feet, not less than once in each room, adjacent to each access door or panel, and on both sides of the partition where exposed piping passes through walls or floors. Place flow directional arrows at each pipe identification location. Use one coat of black enamel against a light background or white enamel against a dark background or approved pipe marking label systems.

Identify valves with signs per NFPA rulings.

Provide hydraulic design information sign of permanently marked weatherproof metal or engraved nameplate material. Secure to main fire risers/valves with brass chain. Information to include location of the design areas, discharge densities, required flow and residual pressure at the base of riser, hose stream demand and sprinkler demand.

END OF SECTION

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SECTION 21 05 29
HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

SCOPE

This section includes specifications for supports of all fire protection equipment and materials as well as piping system anchors. Included are the following topics:

PART 1 - GENERAL
Scope
Related Work
Reference Standards
Quality Assurance
Description
Design Criteria
Submittals

PART 2 - PRODUCTS
Manufacturers
Structural Supports
Pipe Hangers and Supports
Beam Clamps
Riser Clamps
Concrete Inserts
Anchors
Equipment Stands
Corrosive Atmosphere Coatings

PART 3 - EXECUTION
Installation
Hanger and Support Spacing
Riser Clamps
Concrete Inserts and Continuous Insert Channels
Anchors
Roof Mounted Piping Supports

RELATED WORK

Provisions of Division 01 shall govern work under this Section.

Division 03 - Concrete

Section 21 05 00 – Common Work Results for Fire-Suppression
Section 21 10 00 – Water-Based Fire-Suppression Systems

REFERENCE STANDARDS

MSS SP-58
MSS SP-69
NFPA 13 Installation of Sprinkler Systems (Latest prevailing addition).
NFPA 14 Installation of Standpipe and Hose Systems (Latest prevailing addition).
NFPA 20 Installation of Centrifugal Fire Pumps (Latest prevailing addition).
UL Underwriters' Laboratories Listed.
FM Factory Mutual Approved

QUALITY ASSURANCE

Substitution of Materials: Refer to Division 01 of the Project Manual.

DESCRIPTION

Provide all supporting devices as required for the installation of mechanical equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for building piping.

Do not hang any mechanical item directly from a metal deck or run piping so its rests on the bottom chord of any truss or joist.

Fasteners depending on soft lead for holding power or requiring explosive powder actuation will not be accepted.

Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.

DESIGN CRITERIA
Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 and SP-69 unless noted otherwise.

Materials and application of pipe hangers and supports shall be in accordance with NFPA rulings and be UL/FM listed and approved.

SUBMITTALS
Submit data in accordance with Section 21 05 00 and Division 01 of the Project Manual.

Schedule of all hanger and support devices indicating attachment methods and type of device for each pipe size and type of service. Provide details on the working drawings submitted for approval with all pertinent information listed.

PART 2 - PRODUCTS

MANUFACTURERS
B-Line, Fee and Mason, Grinnell, Hilti, Michigan Hanger, Pate, PHD Manufacturing, Piping Technology, Powers/Rawl, Proset, Roof Products & Systems, Unistrut, or Victaulic.

STRUCTURAL SUPPORTS
Provide all supporting steel required for the installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspended or floor supported tanks and equipment. All of this steel may not be specifically indicated on the drawings.

PIPE HANGERS AND SUPPORTS
Hangers for Pipe Sizes 1/2" through 4":
Carbon steel, adjustable swivel ring with 3/8" min. UL/FM approved hanger rods. B-Line B3170NF, Grinnell 69 or 70.

Carbon steel, adjustable clevis, standard, with UL/FM approved size hanger rods. B-Line B3100, Grinnell 260.

Hangers for Pipe Sizes 4" Through 8":
Carbon steel adjustable swivel ring with ½" min. UL/FM approved hanger rods. B-Line B3170NF, Grinnell 69 or 70.

Carbon steel, adjustable clevis, standard with UL/FM approved size hanger rods. B-Line B3100, Grinnell 260.

Multiple or Trapeze Hangers:
Manufactured steel channel system with manufacturers slotted interlocking pipe clamps with screw/nut securing and threaded hanger rods or steel channels with welded spacers and threaded hanger rods.

Steel channel, 12-gauge thickness, Dura-Green epoxy coating, B-Line B11. Restrain individual pipes with B-Line B2000 series or Vibraclamp series strut clamps.

Wall Support:
Carbon steel welded bracket with hanger. B-Line 3060 Series, Grinnell 190 Series.
Steel channels with pipe clamps.

Vertical Support:
Carbon steel riser clamp. B-Line B3373, Grinnell 261 for above floor use. Grinnell 40 with bolts and concrete anchors for attachment to underside of concrete floor deck.

Floor Support:
Carbon steel pipe saddle, stand and bolted floor flange. B-Line B3088T/B3093.

Copper Pipe Supports:
All supports, fasteners, clamps, etc. directly connected to copper piping shall be copper plated or polyvinylchloride coated. Where steel channels are used, provide flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping

and avoid contact with the channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Grinnell PS 1400 series.

PIPE HANGER RODS

Steel Hanger Rods:

Threaded both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts. Steel, electro-plated, threads on both ends, B-Line B3205

Size rods for individual hangers and trapeze support as indicated in the following schedule:

Pipe Size:	Diam. Of Rod:
Up to and Including 4"	3/8" or 9.5mm min.
5",6" and 8"	½" or 12.7mm min.
10" and 12"	5/8" or 15.9mm min.

BEAM CLAMPS

MSS SP-69 Types 19 & 23 malleable black iron clamp for attachment to beam flange to 0.62 inches thick with a retaining ring and threaded rod of 3/8, 1/2, and 5/8 inch diameter. Furnish with a hardened steel cup point set screw. B-Line B3036L/B3034, Grinnell 86/92.

MSS SP-69 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2 inch diameter. B-Line B3054, Grinnell 228.

CONCRETE INSERTS

Poured in Place:

MSS SP-69 Type 18 wedge type to be constructed of a black carbon steel body with a removable malleable iron nut that accepts threaded rod to 7/8 inch diameter. Wedge design to allow the insert to be held by concrete in compression to maximize the load carrying capacity. B-Line B2505, Grinnell 281.

MSS SP-69 Type 18 universal type to be constructed of black malleable iron body with a removable malleable iron nut that accepts threaded rod to 7/8 inch diameter. B-Line B3014N, Grinnell 282.

Drilled Fasteners:

Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor. Hilti, Powers/Rawl, Redhead.

Mechanical-Expansion Anchors:

Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Zinc-coated or stainless steel expansion anchors. Use drill bit of same manufacturer as anchor.

Manufactured By:
Hilti, ITW/Read Head, or equal.

CONTINUOUS CONCRETE INSERT CHANNELS

Steel inserts with an industry standard pre-galvanized finish, nominally 1-5/8 inch by 1-3/8 inch deep by length to suit the application, designed to be nailed to concrete forms and provide a linear slot for attaching other support devices. Installed channels to provide a load rating of 2000 pounds per foot in concrete. Manufacturer's standard brackets, inserts, and accessories designed to be used with channel inserts may be used. Select insert length to accommodate all pipe sizes in the area.

ANCHORS

Use welding steel shapes, plates, and bars to secure piping to the structure.

EQUIPMENT SUPPORT

Support equipment plumb, rigid, and true to line. Examine Drawings, and manufacturer's data to determine how equipment and piping are to be supported, mounted, or suspended. Provide rods, bolts, inserts, pipe stands, brackets and accessories for proper support.

Equipment Stands:

Use structural steel members welded to and supported by pipe supports. Clean, prime and coat with three coat rust inhibiting alkyd paint or one coat epoxy mastic. Where exposed to weather, treat with corrosive atmosphere coatings.

CORROSIVE ATMOSPHERE COATINGS

Factory coat supports and anchors used in corrosive atmospheres with hot dip galvanizing after fabrication, ASTM A123, 1.5 ounces/square foot of surface each side. Mechanical galvanize threaded products, ASTM B695 Class 50, 2.0 mil coating. Field cuts and damaged finishes to be field covered with zinc rich paint of comparable thickness to factory coating.

Corrosive atmospheres include the following locations:

- Locker rooms

PART 3 - EXECUTION

INSTALLATION

Size, apply and install supports and anchors in compliance with manufacturers recommendations.

Secure pipe in place to prevent vibration, maintain proper slope and provide for expansion and contraction.

Design supports of strength and rigidity to suit loading, service, and manner which do not unduly stress the building construction. Where support is from concrete construction, take care not to weaken concrete or penetrate waterproofing. Fasten supports and hangers to building steel framing wherever practical. Do not use another pipe for support. Do not use perforated iron, chain or wire as hangers.

Use inserts for suspending hangers from reinforced concrete slabs wherever practical. Where inserts are not practical, provide channels or angles from which to suspend hangers/supports. Fasten structural steel to concrete with expansion bolts.

Provide expansion anchors in concrete slabs for installation of threaded support rods.

Provide hangers capable of vertical adjustment after piping is erected. Do not pierce ductwork with hanger rods. On threaded support rods and bolts, weld nuts to rods, peen threads, or provide double set of nuts with lock washers to prevent loosening. Use beam clamps for attaching hangers to structural steel.

Coordinate hanger and support installation to properly group piping of all trades.

Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes or continuous insert channels for the supporting steel. Where continuous insert channels are used, pipe supporting devices made specifically for use with the channels may be substituted for the specified supporting devices provided that similar types are used and all data is submitted for prior approval.

Perform welding in accordance with standards of the American Welding Society.

HANGER AND SUPPORT SPACING

Support horizontal piping per NFPA 13.

Provide vertical support at each floor level as the pipe passes through the floor. For piping that does not pass through the floor, provide adequate support to stabilize the vertical portion of the piping.

Provide galvanized steel supports for steel piping.

Provide CPVC dipped hangers or provide Unistrut “Uni-Cushion” vinyl strip at galvanized hangers for copper lines.

Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.

Support riser piping independently of connected horizontal piping.

Adjust hangers to obtain the slope specified in the piping section of these specifications.

Space hangers for pipe as follows:

Pipe Material:	Pipe Size:	Max. Horiz. Spacing:	Max. Vert. Spacing:
Copper	3/4" through 1"	8'-0"	10'-0"
Copper	1-1/4" through 1-1/2"	10'-0"	10'-0"
Copper	2" through 3"	12'-0"	10'-0"
Copper	3-1/2" through 8"	15'-0"	10'-0"
Steel	1" through 1-1/4"	12'-0"	15'-0"

Steel	1-1/2" through 8"	15'-0"	15'-0"
Steel	8" through 12"	15'-0"	20'-0"

Unsupported length from the last hanger and an end sprinkler shall be as follows:

Pipe Size:	Length:
1" piping	Not greater than 36"
1-1/4" piping	Not greater than 48"
1-1/2" piping	Not greater than 60" or larger

RISER CLAMPS

Support vertical piping with clamps secured to the piping and resting on the building structure or secured to the building structure below at each floor. Use method of securing the vertical risers to the building structure below in stairwell locations.

ANCHORS

Install where indicated on the drawings and details. Where not specifically indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

END OF SECTION

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SECTION 21 10 00
WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

SCOPE

This section contains specifications for an Automatic Fire Sprinkler System for this project. Included are the following topics:

PART 1 – GENERAL
- Scope
- Related Work
- Reference Standards
- Description
- System Description
- Design Standards
- Quality Assurance
- Submittals

PART 2 – PRODUCTS
- Pipe
- Fittings
- Joints
- Valves
- Flow Switches
- Tamper Switches
- Sprinklers
- Flexible Sprinkler Drop Fittings
- Fire Department Connection
- Local Alarm Bell
- Pipe Covering System
- Miscellaneous Equipment

PART 3 – EXECUTION
- Installation
- General
- Valves
- Gauges
- Switches
- Sprinklers
- Flexible Sprinkler Drop Fittings
- Dry system Specialties
- Pre-Action System
- Fire Department Connection
- Pipe Covering System
- Testing

RELATED WORK

Applicable provisions of Division 01 shall govern work under this Section.

Section 21 05 00 – Common Work Results for Fire-Suppression
Section 21 05 29 – Hangers and Supports for Fire-Suppression Piping and Equipment

REFERENCE STANDARDS

Applicable provisions of Division 01 shall govern work under this section.

Local and State Codes and Regulations.

National Fire Codes (NFC) published by NFPA; latest edition of standards listed:
- NFPA 13 - Sprinkler Systems

Local Fire Department requirements.

All items to be UL listed or FM approved for intended usage.

DESCRIPTION

Fire Protection Contractor shall furnish all calculations, design, drawings, material, equipment, labor and related items required to complete the work indicated on drawings and specifications.

The work under this Section includes, but is not limited to the following:

- Provide all components for a complete wet pipe automatic sprinkler system including shutoff valves with supervisory switch, fire department connection, main drain valve, test valve(s), alarms, piping, and all necessary components to make a complete, operational, and approved system.
- Provide complete, approved automatic sprinkler system(s) to give fire suppression coverage to all areas/rooms, including electrical rooms, elevator shafts, and elevator equipment rooms.

This portion of the project is design build. The contractor shall follow the specifications for type of systems, materials and equipment to use.

The contractor shall prepare, seal and submit drawings and calculations as required to obtain approval and building permit from State, Insurance Company, and local authority. Submit drawings and calculations to all authorities as required.

These documents, along with local regulations and codes, will be the basis for the Fire Protection design and construction.

The contractor shall calculate, size and select all systems as defined by the documents. This shall include coordination with other trade contractors including wiring of flow switch(es) and supervisory switch(es). All calculations, sizes, and system layouts shall include provisions for future additions.

SYSTEM DESCRIPTION

Connect to the existing fire protection system and extend into the new addition. Provide a wet pipe automatic sprinkler riser, cross main, and branch piping to connect to sprinkler heads in all spaces of the addition. Provide a new fire department connection (coordinate location with local Fire Marshall). See Fire Protection Drawings for location of main, riser, and Fire Department Connection.

Provide pre-fabricated modular pipe covering system to conceal pipes which would otherwise be exposed along cell fronts, in dormitory, and other areas where exposed piping is required to be concealed for security.

DESIGN STANDARDS

Sprinkler system shall be designed and hydraulically calculated by the Contractor to provide densities as listed on the drawings. Hydraulically calculate the system based on Light Hazard Occupancy in general areas.

Available water supply data for system design is as follows:

Performed By: City of Madison

Water Supply Hydrant Location	Outlet Elevation	Flow (GPM)	Static (PSI)	Residual (PSI)
Northport Drive	867.00 ft.	1,500	90	86

Water test data is preliminary for bidding purposes. Contractor shall perform a field flow and pressure test on municipal water supply main to verify existing conditions, as well as conditions of any new municipal main installation, in the adjacent street, and obtain any additional test data required for design. Tests to be representative of high water use periods.

Contractor shall submit seven (7) copies of hydraulic calculations with shop drawings on standard form specified in NFPA No. 13, Chapter 7, Sections 7-2 through 7-3.5 inclusive and Figures A-7-3.3 and A-7- 3.4.

QUALITY ASSURANCE

Substitution of Materials: Refer to Section 21 05 00 and Division 01 of the Project Manual.

Fire protection system components shall be rated for a minimum operating pressure of 175 psig.

To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

SUBMITTALS

Shop Drawings:

Submit shop drawings of all fire sprinkler system components.

Plans:
Submit contractor-prepared plans/drawings.

Submit per NFPA 13; installation plans, working plans, shop drawings, hydraulic calculations, and manufacturer's data on devices, etc., indicating by model and number to be used for review and approval. Contractor shall obtain the necessary insurance underwriters, State and Local Fire Department approvals prior to submitting shop drawings. Include copy of approval letter in submission to Architect/Engineer.

Prepare drawings at minimum scale of 1/8" per foot for plans and 1/4" per foot or larger for details. Show all piping, lighting, equipment, ductwork, sprinklers, hangers, roof construction and occupancy of each area, including ceiling and roof heights.

Installation shall be coordinated with the latest architectural, structural, mechanical, plumbing and electrical drawings.

Contractor shall submit drawings to Engineer which have been reviewed and stamped "approved" by the authority having jurisdiction. No work shall commence until all approvals have been obtained. Allow sufficient time in the construction schedule for the approvals.

As-Built Drawings:
Maintain at the site an up-to-date marked set of as-built drawings which shall be corrected and delivered to the Architect upon completion of the work.

Furnish the Architect one (1) reproducible print of corrected shop drawings, including plans, revised to show "as built" conditions.

PART 2 - PRODUCTS

PIPE
Wet Systems:
Carbon steel pipe, black, thickness per NFPA 13, conforming to ASTM A53, A135, A795.

Sprinkler piping shall be schedule 40 threaded up to and including 2" in size.

Schedule 10 threaded light wall not allowed (2" and under).

FITTINGS
Malleable iron, Class 150, threaded, ANSI B16.3.

Ductile iron, grooved end, 300 lb/in2 working pressure rating, UL listed or FM approved for automatic sprinkler.

Ductile or malleable iron, plain end with EPDM gasket, carbon steel bolts or locking lugs UL listed or FM approved for automatic sprinkler, Grinnell "Sock-it".

Carbon steel, butt-welded, class 150, ASTM A234.

Carbon steel, Class 150, flanged, ASTM A105.

JOINTS
Iron Pipe:
Tapered pipe threads, with Teflon tape, ANSI B2.1.

Mechanical coupling, EPDM gasket, UL listed or FM approved for automatic sprinkler.

Rigid Type:
Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's latest recommendations. Victaulic FireLock® EZ Style 009H (2" thru 4") and Victaulic Style 107H QuickVic™ (2" thru 8") shall be installation ready stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. 10" and larger sizes shall be Victaulic Style 07 Zero-Flex standard rigid coupling.

Flexible Type:
Use in seismic areas and where required by NFPA 13. Victaulic Style 177 QuickVic™ (2" thru 8") shall be installation ready stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. 10" and larger sizes shall be Victaulic Style 75 or 77 standard flexible coupling.

VALVES
Manufacturers:
Grinnell, Nibco, TYCO, Victaulic, or Wilkins.

Shutoff Valve:
Butterfly Valve:
Ductile iron body, epoxy coated, EPDM encapsulated ductile iron disc, 300 psi maximum working pressure, indicating type, with tamper switch in actuator, grooved end connections, UL Listed or FM approved, Victaulic Figure 705-W.

Check Valve:
Ductile iron body, rubber-encapsulated disc, 250 psi maximum working pressure, grooved end connections. Victaulic style 717.

Test Drain Valve:
Ball valve type, bronze, combination test and drain, with site glass, Sure-Test by G/J Innovations.

If design flow cannot be reached through the inspector's test drain, then the FPC shall install forward flow by-pass around the fire department connection check valve.

FLOW SWITCHES
UL listed and FM approved vane type waterflow switch with metal enclosure, adjustable pneumatic retard and electrical characteristics compatible with alarm system. Equal to Potter Model VSR-F.

TAMPER SWITCHES
For O S & Y valve or post indicator installations, UL listed, FM approved, to monitor position of valve, tamper resistant cover screws, single or double SPDT switch contacts, corrosion resistant, for indoor or outdoor use, NEMA 4 & 6P enclosures. Equal to Potter Model PCVS-1, -2 and OSYSU-1, 2.

SPRINKLERS
Manufacturer:
Products of the following manufacturers determined to be equal by the Architect/Engineer will be accepted: Grinnell, Reliable, TYCO, Victaulic and Viking.

General:
Fusible link or glass bulb type, cast brass or bronze construction. Provide heads with nominal 1/2" discharge orifice except where greater than normal density requires large orifice.

Select fusible link or glass bulb temperature rating to not exceed maximum ambient temperature rating allowed under normal conditions at installed location. Provide ordinary temperature (165 degree) fusible link or glass bulb type except at skylights, sealed display windows, unventilated attics and roof spaces, over cooking equipment, adjacent to diffusers, unit heaters, uninsulated heating pipes or ducts, mechanical rooms, storage rooms, or where otherwise indicated.

Provide quantity of spare heads as noted below and 1 wrench for each type of head and each temperature range installed. Provide 6 spare heads per 300 or less installed heads, 12 per 1000 or less and 24 for more than 1000. Provide steel cabinet for storage of heads and wrenches.

Types:
Refer to Sprinkler Schedule on plans for sprinkler head types and finishes in each area. Provide sprinkler guards in areas where sprinklers may be subject to damage (i.e. mechanical rooms).

Finished Areas:
Chrome plated bronze body quick response pendent, concealed, or side-wall sprinklers with glass bulb heat sensor. Semi-recessed and sidewall sprinklers shall have adjustable recessed escutcheon. Concealed sprinklers shall have adjustable cover plates. Cover plates shall match ceiling color. Design Basis: Victaulic Model V27.

Unfinished Areas:
Plain bronze body, upright or pendent, quick response sprinklers, with solder link or glass bulb for wet system. Plain bronze, upright or pendent open sprinkler for dry system. Design Basis: Victaulic Model V27 or V36.

Ratings:
See sprinkler ratings indicated on Sprinkler Schedule on plans. Use higher temperature-rated sprinkler heads in areas near heat sources, elevator equipment rooms, and elevator shafts.

FLEXIBLE SPRINKLER DROP FITTINGS

Manufacturers: FlexHead Industries, Victaulic or Viking.

Corrugated Type 304 stainless steel hose with braided Type 304 stainless steel exterior cover, welded stainless steel or zinc plated steel inlet and outlet threaded fittings with EPDM seals. 175 PSI pressure rating. 225 °F temperature rating, 1" minimum internal hose diameter. 40" maximum hose length, straight or angle outlet configuration. Galvanized steel ceiling support bar and brackets selected to match project ceiling support system requirements. UL Listed and FM approved.

Flexible drops are only allowed for use above fully accessible ACT ceilings.

FIRE DEPARTMENT CONNECTION
Manufacturer:
Badger-Powhatan, Croker, Elkhart Brass, J.W. Moon, Potter-Roemer, and W.D. Allen.

Exposed:
Wall mounted, exposed, two-way inlet, cast brass construction with pin lug swivel plugs, labeled backplate, with drop clappers, threads to match local fire department and finish to match existing fire department connection color. Potter-Roemer 5751.

Flush:
Wall mounted, flush, two-way inlet, cast brass construction with pin lug swivel plugs, labeled backplate, with drop clappers, threads to match local fire department and finish to match existing fire department connection color to match building color scheme. Potter-Roemer 5021.

Storz:
Wall mounted, 4 inch storz inlet, cast brass construction, labeled backplate, with threads to match local fire department and hard coated aluminum finish. Potter-Roemer 5795/5799 Series.

General:
Mounting height, distance from curb, etc., shall be as specified by local fire department.

LOCAL ALARM BELL
UL listed and FM approved weatherproof electric alarm bell with red painted metal housing, mounting base and gong, solenoid operator, weatherproofing O-ring seal and electrical characteristics compatible with alarm system. Equal to Potter Model PBA.

Support Devices:
All pipe support devices shall be tested and listed by an NFPA recognized independent laboratory for suitability with the intended application.

UL Listed low profile steel hanger for securement of steel and listed CPVC sprinkler pipe.

UL Listed copper coated hanger for securement of copper tubing.

Zinc plated spring steel shield clips of the size recommended by manufacturer, for securement of the cover.

Piping Cover:
The piping cover shall be 18-gauge cold rolled steel with paintgrip galvanized finish (treated for painting), ASTM A527, G90-U lock forming. The piping cover shall have a snap-lock interfacing with the shield clips such that it is irremovable with the use of ordinary tools.

Provide 5'-0" section shield covers with L-Design or U-Design shapes for sidewall or pendent installations respectively.

Cover joints shall be overlapping/interlocking integral joints with provision for securement utilizing steel rivets. Rivet spacing shall be no greater than 1-¼" intervals along the joint and positioned at a distance no greater than ½" from the end of the overlapping section.

Cover design shall include a groove at the interfacing of the cover and the construction surface to facilitate the application of sealant/adhesive compounds and enhance the security of such compounds from dislodging.

Accessories:
The system shall include tamper-resistant end caps, pre-fabricated corners, wall flanges, couplings, and other items necessary to complete the system.

The system shall include a spacer ring at the point of each sprinkler outlet to preclude intentional gapping between the sprinkler escutcheon and the cover.

MISCELLANEOUS EQUIPMENT
Provide other equipment and accessories, not listed, but required for a complete sprinkler system in accordance with NFPA and FM requirements.

PART 3 - EXECUTION

INSTALLATION
Install sprinkler system in accordance with requirements of NFPA 13 and local regulations of the fire marshal.

Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by Victaulic. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A Victaulic factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.

GENERAL
Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of window, doorway, stairway or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. Coordinate locations of fire protection piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, ceiling grid layout, light fixtures and grilles before installing piping. All exposed overhead piping shall be installed above the bottom chord of roof joists.

Maintain piping in clean condition internally during construction.

Provide clearance for access to valves and piping specialties.

Install piping so that system can be drained. Where possible, slope to main drain valve. Piping may be installed level (WET SYSTEMS ONLY). Where piping cannot be fully drained, install nipple and cap for drainage of less than 5 gallons or valve/nipple/cap for drainage over 5 gallons.

Do not install piping within exterior walls.

Do not route piping above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.

VALVES
Properly align piping before installation of valves. Do not support weight of piping system on valve ends. Mount valves in locations which allow access for operation, servicing and replacement. Install all valves with the stem in the upright or horizontal position. Valves installed with the stems down will not be accepted. All system shut-off valves shall have a supervisory switch.

GAUGES
Provide a valved pressure gauge in main sprinkler risers.

SWITCHES
Provide valved test connection for flow switch adjacent to flow switch. Test flow switch to verify proper operation.

SPRINKLERS
Locate sprinklers maintaining clearances from obstructions, ceilings and walls. Install sprinklers level in locations not subject to spray pattern interference.

Sprinklers shall be centered in all ceiling panels and tiles. A 1” tolerance for sprinkler placement is acceptable.

FLEXIBLE SPRINKLER DROP FITTINGS
Install in accordance with manufacturer’s installation instructions following minimum bend radii, maximum number of bends and bend distance from end requirements.

FIRE DEPARTMENT CONNECTION

Support from structure independent of piping. Locate 24" above grade or as directed by local Fire Marshall. Fill wall penetration with insulation and caulk exterior and interior face of wall opening weather tight.

PIPE COVERING SYSTEM

Indicate on sprinkler design drawings locations where covering system will be used. Installation shall be per the manufacturer's guidelines.

The cover shall be linear and snug-fitting. Support devices shall be anchored squarely and firmly against the structure in a straight line.

The installation shall be free of voids between the interfacing of the cover and the construction surface. Voids shall be sealed with "Sikadur" 51 two part epoxy, "Sikaflux" TR two part epoxy. Manufacturer shall supply on-site installation instruction for the project start-up.

TESTING

Refer to Section 21 05 00 – Common Work Results for Fire Suppression.

Hydro-statically pressure test the fire sprinkler system piping as required in NFPA 13. Keep records of all testing for submission in Operation and Maintenance Manuals.

END OF SECTION

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SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

SCOPE

This section includes information common to two or more technical plumbing specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

PART 1 – GENERAL
- Scope
- Related Work
- Regulatory Requirements
- Reference Standards
- LEED Certification
- Quality Assurance
- Abbreviations and Symbols
- Definitions
- Coordination
- Electronic Drawings
- Continuity of Existing Services
- Protection of Finished Surfaces
- Sealing and Firestopping
- Equipment Furnished by Others
- Provisions for Future
- Off Site Storage
- Submittals
- Specified Materials and Equipment
- Equipment Installation
- Operating and Maintenance Manuals
- Record Drawings
- Training of Owner Personnel
- Testing
- Cleaning
- Warranty
- Certified Startup Reports

PART 2 - PRODUCTS
- Electrical Requirements
- Access Panels and Doors
- Pipe Penetrations
- Equipment, Piping, and Valve Identification
- Equipment Accessories
- Thermometers and Gauges
- Bedding and Backfill

PART 3 - EXECUTION
- General
- Asbestos Abatement
- Demolition
- Excavation and Backfill
- Dewatering
- Rock Excavation
- Surface Restoration
- Concrete Work
- Openings, Cutting and Patching
- Building Access
- Equipment Access
- Coordination of Work
- Piping Installation
- Lubrication and Maintenance
- Sleeves
- Pipe Penetrations

Escutcheon Plates
Flashing of Roof and Wall Penetrations
Painting
Identification

RELATED WORK
Applicable provisions of Division 01 govern work under this Section.

This section applies to all Division 22 sections of plumbing.

REGULATORY REQUIREMENTS
Codes and Standards:
All plumbing work shall conform to the requirements of Wisconsin Administrative Code SPS 382 and SPS 384, Wisconsin Uniform Plumbing Code.

All materials and workmanship shall comply with applicable Codes, local ordinances, industry standards and utility regulations. In case of differences between such Codes, and the Contract Documents, the most stringent shall govern. Promptly notify the A/E in writing of any such difference.

Non-Compliance:
Should the Contractor perform any work that does not comply with the above requirements, without having notified the A/E, he shall bear all costs necessary to correct the deficiencies.

Permits, Inspections and Fees:
All required, permits, and inspections shall be requested and obtained by the Contractor.

All fees and charges for approvals, reviews, or other inspections shall be paid by the Contractor.

All fees and charges assessed by local utilities for water, sewer, gas or other services shall be included in the bid and shall be paid by the Contractor(s).

REFERENCE STANDARDS
Standards cited in the Specifications shall be the most recent editions.

Abbreviations of standards organizations referenced in this and other sections are as follows:

ABMA	American Boiler Manufacturers Association
ACPA	American Concrete Pipe Association
AGA	American Gas Association
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASME	American Society of Mechanical Engineers
ASPE	American society of Plumbing Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
CISPI	Cast Iron Soil Pipe Institute
CGA	Compressed Gas Association
CS	Commercial Standards, Products Standards Sections, Office of Eng. Standards Service, NBS
EPA	Environmental Protection Agency
FS	Federal Specifications, Superintendent of Documents, U.S. Government Printing Office
GAMA	Gas Appliance Manufacturers Association
IAPMO	International Association of Plumbing & Mechanical Officials
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
MCA	Mechanical Contractors Association
MICA	Midwest Insulation Contractors Association
MSS	Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
NBS	National Bureau of Standards
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation

PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association. Inc.
STI	Steel Tank Institute
UL	Underwriters Laboratories Inc.

Standards referenced in this section:

ACI 614	Recommended Practice for Measuring, Mixing and Placing of Concrete
ASTM D1557	Standard Test Method for Moisture-Density Relations of Soils
ASTM E814	Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
D.O.T.	Standard Specifications for Road and Bridge Construction, State of Wisconsin, Dept. of Transportation
UL1479	Fire Tests of Through-Penetration Firestops
UL723	Surface Burning Characteristics of Building Materials

LEED CERTIFICATION

The project will be LEED Certified thru the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) program. Refer to Section 01 81 13 – Sustainable Design Requirements for additional requirements.

In addition to complying with Division 22 drawings and specifications, equipment and material shall also comply with Section 01 81 13 and LEED requirements.

The Division 22 contractor will be expected to provide all required documentation, submittals, etc. in accordance with prerequisites and credits associated with Division 22 work and LEED Certification.

QUALITY ASSURANCE

Substitution of Materials: Refer to Division 01 of the Project Manual.

All products and materials used are to be new, undamaged, clean and in good condition. Existing products and materials are not to be reused unless specifically indicated.

Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the intended performance from the system into which these items are placed.

ABBREVIATIONS AND SYMBOLS

Key to abbreviations and symbols shall be on the Drawings.

The following are additional abbreviations used in the Specifications:

A/E	Architect/Engineer
GC	General Contractor
PC	Plumbing Contractor
FPC	Fire Protection Contractor
HC	Heating Ventilating and Air Conditioning Contractor
EC	Electrical Contractor

DEFINITIONS

Furnish:

Supply and deliver to Project site ready for unpacking, assembly and installation.

Install:

Operations at Site including unpacking, assembling, erecting, placing, anchoring, applying, finishing, cleaning, and connecting related devices required for product fully functional for intended use after installation.

Provide:

Furnish and install, such that product is fully functional for intended use.

COORDINATION

The Drawings show the general arrangement of piping and equipment and shall be followed as closely as actual building construction and the work of other trades permits. Architectural and Structural Drawings shall take precedence. Because of the scale of the Drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate conditions affecting the Work and arrange accordingly, providing offsets, fittings and accessories as may be required to meet conditions.

ELECTRONIC DRAWINGS

Drawings show general arrangements of piping, equipment and appurtenances and shall be followed as closely as actual building construction and work of other trades permits. Work shall conform to requirements shown on Drawings. General and structural drawings shall take precedence. Because of the scale of Drawings, it is not possible to indicate all offsets, fittings and accessories required. Investigate structural and finish conditions affecting work and arrange work accordingly, providing offsets, fittings and accessories required to meet constructed conditions.

Plumbing equipment and systems, including piping and ductwork shall be installed as high as possible unless otherwise noted on Drawings. Equipment and systems shall also be installed to maintain required operation and maintenance clearances.

CONTINUITY OF EXISTING SERVICES

Refer to Division 01 of the Project Manual.

Do not interrupt or change existing services without prior approval from Owner, Architect, Engineer or Construction Manager. When interruption is required, coordinate down-time with Owner to reduce disruption to activities. Scope of Work is indicated on Contract Documents or described herein. Unless specifically stated, any work involved in interrupting or changing existing services is to be done during normal working hours.

PROTECTION OF FINISHED SURFACES

Refer to Division 01 of the Project Manual.

Furnish one can of touch-up paint for each different color factory finish to be finished surface of product. Deliver touch-up paint with other "loose and detachable parts" as covered in General Requirements.

SEALING AND FIRESTOPPING

Sealing and firestopping of sleeves/openings between piping, etc. and the sleeve or structural opening shall be the responsibility of the contractor whose work penetrates the opening. The contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.

EQUIPMENT FURNISHED BY OTHERS

None.

PROVISIONS FOR FUTURE

None.

OFF SITE STORAGE

Refer to Division 01 of the Project Manual.

SUBMITTALS

Refer to Division 01, of the Project Manual.

Submit shop drawings with space for approval stamps of GC and A/E.

Submit the following plumbing system data sheet for approval by the GC and A/E. List piping material type for each piping service on the project, ASTM number, schedule or pressure class, joint type, manufacturer and model number where appropriate. List valves and specialties for each piping service, fixture and equipment with manufacturer and model number.

PLUMBING SYSTEM DATA SHEET

Item	Pipe Service/Sizes	Manufacturer/Model No.	Remarks
Pipe			
Fittings			
Unions			
Valves:			
Ball			
Butterfly			
Balancing			
Check			
Other			
Pipe Specialties:			
Building Penetrations			
Hangers & Supports			
Insulation			

Plbg. Specialties:
- Floor/Roof Drains
- Cleanouts
- Water Hammer Arrestors
- Wall/Yard Hydrants
- Hose Bibbs

Plbg. Fixtures:
- Lavatory
- Faucet
- Flush Valves
- Stop/Supplies
- Showers
- Waste/Trap
- Water Closets
- Urinals

Submit manufacturer's color charts where finish color is specified to be selected by Architect/Engineer.

Shop drawing submittals are to be bound, labeled, contain the project manual cover page and a material index list page showing item designation, manufacturer and additional items supplied with the installation. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Include wiring diagrams of electrically powered equipment.

Firestop Systems:
Contractor shall submit product data for each firestop system. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgement can be based upon.

SPECIFIED MATERIALS AND EQUIPMENT
Design is based on equipment specified by manufacturer and model number as specified on Drawing Schedules. Where certain items are specified by manufacturer or trade name, Contractor's bid shall be based on use of named item. Where one (1) make is described and other makes are listed, comparable models of other named equipment may also be used, provided they meet requirements of Specifications.

When equipment or accessories used differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those on Drawing schedules, Contractor shall be responsible for costs involved in integrating equipment or accessories into system. Contractor shall be responsible for obtaining original design performance from system into which items are placed, regardless of whether manufacturer/model is specified equivalent or substitute.

If Contractor wishes to use items other than those named in Specifications in base bid, request for approval of substitution must be made in writing to A/E at least 14 days prior to opening of bids. Include complete technical and descriptive data with request. If approved, an Addendum will be issued notifying bidders of approval. Request for approval will be considered only if requested by prime bidding Contractor.

EQUIPMENT INSTALLATION
Drawings show general arrangement and location of equipment and appurtenances. It is Contractor’s responsibility to install equipment in a location and manner that allows for proper service and maintenance access to equipment. Work shall generally conform to requirements shown on Drawings. However, location of equipment may require field adjustments to obtain required service space. DO NOT SCALE OFF PLANS to determine proper location of equipment. Because of scale of Drawings, it is not possible to indicate exact routing of piping, and offsets, fittings and accessories required to provide proper service access to equipment. Contractor shall route and install ductwork and piping to provide required service access to equipment.

If, during construction phase of Project, contractor feels inadequate space exists, or equipment locations must be substantially modified to provide proper service and maintenance access, prior to installing equipment, contractor shall notify engineer in writing, outlining general concerns and proposed modifications. Equipment installed without providing manufacturer’s required maintenance and service clearance shall be considered defective. Contractor shall remove and relocate piping, ductwork and equipment, to provide required service clearances at contractor’s expense.

OPERATING AND MAINTENANCE INSTRUCTIONS
Refer to Division 01 of the Project Manual.

Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:

- Copies of all approved shop drawings.
- Manufacturer's wiring diagrams for electrically powered equipment
- Records of tests performed to certify compliance with system requirements
- Certificates of inspection by regulatory agencies
- Parts lists for fixtures, equipment, valves and specialties.
- Manufacturer's installation, operation and maintenance recommendations for fixtures, equipment, valves and specialties.
- Valve schedules
- Lubrication instructions, including list/frequency of lubrication
- Warranties
- Additional information as indicated in the technical specification sections

RECORD DRAWINGS

Refer to Division 01 of the Project Manual.

Maintain Record Drawings on daily basis to be turned over at completion of Project.

TRAINING OF OWNER PERSONNEL

Instruct Owner's personnel in proper operation and maintenance of systems and equipment provided as part of Project, using Operating and Maintenance manuals during instruction. Demonstrate startup and shutdown procedures for equipment. Training shall be during normal working hours.

TESTING

Provide materials, labor, and equipment required for testing.

Notify Inspector(s) one day prior to the time when the test is ready to be performed.

After testing, submit in writing the time, date, name and title of the person approving the test. This shall also include the description and what portion of the system has been tested. The person approving the test shall sign the submittal.

Records shall be maintained of testing that has been completed, and shall be made available at the job site.

Upon completion of the work, records and certifications approving testing requirements shall be submitted.

Defective work or material shall be replaced or repaired, and the test repeated. Repairs shall be made with new materials.

CLEANING

Keep the premises broom clean and free of surplus materials, rubbish and debris.

After fixtures and equipment have been installed, remove stickers, rust stains, labels, and temporary covers.

Foreign matter shall be blown out, or flushed out, of pipes, tanks, pumps, strainers, motors, devices, switches, fixtures, and panels.

Identification plates on equipment shall be free of paint and dirt.

Leave the work in a condition ready for operation.

WARRANTY

Warrant that work shall function for one year immediately following acceptance of the system(s).

Keep the system in good working order at no expense, unless defects are clearly the result of improper or abnormal usage.

Submit for acceptance of the work, written certification that the entire system has been installed and adjusted for operation in accordance with the Contract Documents.

PART 2 – PRODUCTS

ELECTRICAL REQUIREMENTS

General:

Work shall conform to requirements of Division 26.

Power wiring shall be provided by the EC. Control wiring shall be provided by the PC. Plumbing Contractor shall provide wiring diagrams for use by the Electrical Contractor.

ACCESS PANELS AND DOORS

Provide access panels at locations requiring access to mechanical equipment. Locations include, but are not limited to areas above drywall ceilings, shaft enclosures and other furred-in spaces concealing valves, ducts or equipment. Provide UL listed, fire rated access panels when penetrating fire rated chase or shaft areas.

Access panels shall be of size required to provide adequate access to equipment. Minimum size shall be 12 inch by 12 inch for hand access and 24 inch by 24 inch for body access.

Panels shall be Milcor brand or equivalent.

Panels shall include concealed hinges, cam type locking devices, and have frame/border type necessary for particular wall or ceiling construction they are installed. Access panels shall be flush mounted, recessed frame type units. Access panels shall be prime coated steel, able to accept field painting for general applications and stainless steel for use in toilet rooms, shower rooms and similar wet areas.

Refer to Architectural Room Finish Schedule for wall and ceiling surfaces and finishes.

For non-security applications, panel construction shall utilize 16 gauge frame with not less than 18 gauge hinged door panel. Door locks shall be screwdriver operated for panels in general location applications and shall be key locked for public area applications.

PIPE PENETRATIONS

Refer to Division 01 requirements as well as the following.

Fire, Smoke And Fire/Smoke Rated Surfaces:

3M CP 25N/S or CP 25S/L caulk, 3M FS 195 wrap/strip with restricting collar, 3M CS 195 composite sheet, Pipe Shields Inc. Series F fire barrier kits, Proset Systems fire rated floor and wall penetrations, Insta-Foam Products Insta-Fire Seal Firestop Foam or Dow Corning Fire Stop System.

All fire stopping systems shall be provided by the same manufacturer.

UL listed or tested by independent testing laboratory, approved by State and Local Code jurisdictions.

Use product that has a rating not less than rating of wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.

Sleeves in concrete to be Schedule 40 steel pipe with integral water stop unless fire stop material used includes a sleeve that is an integral part of rated assembly.

Use firestop putty, caulk sealant, intumescent wrapstrips, intumescent firestop collars, firestop blocks, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.

Non-Rated Surfaces:

Stamped steel, chrome plated, hinged, split ring escutcheons or floor/ceiling plates for covering openings in occupied spaces.

In exterior wall openings below grade, use modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the un-insulated pipe and cored opening or a water-stop type wall sleeve.

At interior partitions where pipe penetrations are sealed, use Tremco Dymonic, Sika Corp. Sikaflex 1a, Sonneborn Sonolastic NPI, or Mameco Vulken 116 urethane caulk to effect seal. Use galvanized sheet metal sleeves in hollow wall penetrations.

EQUIPMENT, PIPING AND VALVE IDENTIFICATION

Equipment Labels:

After painting and covering, identify equipment, including pumps, tanks, compressors, and control panels. Locate identification conspicuously.

Identification of equipment shall be by engraved white letters on a black 1/16 inch thick plastic laminate panel, beveled edges, screw mounting, permanently attached to the equipment.

Minimum size:
3/4" x 2 1/2" with 3/8" letters.

Manufacturers:
Setonply ® Style 2060 by Seton Name Plate Company or Emedolite Style EIP by EMED Co., or equal by W. H. Brady.

Pipe Identification:
Pipe identification shall conform to ANSI A13.1 "Scheme for Identification of Piping Systems".

Printed labels identifying the fluid conveyed and direction of flow shall be attached to pipes in accessible locations, at intervals not to exceed 20 feet, not less than once in each room, at each branch, adjacent to each access door or panel, at each valve and where exposed piping passes through walls and floors.

Outside Diameter of Pipe Covering	Minimum Size of Letters
up to 1¼"	½"
1½" to 2"	¾"
2½" to 6"	1½"
8" to 10"	2½"
10" and larger	3½"

Manufacturers:
EMED Co., Seton Name Plate Company, or W. H. Brady.

Stencils:
Not less than 1 inch high letters/numbers for marking pipe and equipment.

Valve Tags:
Identify each valve by means of 1½" diameter brass tag fastened to body of valve with copper or brass chain. Identification number shall be stamped thereon with letters a minimum of ½" high. System identification abbreviation shall be stamped with letters a minimum of ¼" high.

The following prefixes shall be used:
PLBG - Plumbing

Manufacturers:
EMED Co., Seton Name Plate Company, or W. H. Brady.

Valve Charts:
Furnish three charts listing each valve. Two charts shall be delivered to A/E. An additional chart shall be framed behind glass and hung in location selected by Owner. Charts shall show the following:

Valve number	Size
Manufacturer	Type of valve
Type of service	Location

Furnish a typewritten chart indicating equipment or areas served by each numbered valve and incorporate in Operating and Maintenance Manuals.

EQUIPMENT ACCESSORIES
Provide equipment accessories, connections, and incidental items.
Install piping connecting to pumps and other equipment without strain at the piping connection. If requested by the A/E, remove the bolts in these flanged connections, or disconnect piping, to demonstrate that piping has been properly connected.

BEDDING AND BACKFILL
Bedding up to a point 12-inches above the top of the pipe shall be thoroughly compacted sand or crushed stone chips meeting the following gradations:

Gradation for Bedding Sand

Sieve Size	% Passing (by Wt)
1 inch	100
No. 16	45 - 80

Gradation for Crushed Stone Chip Bedding

Sieve Size	% Passing (by Wt)
1/2 inch	100
No. 4	75 - 100

No. 200	2 - 10	No. 100	10 - 25

Backfill above the bedding in lawn areas shall be thoroughly compacted excavated material free of large stones, organic, perishable, and frozen materials.

Backfill above the bedding under existing and future utilities, paving, sidewalks, curbs, roads and buildings shall be granular materials, pit run sand, gravel, or crushed stone, free from large stones, organic, perishable, and frozen materials.

PART 3 – EXECUTION

GENERAL

Coordination of Work:

Review the complete set of Drawings and Specifications and report discrepancies to the A/E. Obtain written instructions for changes necessary. Coordinate with each trade prior to beginning installation and make provisions to avoid interferences. Changes required caused by neglect to coordinate shall be made without expense to the project.

Piping shall not be located above electrical panels.

Anchor Bolts, Sleeves, and Supports:

These items required for the Work shall be furnished by the FPC for proper installation of his work. They shall be installed (except as otherwise specified) by the trade furnishing and installing the material in which they are to be located. Location of anchor bolts, sleeves, inserts and supports shall be directed by the trade requiring them. Expense resulting from the improper location or installation of anchor bolts, sleeves, inserts and supports shall be paid for by the Contractor for the trade with responsibility for directing their proper location.

Adjustments In Locations:

Locations of pipes and equipment, shall be adjusted to accommodate the work interferences anticipated and encountered. Prior to fabrication determine the exact route and location of each pipe (subject to A/E's approval).

Right Of Way:

New lines which pitch shall have the right-of-way over those which do not pitch. For example: Gravity drains shall normally have right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed. Notify A/E and other trades of conflicts.

Offsets, transitions and changes in direction of electrical raceways, pipes, and ducts shall be made to maintain proper room and pitch of sloping lines whether or not indicated on the Drawings.

DEMOLITION

Perform all demolition as indicated on the drawings to accomplish new work. Where demolition work is to be performed adjacent to existing work that remains in an occupied area, construct temporary dust partition to minimize the amount of contamination of the occupied space. Where pipe is removed and not reconnected with new work, cap ends of existing services as if they were new work. Coordinate work with the Owner to minimize disruption to the existing building occupants.

All pipe, fixtures, equipment, wiring, associated conduit and similar items demolished, abandoned, or deactivated are to be removed from the site by the Contractor except as specifically noted otherwise. All designated equipment is to be turned over to the Owner for his use at a place and time he so designates. Maintain the condition of material and/or equipment that is indicated to be reused equal to that existing before work began.

EXCAVATION AND BACKFILL

Install lines passing under foundations with minimum of 1-1/2 inch clearance to concrete and insure no disturbance of bearing soil.

Before burying piping, mark up Record Drawings and dimensionally locate piping. Deliver information to A/E Field Representative.

Unless otherwise specifically indicated on Drawings, trenches for utilities shall be of depth that provides the following minimum depths of cover from existing grade or from indicated finish grade, whichever is lower:

Storm and sanitary sewers:
As described in DPS 382.30 (11) (b). Provide insulation for sewers installed at less than minimum depth.

Water service and/or fire service piping:
The top of pipe shall be installed not less than six (6) feet below grade.

Existing utility lines to be retained shown on Drawings or locations of which are made known to Contractor prior to excavation, as well as utility lines uncovered during excavation operations, shall be protected from damage during excavation and backfilling and if damaged, shall be repaired by Contractor at his expense.

Perform excavation and backfill work to accomplish indicated mechanical systems installation in accordance with Section *312000 – Earth Moving***.**

DEWATERING

Provide, operate and maintain all pumps and other equipment necessary to drain and keep all excavation pits, trenches and the entire subgrade area free from water under all circumstances. Obtain general permit from the Wisconsin Department of Natural Resources district office for discharge of construction dewatering effluent. Obtain well permit from the Wisconsin Department of Natural Resources district office for dewatering wells discharging more than 70 GPM. Comply with permit requirements.

ROCK EXCAVATION

Remove rock encountered in the excavation to a minimum dimension of six (6) inches outside the pipe. Rock excavation includes all hard, solid rock in ledges, bedded deposits and unstratified masses, all natural conglomerate deposits so firmly cemented as to present all the characteristics of solid rock; which material is so hard or so firmly cemented that in the opinion of the Engineer it is not practical to excavate and remove same with a power shovel except after thorough and continuous drilling and blasting. Rock excavation includes rock boulders of 1/2 cubic yard or more in volume.

Rock excavation will be computed on the basis of the depth of rock removed and a trench width two (2) feet larger than the outside diameter of the pipe where one (1) pipe is laid in the trench and three (3) feet larger than the combined outside diameter where two (2) pipes are laid in the trench. Include 6 inch pipe and structure bedding in rock excavation. Include rock excavation shown on the plans in the Base Bid.

SURFACE RESTORATION

Completely restore the surface of all disturbed areas to a like condition of the surface prior to the work. Level off all waste disposal areas and clean up all areas used for the storage of materials or the temporary deposit of excavated earth. Remove all surplus material, tools and equipment.

CONCRETE WORK

Cast-in-place concrete within the building will be performed by the Division 03 Contractor unless otherwise noted. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for support or installation of plumbing piping, fixtures, specialties and equipment. Coordinate locations of equipment, pipe penetrations in wet areas, etc. with the Division 03 Contractor.

Plumbing related cast-in-place concrete on the exterior of the building to be provided by this Contractor in conformance with requirements of Division 03. This includes piping thrust restraints, pipe supports, hydrant supports, manholes, catch basins, grease traps, septic tanks, distribution boxes, valve pits, meter pits, cleanout cover pads, yard hydrant pads, etc.

OPENINGS, CUTTING AND PATCHING

Refer to Division 01 of the Project Manual.

Provisions for openings including chases, holes and clearances through walls, floors, and roof, ceilings and partitions shall be made in advance of construction of each part of the building. Openings shall be provided by the GC for the respective materials in which openings occur, during the construction of the building with the exception of pipe sleeves. The PC shall furnish to the GC opening dimensions and locations.

If the PC neglects to inform the GC of his opening requirements before that portion of the building construction is complete, the PC shall cut the openings and provide framing and lintels. In the event holes must be cut through reinforced concrete, avoid spalling and unnecessary damage or weakening of structural members. No chopping or breaking out is permitted. Before cutting or drilling, obtain permission from the A/E. Patch adjacent materials and repair damage resulting from the cutting.

The PC may perform core drilling for openings in existing walls and floors at the direction of the A/E. Framed openings shall be by the GC.

Patch interior trench excavation to match existing slab-on-grade with concrete: 3500 PSI at 28 days, 3" slump, 3/4" maximum aggregate size, 5.5 bags of cement per cubic yard.

BUILDING ACCESS
Arrange for necessary openings in building to allow for admittance of all apparatus. When building access was not previously arranged and must be provided by Contractor, restore opening to original condition after the apparatus has been brought into building. Coordinate with Architect/Engineer.

EQUIPMENT ACCESS
Install piping, conduit, fixtures, and accessories to permit access to equipment for maintenance. Coordinate exact location of wall and ceiling access panels and doors with General Contractor, making sure access is available for equipment and specialties. Where access is required in plaster walls or ceilings, furnish and install access doors required. Coordinate for installation of access doors utilizing General Contractor and other appropriate on-site subcontractor for access door installation.

Accessible ceilings, (i.e. lay-in ceilings) do not require access panels. Provide color coded thumb tacks or screws, depending on surface, for use in accessible ceilings.

COORDINATION OF WORK
Install systems, equipment and piping in cooperation with other trades. Locations of pipes, equipment, fixtures, etc., shall be adjusted to accommodate the work interferences anticipated and encountered. Prior to fabrication determine the exact route and location of each pipe (subject to A/E's approval).

Any work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

Verify that all devices are compatible for the type of construction and surfaces on which they will be used.

Offsets, transitions and changes in direction of electrical raceways, pipes and ducts shall be made as required to maintain proper room and pitch of sloping lines whether or not indicated on the Drawings. Furnish and install all traps, air vents, sanitary vents, etc., as required to effect the offsets, transitions and changes in direction.

New lines which pitch shall have the right-of-way over those which do not pitch. For example: Gravity drains shall normally have right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed. Notify A/E and other trades of any conflicts.

Provide appropriate sections of work with required wall, roof and floor opening locations and dimensions. If Contractor neglects to coordinate information, openings shall be the responsibility of Contractor.

PIPING INSTALLATION
General:
Expansion and contraction of piping shall be provided for by expansion loops, bends, swing joints, or expansion joints to prevent damage to connections, piping, equipment of the building.

Unions or flanges shall be installed on all by-passes, ahead of all traps, adjacent to screw connection valves, and at all connections to equipment, whether or not shown on drawings.

Installation Arrangement:
Install all Work to permit removal (without damage to other parts) of all parts requiring periodic replacement or maintenance. Arrange pipes and equipment to permit ready access to valves, cocks, traps, starters, motors, control components and to clear the openings of swinging and overhead doors and of access panels.

Connections Different From Those Shown:
Where equipment requiring different arrangement or connections from those shown is used, install the equipment to operate properly and in harmony with the intent of the Drawings and Specifications. When requested by the A/E, submit drawings showing the proposed installation.

If the proposed installation is approved, make all incidental changes in piping, ductwork, supports, insulation, wiring, panelboards, etc. Provide any additional motors, controllers, valves, fittings and other additional equipment required for the proper operation of the system resulting from the selection of equipment, including all required changes in affected trades. The Contractor shall be responsible for the proper location of rough-in and connections by other trades.

All changes shall be made at no increase in the Contract amount or additional cost to the other trades.

LUBRICATION AND MAINTENANCE
Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any reason. Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions until the work is

accepted by the Owner. Maintain a log of all lubricants used and frequency of lubrication; include this information in the Operating and Maintenance Manuals at the completion of the project.

SLEEVES

Provide galvanized sheet metal sleeves for pipe penetrations through interior and exterior walls to provide a backing for sealant or firestopping. Patch wall around sleeve to match adjacent wall construction and finish. Grout area around sleeve in masonry construction. In finished spaces where pipe penetration through wall is exposed to view, sheet metal sleeve shall be installed flush with face of wall. In existing poured concrete walls where penetration is core drilled, pipe sleeve is not required.

Pipe sleeves are not required in existing poured concrete walls where penetrations are core drilled.

Pipe sleeves in new poured concrete construction shall be schedule 40 steel pipe (sized to allow insulated pipe to run through sleeve), cast in place.

In all piping floor penetrations, fire rated and non-fire rated, top of sleeve shall extend 1 inch above the adjacent finished floor. In existing floor penetrations, core drill sleeve opening large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting, non-shrink grout. If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve that will transfer weight to existing floor structure.

For floor penetrations through existing floors in mechanical and wet locations listed below, core drill opening and provide 1-1/2" x 1-1/2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from entering the penetration. Provide urethane caulk between angles and floor and fasten angles to floor a minimum of 8" on center. Seal corners watertight with urethane caulk. Or, core drill sleeve openings large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting non-shrink grout/cement.

For pipe penetrations through existing floors in food service areas, core drill sleeve opening large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting non-shrink grout/cement. Size sleeve to allow insulated pipe to pass through sleeve and paint the sleeve.

Pipe sleeves are not required in cored floor pipe penetrations through existing floors that are not located in mechanical rooms, food service areas or wet locations listed above.

PIPE PENETRATIONS

General:

Coordinate location of building surface penetrations with appropriate contractors. Furnish sleeves, inserts, and devices to be built into structure to contractor performing Work. Prepare Shop Drawings for approval for penetrations of structural elements, including floor slabs, shear walls, and bearing walls. Do not allow penetrations to be made until Shop Drawings are approved.

Fire Rated Surfaces:

Install products in accordance with the manufacturer's instructions where pipe penetrates a fire rated surface. When pipe is insulated, use product that maintains integrity of insulation and vapor barrier. Where sleeve must be installed in existing floor, grout area around sleeve to restore floor integrity. In wet area floor penetration, top surface of penetration to be 2 inches above adjacent floor with additional height obtained by means of concrete pad poured integral with floor.

Non-Rated Surfaces:

Install escutcheons or floor/ceiling plates where pipe penetrates non-fire rated surfaces in occupied spaces. Size units to accommodate insulation, where applicable. Escutcheons are not required when insulation completely covers wall opening and insulation end is trimmed in a neat manner. Occupied spaces for this Paragraph include only those rooms with finished ceilings and penetration occurs below ceiling.

In exterior wall openings below grade, place water-stop type wall sleeve before concrete pour or core drill opening after pour. Assemble rubber links to proper size for pipe and tighten in place in accordance with manufacturer's instructions.

Install galvanized sheet metal sleeve in hollow wall penetrations to provide backing for sealant. Apply sealant to both sides of penetration in a manner that annular space between pipe sleeve and pipe or insulation is completely blocked.

Completely seal (or caulk) around pipe penetrations through non-rated, smoke tight corridor walls in healthcare facilities. Refer to architectural drawings for additional information.

ESCUTCHEON PLATES

Provide plates on pipes passing through finished floors, walls and ceilings, with outside diameter to cover sleeve opening and inside diameter to fit snugly around pipe. Set tight to building surface. Escutcheon plates shall be chromium plated metal.

PAINTING

Refer to Division 09.

All exposed steel support structures (all metal surfaces located both inside and outside the building) shall be painted after installation with one coat of a compatible metal primer coat and two coats of a finish coat of paint for the application. Color shall be gray unless otherwise specified.

Exposed piping (uninsulated piping located inside the building) shall be painted after installation with 1 coat of compatible metal primer coat and 2 coats of finish coat of paint for application.

Coordinate paint color with architect.

Piping systems shall be clearly identified after painting with pipe markings specified under the Paragraph titled Identification under this Section.

IDENTIFICATION

Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion.

Where stenciling is not appropriate for equipment identification, engraved name plates may be used.

Identify interior piping not less than once every 30 feet, not less than once in each room, adjacent to each access door or panel, and on both side of the partition where accessible piping passes through walls or floors. Place flow directional arrows at each pipe identification location. Use one coat of black enamel against a light background or white enamel against a dark background.

Identify all exterior buried piping for entire length with underground warning tape except for sewer piping which is routed in straight lines between manholes or cleanouts. Place tape 6"-12" below finished grade along entire length of pipe. Extend tape to surface at building entrances, meters, hydrants and valves. Where existing underground warning tape is broken during excavation, replace with new tape identifying appropriate service and securely spliced to ends of existing tape.

Identify valves with brass tags bearing a system identification and a valve sequence number. Identify medical gas and vacuum valves with brass tags and wall or cabinet mounted color coded engraved nameplate with the following "(Type of Gas) Shutoff Valve for (Location or Zone)". Valve tags are not required at a terminal device unless the valves are greater than ten feet from the device, located in another room or not visible from device. Provide a typewritten valve schedule and pipe identification schedule indicating the valve number and the equipment or areas supplied by each valve and the symbols used for pipe identification; locate schedules in mechanical room and in each Operating and Maintenance manual. Schedule in mechanical room to be framed under clear plastic.

END OF SECTION

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SECTION 22 05 14
PLUMBING SPECIALTIES

PART 1 - GENERAL

SCOPE

This section includes specifications for backflow preventers, hose bibs, water hammer arrestors and other miscellaneous plumbing specialties. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference Standards
- Quality Assurance
- Submittals

PART 2 - PRODUCTS
- General
- Hose Bibbs/Wall Hydrants

PART 2 - EXECUTION
- Installation

RELATED WORK

Requirements of Division 01 shall govern work under this Section.

Section 22 05 00 – Common Work Results for Plumbing
Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
Section 22 07 00 – Plumbing Insulation
Section 22 11 00 – Facility Water Distribution
Section 22 13 00 – Facility Sanitary Sewerage
Section 22 14 00 – Facility Storm Drainage
Section 22 30 00 – Plumbing Equipment
Section 22 40 00 – Plumbing Fixtures

REFERENCE STANDARDS

ANSI A112.14.1 - Backwater Valves
ANSI A112.26.1/PDI WH-201 - Water Hammer Arrestors.
ASSE 1001 - Pipe Applied Atmospheric Type Vacuum Breakers.
ASSE 1010 - Water Hammer Arrestors.
ASSE 1011 - Hose Connection Vacuum Breakers.
ASSE 1012 - Backflow Preventers with Intermediate Atmospheric Vent.
ASSE 1013 - Reduced Pressure Principle Backflow Preventers.
ASSE 1018 - Trap Seal Primer Valves.
ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining, Anti-Backflow Type.

QUALITY ASSURANCE

Substitution of Materials: Refer to Section 22 05 00 and Division 01 of the Project Manual.

Plumbing products requiring approval by the State of Wisconsin Dept. of Safety and Professional Services must be approved or have pending approval at the time of shop drawing submission.

SUBMITTALS

Submit product data sheets in accordance with Division 01 and Section 22 05 00.

Submit and pay all fees to State of Wisconsin for reduced pressure zone backflow prevention device review. Submit State approval of reduced pressure zone backflow prevention device with product data sheets in accordance with Division 01 and Section 22 05 00.

PART 2 - PRODUCTS

GENERAL
Refer to Plumbing Equipment Schedule for specific model numbers and sizing information regarding the plumbing fittings and specialties specified herein.

BACKFLOW PREVENTION DEVICES
Acceptable Manufacturers:
Cash-Acme, Chicago, Cla-Val, Conbraco, Febco, Nidel, Watts, Wilkins, or Woodford.

Vacuum Breakers:
For use in finished areas with concealed piping, brass construction, chromium plated, Chicago Faucet No. 892-G (½").

For exposed piping in unfinished areas, brass construction, Watts series 288A.

Hose thread inlet and outlet, non-removable hose connection, vacuum breaker for use on service sink faucets, Chicago Faucet No. E27, ¾ inch.

HOSE BIBBS/WALL HYDRANTS
Hose bibbs and wall hydrants shall be manufactured by Chicago Faucet, MIFAB, Woodford, or Zurn.

PART 3 - EXECUTION

INSTALLATION
Hose Bibbs/Wall Hydrants:
Install 24 inches above finished grade or floor.

END OF SECTION

SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

SCOPE

This section includes specifications for supports of all plumbing equipment and materials as well as piping system anchors. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference Standards
- Quality Assurance
- Design Criteria
- Submittals

PART 2 - PRODUCTS
- Manufacturers
- Pipe Hangers and Supports
- Pipe Hanger Rods
- Beam Clamps
- Riser Clamps
- Concrete Inserts
- Anchors
- Equipment Support

PART 3 - EXECUTION
- Installation
- Structural Supports
- Hanger and Support Spacing
- Riser Clamps
- Concrete Inserts
- Anchors

RELATED WORK

Applicable provisions of Division 01 shall govern work under this section.

Section 22 05 00 – Common Work Results for Plumbing
Section 22 07 00 – Plumbing Insulation
Section 22 11 00 – Facility Water Distribution
Section 22 13 00 – Facility Sanitary Sewerage
Section 22 14 00 – Facility Storm Drainage
Section 22 40 00 – Plumbing Fixtures

REFERENCE STANDARDS

MSS SP-58
MSS SP-69

QUALITY ASSURANCE

Refer to Division 01, of the Project Manual.

DESIGN CRITERIA

Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 and SP-69 unless noted otherwise.

Piping connected to pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.

Do not hang any mechanical item directly from a metal deck or run piping so its rests on the bottom chord of any truss or joist.

General:
Secure pipe in place to prevent vibration, maintain proper slope and provide for expansion and contraction.

Design supports of strength and rigidity to suit loading, service, and manner which do not unduly stress the building construction. Where support is from concrete construction, take care not to weaken concrete or penetrate waterproofing. Fasten supports and hangers to building steel framing wherever practical. Do not use another pipe for support. Do not use perforated iron, chain or wire as hangers.

Use inserts for suspending hangers from reinforced concrete slabs wherever practical. Where inserts are not practical, provide channels or angles from which to suspend hangers/supports. Fasten structural steel to concrete with expansion bolts.

Provide expansion anchors in concrete slabs for installation of threaded support rods.

Provide hangers capable of vertical adjustment after piping is erected. Do not pierce ductwork with hanger rods. On threaded support rods and bolts, weld nuts to rods, peen threads, or provide double set of nuts with lock washers to prevent loosening. Use beam clamps for attaching hangers to structural steel.

On piping insulated with vapor barrier covering, use protection shield to cover bottom one-half of insulated pipe. Shield to be a minimum of 12" long and of 16 gauge galvanized steel.

Exception:
For insulated drain pipe, the pipe may rest on the hanger and the insulation to wrap around the hanger and pipe.

Submit anchor drawings for approval upon request.

Hangers, supports, and support methods other than those specified shall not be used without obtaining approval on method of support by the Structural Engineer prior to installing piping systems. Submit support method arrangement, pipe weight and spacing scheme for approval.

Hanger and Support Spacing:
Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

Place a hanger within 12 inches of each horizontal elbow, valve, strainer, or similar piping specialty item.

Use hangers with 1-1/2 inch minimum vertical adjustment.

Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.

Support riser piping independently of connected horizontal piping.

Adjust hangers to obtain the slope specified in the piping section of these specifications.

Space hangers for pipe as follows:

Pipe Material	Pipe Size	Max. Horiz. Spacing	Max. Vert. Spacing
Cast Iron	2" and larger	5'-0"	15'-0"
Copper	1/2" through 3/4"	5'-0"	10'-0"
Copper	1" through 1-1/4"	6'-0"	10'-0"
Copper	1-1/2" through 2-1/2"	8'-0"	10'-0"
Copper	3"	10'-0"	10'-0"
Copper	4" and larger	12'-0"	10'-0"
Ductile Iron	All	10'-0"	20'-0"
Glass	Per Pipe Mfr.	8'-0"	12'-0"
Steel	1/2" through 1-1/4"	7'-0"	15'-0"
Steel	1-1/2" through 6"	10'-0"	15'-0"
Steel	8" through 12"	14'-0"	20'-0"
Steel	14" and over	20'-0"	20'-0"
Plastic	Drain and Vent	4'-0"	10'-0"
Plastic	1" or less	32"	4'-0"
Plastic	1-1/4" and over	4'-0"	6'-0"
Plastic	Pure Water 1-1/2” or less	Continuous	5’-0”

SUBMITTALS
Submit data in accordance with Section 22 05 00 and Division 01 of the Project Manual.

Schedule of all hanger and support devices indicating attachment methods and type of device for each pipe size and type of service.

Submit anchor drawings to the A/E for approval upon request.

PART 2 - PRODUCTS

MANUFACTURERS
B-Line, Fee and Mason, Grinnell, Michigan Hanger, Pate, PHD Manufacturing, Piping Technology, Powers/Rawl, Proset, Roof Products & Systems, Unistrut, or Victaulic.

PIPE HANGERS AND SUPPORTS
Overhead Supports:
Adjustable clevis hanger, steel, Dura-Green epoxy coating or electro-plated, B-Line Figure B3100.

Adjustable J hook hanger, steel, Dura-Green epoxy coating or electro-plated, B-Line figure B3690.

Adjustable band hanger, steel, Dura-Green epoxy coating or electro-plated, B-Line Figure B3172.
Multiple or Trapeze Hangers:
Where several pipes are running parallel and pitching in the same direction, strut style support may be used. Steel channel, 12-gauge thickness, Dura-Green epoxy coating or electro-plated, B-Line B11. Restrain individual pipes with B-Line B2000 series or Vibraclamp series strut clamps.

Wall Support:
Carbon steel welded bracket with hanger. B-Line 3068 Series, Grinnell 194 Series.

Perforated, epoxy painted finish, 16-12 gauge, min., steel channels securely anchored to wall structure, with interlocking, split-type, bolt secured, galvanized pipe/tubing clamps. B-Line type S channel with B-2000 series clamps, Grinnell type PS 200 H with PS 1200 clamps.

When copper piping is being supported, provide flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Grinnell PS 1400 series.

Vertical Support:
Riser clamp, steel, Dura-Green epoxy coating or electro-plated, B-Line Figure B3373.

Riser clamp, flexible sleeve with stainless steel band, Proset PS #33.

Floor Support:
Carbon steel pipe saddle, stand and bolted floor flange. B-Line B3088T/B3093.

Copper Pipe Supports:
All supports, fasteners, clamps, etc. directly connected to copper piping shall be copper plated or polyvinylchloride coated. Where steel channels are used, provide isolation collar between supports/clamps/fasteners and copper piping.

PIPE HANGER RODS
Steel Hanger Rods:
Steel, electro-plated, threaded both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts. B-Line B3205.

Size rods for individual hangers and trapeze support as indicated in the following schedule:

Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed the limits indicated.

Maximum Load (Lbs.) (650°F Maximum Temp.)	Rod Diameter (inches)
610	3/8
1130	1/2

1810	5/8
2710	3/4
3770	7/8
4960	1
8000	1-1/4

BEAM CLAMPS
MSS SP-69 Types 19 & 23 malleable black iron clamp for attachment to beam flange to 0.62 inches thick with a retaining ring and threaded rod of 3/8, 1/2, and 5/8 inch diameter. Furnish with a hardened steel cup point set screw. B-Line B3036L/B3034, Grinnell 86/92.

MSS SP-69 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2 inch diameter. B-Line B3054, Grinnell 228.

CONCRETE INSERTS
Poured in Place:
MSS SP-69 Type 18 wedge type to be constructed of a black carbon steel body with a removable malleable iron nut that accepts threaded rod to 7/8 inch diameter. Wedge design to allow the insert to be held by concrete in compression to maximize the load carrying capacity. B-Line B2505, Grinnell 281.

MSS SP-69 Type 18 universal type to be constructed of black malleable iron body with a removeable malleable iron nut that accepts threaded rod to 7/8 inch diameter. B-Line B3014N, Grinnell 282.

Mechanical-Expansion Anchors:
Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Zinc-coated or stainless steel expansion anchors. Use drill bit of same manufacturer as anchor.

Manufactured By:
Hilti, ITW/Read Head, or equal.

ANCHORS
Use welding steel shapes, plates, and bars to secure piping to the structure.

EQUIPMENT SUPPORT
Examine Drawings, and manufacturer's data to determine how equipment, fixtures, and piping are to be supported, mounted or suspended. Support all equipment plumb, rigid, and true to line. Provide rods, bolts, inserts, pipe stands, brackets and accessories for proper support.

Equipment Stands:
Use structural steel members welded to and supported by pipe supports. Clean, prime and coat with three coat rust inhibiting alkyd paint or one coat epoxy mastic. Where exposed to weather, treat with corrosive atmosphere coatings.

CORROSIVE ATMOSPHERE COATINGS
Factory coat supports and anchors used in corrosive atmospheres with hot dip galvanizing after fabrication, ASTM A123, 1.5 ounces/square foot of surface each side. Mechanical galvanize threaded products, ASTM B695 Class 50, 2.0 mil coating. Field cuts and damaged finishes to be field covered with zinc rich paint of comparable thickness to factory coating.

Corrosive atmospheres include the following locations:
- Locker rooms

PART 3 - EXECUTION

INSTALLATION
Size, apply and install supports and anchors in compliance with manufacturers recommendations.

Install supports to provide for free expansion of the piping system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.

Coordinate hanger and support installation to properly group piping of all trades.

Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes or continuous insert channels for the supporting steel. Where continuous insert channels are used, pipe supporting devices made specifically for use with the channels may be substituted for the specified supporting devices provided that similar types are used and all data is submitted for prior approval.

Size and install hangers and supports, except for riser clamps, for installation on the exterior of piping insulation. Where a vapor barrier is not required, hangers may be installed either on the exterior of pipe insulation or directly on piping.

Perform welding in accordance with standards of the American Welding Society.

STRUCTURAL SUPPORTS

Provide all supporting steel required for the installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspended or floor supported tanks and equipment. All of this steel may not be specifically indicated on the drawings.

RISER CLAMPS

Support vertical piping with clamps secured to the piping and resting on the building structure or secured to the building structure below at each floor.

CONCRETE INSERTS

Select size based on the manufacturer's stated load capacity and weight of material that will be supported. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inch size. Where concrete slabs form finished ceiling, provide inserts that are flush with the slab surface.

ANCHORS

Install where indicated on the drawings and details. Where not specifically indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

END OF SECTION

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SECTION 22 07 00
PLUMBING INSULATION

PART 1 - GENERAL

SCOPE

This Section includes insulation specifications for plumbing systems. Included are the following requirements:

PART 1 – GENERAL
- Scope
- Related Work
- Description
- Quality Assurance
- Definitions
- Submittals

PART 2 – PRODUCTS
- Acceptable Manufacturers
- Insulation and Jackets
- Plenum Wrap

PART 3 - EXECUTION
- General
- Installation
- Pipe Insulation Schedule

RELATED WORK

Requirements of Division 01 shall govern work under this Section.

Section 22 05 00 - Common Work Results for Plumbing
Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
Section 22 11 00 - Facility Water Distribution
Section 22 13 00 - Facility Sanitary Sewerage
Section 22 14 00 - Facility Storm Drainage

DESCRIPTION

Furnish and install insulating materials, fittings, finishes, and accessories specified for piping and related equipment. The following types of insulation are specified in this Section:

- Pipe insulation

Install insulation materials in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions. Exceptions to these standards will only be accepted where specifically modified in these Specifications, or where prior written approval has been obtained from Engineer.

QUALITY ASSURANCE

Substitution of Materials: Refer to Section 22 05 00 and Division 01 of the Project Manual.

Label insulating products delivered to construction site with the manufacturer's name and description of materials.

DEFINITIONS

Concealed:

Shafts, furred spaces, space above finished ceilings, utility tunnels and crawl spaces. Other areas, including walk-through tunnels, shall be considered as exposed.

Exposed to weather:

Located outdoors, either on grade, on a wall, or on a roof, in location where sun, wind, rain, snow and other elements will come in contact with it.

Unconditioned spaces:

Unheated or non-cooled attics, utility tunnels and crawl spaces where ambient temperatures may rise above 90 degrees F or drop below 50 Degrees F. Ducts in these instances are considered to be located outside of building thermal envelope.

SUBMITTALS

Submit data in accordance with Section 22 05 00 and Division 01 of the Project Manual

Include manufacturer's data for the following:

- Pipe insulation

Submittal shall include the following information:

Manufacturer's technical data sheets for each product with the following information:

- Density
- Thermal characteristics
- Temperature limitations
- Jacket type
- Materials of composition
- Material safety data sheets

Schedule of all insulating materials to be used including:

- Application / intended use of each insulation type
- Insulation type and thickness
- Jacket type
- Fastening methods and adhesive type

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS

Armstrong, Halstead, Johns-Manville, Knauf, or Owens-Corning.

INSULATION AND JACKETS

Glass Fiber:

Manville Micro-Lok meeting ASTM C547; rigid molded, non-combustible, "K" Value: 0.23 at 75°F, maximum service temperature: 850°F, with vapor Retarder Jacket: AP-T Plus White Kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self-sealing longitudinal laps and butt strips or AP Jacket with outward clinch expanding staples or vapor barrier mastic as needed.

PVC Fitting Covers and Jackets:

White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation. Jacket thickness to be .02 inch (20 mil).

PART 3 - EXECUTION

GENERAL

Application of insulation to piping equipment shall be done in accordance with the manufacturer's installation recommendations. Where thickness of insulation is not specified, use thickness recommended by manufacturer or required by applicable Codes.

Insulation shall be applied in as warm an environment as possible, and in no instance below 25° F.

No pipe shall be covered until after it has been installed, inspected, tested, and approved.

INSTALLATION

All pipe insulation shall be installed with joints butted firmly together. All valves and fittings shall be insulated with mitered sections of insulation equal in density and thickness to the adjoining insulation, or with insulating cement equal in thickness to the adjoining insulation, or with "Zeston" type, premolded PVC fittings installed in accordance with the manufacturer's instructions. Fittings are to be finished with 8 oz. glass mesh and mastic (use breather mastic on systems operating above 50°F except where Zeston PVC covers are used). Jackets on pipe insulation may be stapled using outward clinch staples spaced 3" apart at least ¼" in from the lap edge on systems operating at 60°F and above; below 60°F the laps are to be vapor sealed using self-sealing lap, lap-seal tape gun or adhesive such as Armstrong 520. All insulation ends are to be tapered and sealed regardless of service.

On all piping insulated with vapor barrier covering, use protection shield to over bottom one-half of insulated pipe. Shield to be minimum of 12" long and 16 gauge galvanized steel. Provide half-round, 12" long, hanger block at the bottom half of the pipe in place of the fiberglass pipe insulation. The hanger blocks shall be molded cork or calcium silicate pipe insulation of the same thickness as the adjoining fiberglass pipe insulation. The vapor barrier jacket shall be continuous through the hanger location.

Vapor barrier jackets shall be applied with a continuous, unbroken vapor seal. Pipe hangers shall be sized large enough to be installed over the outer surfaces of the insulation.

Exception:
For insulated drain pipe, the pipe may rest directly on the hanger and the insulation to wrap around the hanger and pipe.

Provide a complete vapor barrier for insulation on the following systems:

- Cold hard water
- Cold soft water
- Non-potable cold soft water
- Storm drainage
- Clearwater waste drainage

Omit insulation for:

- Unions and flanges.
- Vents to atmosphere, discharges from safety and relief valves and drain pipes.

Provide finished edges at all access doors and end.

PIPE INSULATION SCHEDULE
Provide insulation on new and remodeled piping.

Minimum Insulation Thickness:

	PIPE SIZE			
SYSTEMS	**1" or less**	**1-1/4" to 2"**	**2-1/2" to 4"**	**5" and up**
Storm Drain*	---	---	1"	1"
Clearwater Waste*	---	1"	1"	1"
Domestic Cold Water	1/2"	1/2"	1"	1"
Domestic Hot Water	1"	1"	1-1/2"	1-1/2"
Domestic Hot Water Return	1"	1"	1-1/2"	---
Non-Potable Cold Water	1/2"	1/2"	1"	---
Non-Potable Hot Water	1"	1"	1-1/2"	---

* Provide pipe insulation on above ground horizontal storm and clearwater drain piping, underside of roof drain, and initial 5 feet of vertical conductors.

END OF SECTION

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SECTION 22 11 00
FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

SCOPE

This section contains specifications for plumbing pipe and pipe fittings for this project. Included are the following topics:

PART 1 – GENERAL
- Scope
- Related Work
- Description
- Quality Assurance
- Submittals

PART 2 – PRODUCTS
- Water Distribution Pipe and Fittings
- Valves
- Unions and Flanges
- Dielectric Couplings
- Water Hammer Suppressors

PART 3 – EXECUTION
- Trenching, Backfilling and Compacting
- Water Piping System
- Testing

RELATED WORK

Requirements of Division 01 shall govern work under this Section.

22 05 00 – Common Work Results for Plumbing
22 05 14 – Plumbing Specialties
22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

DESCRIPTION

Provide a domestic water distribution system including hot and cold water supply piping, hot water return piping, tempered water piping, pure water piping, valves, fittings, hardware, and specialties. Connect to plumbing fixtures, specialties, and equipment.

QUALITY ASSURANCE

Substitution of Materials: Refer to Section 22 05 00 and Division 01 of the Project Manual.

Order all pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.

Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

SUBMITTALS

Submit valve product data sheets in accordance with Section 22 05 00 and Division 01 of the Project Manual.

Include materials of construction, dimensional data, ratings/capacities/ranges, approvals, test data, and identification as referenced in this section and/or on the drawings.

PART 2 - PRODUCTS

WATER DISTRIBUTION PIPE AND FITTINGS

Under Ground:

2" and Smaller:

Copper tube, type K, soft temper, ASTM B88, with wrought copper fittings. ANSI B16.22. Join using lead free flux and solder, ASTM B32, flux ASTM B813.

Plastic, 80% Engel minimum Cross-linked Polyethylene ("PEX") pipe, type PEX-a only, ASTM F876, ASTM F877, 100 psi pressure rating at 180°F, ASTM F1960 cold expansion polymer or lead-free brass/bronze fittings from same manufacturer as pipe, all rated for potable water NSF/ANSI 61. Bronze/brass fittings shall be used when adapting from PEX to metallic piping. Approved manufacturers: Rehau, Sioux Chief, and Uponor.

Above Ground:

Copper tube, Type L, hard temper, ASTM B88; with wrought copper fittings, ANSI B16.22. Join using lead free flux, ASTM B813, and solder, ASTM B32.

Wrought copper, ANSI B16.22 or cast bronze, ANSI B16.18 fittings, copper tube dimensioned grooved ends (flaring of tube and fitting ends to IPS dimensions is not permitted), joined with mechanical couplings, synthetic rubber gasket seal, Victaulic style 607 QuickVic™ Installation Ready stab-on design, for direct 'stab' installation onto roll grooved copper tube without prior field disassembly and no loose parts.

VALVES

Manufacturer:

Valves throughout the project shall be by one manufacturer, unless otherwise specified.

Standard valves are based on Nibco models. Equivalent style valves as manufactured by Apollo, Crane, DeZurik, Gustin-Bacon, Grinnell, Hammond, Jenkins, Lunkenheimer, Milwaukee Valve, Stockham, Victaulic, or Watts are acceptable. Valves shall be of standard dimensions, comparable to the number specified.

Balancing valves are based on Bell & Gossett models. Equivalent style valves by Armstrong, Flowset, Nibco, Taco, or Victaulic/TA Hydronics are acceptable.

Shutoff Valves:

Except as otherwise specified, all shutoff valves 2-1/2 inch and smaller shall be ball valves and shutoff valves 3 inch and larger shall be butterfly valves, unless required otherwise by local Water Utility specifications.

Ball Valves:

Bronze, two piece full port ball valves with bronze body, solder or threaded ends, chromium plated brass or stainless steel ball, reinforced Teflon seats and seals, blowout proof stem design, rated at 600 PSI non-shock WOG, Nibco model T/S-585-70. Include handle extension for insulated piping, NIB-SEAL by Nibco.

Bronze, two piece full port ball valves with bronze body, solder or threaded ends, stainless steel ball, reinforced Teflon seats and seals, blowout proof stem design, rated at 600 PSI non-shock WOG, Nibco model T/S-585-70-66. Include handle extension for insulated piping, NIB-SEAL by Nibco.

Bronze, three piece full port ball valves with bronze body, solder or threaded ends, stainless steel ball, reinforced Teflon seats and seals, blowout proof stem design, rated at 600 PSI non-shock WOG, Nibco model T/S-595-66. Include handle extension for insulated piping, NIB-SEAL by Nibco.

Butterfly Valves:

Ductile iron butterfly valve, polymid coated, EPDM elastomer coated disc, extended neck, grooved ends, 300 psi WOG pressure rated, Nibco GD 4765. Include lever handle through 6-inch size and gear operator for 8 inch and larger size.

Cast bronze butterfly valve, EPDM elastomer coated ductile iron disc, copper tube dimensioned grooved ends, 300 psi maximum pressure rated, Victaulic Series 608. Include lever handle through 6-inch size.

Check Valves:

3" and Smaller:

Bronze body, Class 125, Y-pattern, swing type, check valve with solder ends, all bronze internal components and renewable seat and disc, Nibco model S-413-B.

2" and Smaller:

Bronze body, ASTM B62, in-line lift type, spring, Buna-N disc, 250 psig WOG rating. Nibco 480

Balancing Valves:
½" thru 2":
Bronze body balancing valve with sweat or threaded ends, calibrated brass orifice, integral adjustment knob with calibrated scale, memory stop indicator, drain tapping and differential pressure metering connections, Bell & Gossett "Circuit Setter".

UNIONS AND FLANGES
Unions:
Bronze, solder connection, Nibco figure 733.

Flanges:
Cast copper alloy, class 125, MSS SP-106, Nibco figure 741.

DIELECTRIC COUPLINGS
Steel casing, zinc electroplated, with inert thermoplastic lining, various end types, Clearflow, style 47 by Victaulic.

Dielectric flanges 2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets and pressure rating of not less than 175 psig at 180 degrees Fahrenheit. Watts Regulator Company, Lochinvar, Wilkins, Epco Sales, Inc.

WATER HAMMER SUPPRESSORS
Acceptable manufacturers are MIFAB, PPP, Sioux Chief, and Watts.

Piston compressed air column type, with sealed air chamber.

Water supply piping serving fixtures, appliances, equipment and devices with quick closing and/or solenoid-actuated valves shall be provided with water hammer arrestors. Also provide where indicated on the water supply piping as shown on the water supply isometrics. Devices shall be mechanical arrestors installed in accordance with PDI Standard WH201. Air chambers are not considered to be equal.

Shop drawings are required. Submit to A/E for approval prior to installation.

Water hammer arrestors must be accessible for inspection and replacement. Provide access panel.

PART 3 - EXECUTION

TRENCHING, BACKFILLING AND COMPACTING
See Section 22 05 00.

WATER PIPING SYSTEM
Piping shall be pitched to drain entire system; install drain valves at low points. Provide unions at equipment and valves. Provide offsets and transition fittings as required. Avoid dips or depressions in pipe runs.

No water piping shall be installed in exterior walls, unless adequately protected from freezing. Two inch insulation shall be installed on back and sides of chase, front shall be open to room heat, covered only by finished wall material.

Install unions, couplings, or flanges at all final equipment connections and as required to facilitate removal of equipment.

Install dielectric couplings at every connection between copper pipe and other metals. Use dielectric unions for connecting copper and steel piping.

Provide backflow devices as required by Code on water connections to HVAC equipment and other equipment.

Extend hot water piping from water heater and connect to all fixtures and equipment as required.

Hot water and cold water lines shall be kept at least 6 inches apart whenever possible.

Hot Water Re-Circulating System:
Install return system including check valves, balancing valves, and pumps. Pitch and grade all lines as required to ensure satisfactory circulation.

Adjust each balancing valve and set position stop. Balance system to minimum flow in return piping branches needed to maintain even supply water temperature and to provide continuous circulation throughout building. Provide balancing report along with O&M manual submittals. Test and demonstrate to A/E upon request.

Valve Installation:
Install shutoff valves with stem vertical. Exception; the stem may be horizontal if a vertical installation would not allow access to the valve handle

All valves with screwed ends shall be installed using "Teflon" tape applied on male portion of piping fitting.

Each individual fixture or piece of equipment shall have an independent shut-off valve adjacent to fixture in addition to the required branch shut-off. Where valves are installed in walls an access panel shall be provided.

Branches:
Valve shut-off full size of branch for each branch take-off to supply stack or fixture group.

Drains:
Provide valved drains at low points of systems as required or directed. All piping shall be arranged to drain through valved drains.

Flushing Mains and Branch Piping:
Upon completion of the water distribution system, test all valves to insure their full opening and flush out the system progressively by opening drain valves and building outlets and permitting the flow to continue from each until the water runs clear.

Pipe Insulation:
Provide pipe insulation for all domestic water piping per Section 22 07 00.

Sterilization of Water Distribution System:
As soon as the water distribution system has been flushed out as above specified, it shall be sterilized in accordance with the requirements of the local Health Department/Water Utility or in the absence of such, by the following method:

Introduce chlorine or a solution of calcium or sodium hypochlorite, filling the lines slowly and applying the sterilizing agent at a rate of 50 parts per million of chlorine, as determined by residual chlorine tests at the ends of the lines. Open and close all valves and hydrants while the system is being chlorinated.

After the sterilizing agent has been applied for 24 hours, test for residual chlorine at the ends of the lines. If less than 5 PPM as indicated, repeat the sterilization process.

When tests show at least 5 PPM of residual chlorine flush out the system until all traces of the chemical used are removed.

Samples
After disinfecting the water distribution system, take water samples to check for bacteria. Take 5 water samples from remote faucets, plus the main entrance. Send the samples to the Wisconsin Department of Health Lab to sample for a safe water supply system.

TESTING
Refer to Division 01, "Starting of Systems" and Section 22 05 00.

Hydro-statically pressure test water piping to 150 psig for 4 hours. No decrease in pressure is allowed. Provide pressure gauge with shutoff and a bleeder valve at the highest point of the system tested. Inspect joints in system under test. No leaks allowed.

Do not conceal pipe until satisfactorily tested.

Testing with air will not be allowed.

END OF SECTION

SECTION 22 13 00
FACILITY SANITARY SEWERAGE

PART 1 - GENERAL

SCOPE

This section contains specifications for plumbing pipe and pipe fittings for this project. Included are the following topics:

PART 1 – GENERAL
- Scope
- Related Work
- Description
- Quality Assurance
- Submittals

PART 2 – PRODUCTS
- Underground Pipe Fittings
- Above Ground Pipe and Fittings
- Drains and Cleanouts

PART 3 - EXECUTION
- Drain and Vent Piping System
- Pipe Joints
- Acid Drain and Vent System
- Vent Flashing
- Cleanouts
- Traps
- Testing

RELATED WORK

Requirements of Division 01 shall govern work under this Section.

22 05 00 – Common Work Results for Plumbing
22 05 14 – Plumbing Specialties
22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

DESCRIPTION

Interior sanitary waste and vent and acid drain and vent piping systems including branches, drains, cleanouts, stacks, fittings and hardware.

Work under this section shall commence from 5 feet outside the building wall with connections to sanitary building sewer lateral(s).

QUALITY ASSURANCE

Substitution of Materials: Refer to Section 22 05 00 and Division 01 of the Project Manual.

Order all pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.

Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

SUBMITTALS

Submit data in accordance with Section 22 05 00 and Division 01 of the Project Manual.

Schedule from the contractor indicating the ASTM, or CISPI specification number of the pipe being proposed along with its type and grade, and sufficient information to indicate the type and rating of fittings for each service.

Include materials of construction, dimensional data, ratings/capacities/ranges, approvals, test data, and identification as referenced in this section and/or on the drawings.

PART 2 - PRODUCTS

UNDERGROUND PIPE AND FITTINGS

Cast iron, no-hub, service weight, ASTM A888, CISPI 301, with rubber gasket couplings, ASTM C564, and stainless steel clamp, CISPI 310. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the engineer. Piping and fittings shall be manufactured by AB&I, Charlotte, or Tyler.

Cast iron soil pipe, bell and spigot, service weight, coated, ASTM A74, with rubber gaskets, ASTM C564. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the engineer. Piping and fittings shall be manufactured by AB&I, Charlotte, or Tyler.

PVC, Schedule 40, Type I, ASTM D-1785, and PVC drain-waste-vent fittings, ASTM D-2665, with solvent weld joints, ASTM D2855. Solid wall PVC only.

ABOVE GROUND PIPE AND FITTINGS

Cast iron, no-hub, service weight, ASTM A888, CISPI 301, with rubber gasket couplings, ASTM C564, and stainless steel clamp, CISPI 310. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the engineer. Piping and fittings shall be manufactured by AB&I, Charlotte, or Tyler.

PVC, Schedule 40, Type I, ASTM D-1785, and PVC drain-waste-vent fittings, ASTM D-2665, with solvent weld joints, ASTM D2855. Solid wall PVC only.

DRAINS AND CLEANOUTS

Drains and cleanouts manufactured by J.R. Smith, Josam, Wade, Watts, or Zurn.

Install trap-seal barrier type on floor drains in mechanical rooms.

Refer to Plumbing Drain and Cleanout Schedule.

Floor Drains:

See Plumbing Drain and Cleanout Schedule for type, manufacturer model required for this project.

PART 3 - EXECUTION

DRAIN AND VENT PIPING SYSTEM

Connect all drain and vent piping to each fixture and piece of equipment and install all required piping as shown on drawings. Provide all necessary fittings and hardware to make required offsets and transitions.

Changes in direction of drainage piping shall be made by the appropriate use of 45 degree wyes, long or short sweep 1/4 bends, 1/6, 1/8, 1/16 bends or combination.

Fittings to be installed to make for the least possibility of stoppage. All horizontal drainage piping less than 3 inches shall be pitched a minimum of 1/4 inch per foot of run. Pitch drainage piping 3 inch and larger a minimum of 1/8" per foot of run.

When running drain piping below a footing and parallel to it, piping shall be in all cases be at least one foot greater in distance away from footing than below its bottom. Where possible, run sewers at centerpoint between two parallel footings and maintain above-mentioned distances at a minimum. When running drain piping under a footing, disturb as little of the soil under footing as possible. Provide concrete fill under all footings where excavations wider than 18" are required.

When running drain piping through a footing, provide a steel pipe sleeve with 2" thick minimum compressible wrap.

Connect to all drains, fixtures and equipment as required.

PIPE JOINTS

Install cast iron pipe and fittings, hubless pattern, as recommended by CISPI standards 301, 310, and in their publication "Installation Suggestions for Cast Iron No-Hub Pipe and Fittings".

Prepare PVC pipe ends as recommended by manufacturer. Use a P-70 type primer (for PVC) and a PVC solvent cement appropriate to the pipe size and temperature range.

Soldered joints shall be as described in Section 22 05 00.

VENT FLASHING

All vent pipes passing through roof shall be covered with sheet lead weighing not less than 4 pounds per square foot. Sheet lead shall be well flashed onto the roof, 12" around pipe. Vent pipes shall extend a minimum of 12" above roof.

CLEANOUTS

Provide and install cleanouts as shown on plans and as required by Code.

TRAPS

Trap all fixtures and equipment. Trap seals shall be standard depth, except when deep seals are required by Code. Traps shall be set true and level and located within the limits of the Code requirements. A trap shall not be used as a separator, interceptor or other type of device to retain solids. All traps above grade shall be provided with approved screw-type cleanout plugs.

Traps shall be protected during construction and sealed to prevent foreign matter from entering. Provide adjustable expansion plug, plastic cap, or approved equivalent.

Install trap-seal protection barrier type on floor drains in mechanical rooms during trim out stage of floor drain installation.

TESTING

Refer to Testing paragraph of Section 22 05 00.

Hydro-statically pressure test all piping to 10 feet of water column pressure for 2 hours. No leaks allowed. Provide mint test of entire system as required by local inspector.

END OF SECTION

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SECTION 22 14 00
FACILITY STORM DRAINAGE

PART 1 - GENERAL

SCOPE

This section contains specifications for plumbing pipe and pipe fittings for this project. Included are the following topics:

PART 1 – GENERAL
- Scope
- Related Work
- Description
- Quality Assurance
- Submittals

PART 2 – PRODUCTS
- Underground Pipe Fittings
- Above Ground Pipe and Fittings
- Drains and Cleanouts

PART 3 - EXECUTION
- Drain and Vent Piping System
- Pipe Joints
- Cleanouts
- Traps
- Testing

RELATED WORK

Requirements of Division 01 shall govern work under this Section.

22 05 00 – Common Work Results for Plumbing
22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
22 05 14 - Plumbing Specialties

DESCRIPTION

Interior storm drainage, clear-water waste and vent piping systems including branches, drains, cleanouts, stacks, fittings and hardware.

Work under this section shall commence from 5 feet outside the building wall with connections to storm building sewer lateral(s).

QUALITY ASSURANCE

Substitution of Materials: Refer to Section 22 05 00 and Division 01 of the Project Manual.

Order all pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.

Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

SUBMITTALS

Submit data in accordance with Section 22 05 00 and Division 01 of the Project Manual.

Schedule from the contractor indicating the ASTM, or CISPI specification number of the pipe being proposed along with its type and grade, and sufficient information to indicate the type and rating of fittings for each service.

Include materials of construction, dimensional data, ratings/capacities/ranges, approvals, test data, and identification as referenced in this section and/or on the drawings.

PART 2 - PRODUCTS

UNDERGROUND PIPE AND FITTINGS

Cast iron, no-hub, service weight, ASTM A888, CISPI 301, with rubber gasket couplings, ASTM C564, and stainless steel clamp, CISPI 310. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the engineer. Piping and fittings shall be manufactured by AB&I, Charlotte, or Tyler.

Cast iron soil pipe, bell and spigot, service weight, coated, ASTM A74, with rubber gaskets, ASTM C564. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the engineer. Piping and fittings shall be manufactured by AB&I, Charlotte, or Tyler.

PVC, Schedule 40, Type I, ASTM D-1785, and PVC drain-waste-vent fittings, ASTM D-2665, with solvent weld joints, ASTM D2855. Solid wall PVC only.

ABOVE GROUND PIPE AND FITTINGS

Cast iron, no-hub, service weight, ASTM A888, CISPI 301, with rubber gasket couplings, ASTM C564, and stainless steel clamp, CISPI 310. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the engineer. Piping and fittings shall be manufactured by AB&I, Charlotte, or Tyler.

PVC, Schedule 40, Type I, ASTM D-1785, and PVC drain-waste-vent fittings, ASTM D-2665, with solvent weld joints, ASTM D2855. Solid wall PVC only.

DRAINS AND CLEANOUTS

Drains and cleanouts manufactured by J.R. Smith, Josam, Wade, Watts, or Zurn.

Refer to Plumbing Drain and Cleanout Schedule.

PART 3 - EXECUTION

DRAIN AND VENT PIPING SYSTEM

Connect all drain and vent piping to each fixture and piece of equipment and install all required piping as shown on drawings. Provide all necessary fittings and hardware to make required offsets and transitions.

Changes in direction of drainage piping shall be made by the appropriate use of 45 degree wyes, long or short sweep 1/4 bends, 1/6, 1/8, 1/16 bends or combination.

Fittings to be installed to make for the least possibility of stoppage. All horizontal drainage piping less than 3 inches shall be pitched a minimum of 1/4 inch per foot of run. Pitch drainage piping 3 inch and larger a minimum of 1/8" per foot of run.

When running drain piping below a footing and parallel to it, piping shall be in all cases be at least one foot greater in distance away from footing than below its bottom. Where possible, run sewers at centerpoint between two parallel footings and maintain above-mentioned distances at a minimum. When running drain piping under a footing, disturb as little of the soil under footing as possible. Provide concrete fill under all footings where excavations wider than 18" are required.

When running drain piping through a footing, provide a steel pipe sleeve with 2" thick minimum compressible wrap.

Connect to all drains, fixtures and equipment as required.

PIPE JOINTS

Install cast iron pipe and fittings, hubless pattern, as recommended by CISPI standards 301, 310, and in their publication "Installation Suggestions for Cast Iron No-Hub Pipe and Fittings".

Prepare PVC pipe ends as recommended by manufacturer. Use a P-70 type primer (for PVC) and a PVC solvent cement appropriate to the pipe size and temperature range.

Soldered joints shall be as described in Section 22 05 00.

VENT FLASHING

All vent pipes passing through roof shall be covered with sheet lead weighing not less than 4 pounds per square foot. Sheet lead shall be well flashed onto the roof, 12" around pipe. Vent pipes shall extend a minimum of 12" above roof.

CLEANOUTS

Provide and install cleanouts as shown on plans and as required by Code.

TRAPS

Trap all fixtures and equipment. Trap seals shall be standard depth, except when deep seals are required by Code. Traps shall be set true and level and located within the limits of the Code requirements. A trap shall not be used as a separator, interceptor or other type of device to retain solids. All traps above grade shall be provided with approved screw-type cleanout plugs.

Traps shall be protected during construction and sealed to prevent foreign matter from entering. Provide adjustable expansion plug, plastic cap, or approved equivalent.

TESTING

Refer to Testing paragraph of Section 22 05 00.

Hydro-statically pressure test all piping to 10 feet of water column pressure for 2 hours. No leaks allowed. Provide mint test of entire system as required by local inspector.

END OF SECTION

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SECTION 22 14 05
FOUNDATION DRAINAGE

PART 1 - GENERAL

SCOPE
This section includes specifications for plumbing pipe and pipe fittings for this project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Related Documents
- Description
- Product Handling
- Quality Assurance
- Submittals

PART 2 - PRODUCTS
- Pipe and Fittings
- Joints
- Filter Fabric
- Stone
- Cleanouts

PART 2 - EXECUTION
- Installation

RELATED WORK
Requirements of Division 01 shall govern work under this Section.

Section 22 05 00 – Common Work Results for Plumbing
Section 22 05 14 – Plumbing Specialties
Section 22 14 00 – Facility Storm Drainage
Section 22 30 00 – Plumbing Equipment

DESCRIPTION
Provide subsoil/foundation drainage system where shown on the plans in a configuration for proper installation.

QUALITY ASSURANCE
Use adequate numbers of skilled workmen who are trained and experienced in the necessary crafts and who are familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

PRODUCT HANDLING
Comply with provisions of Division 01 - General Requirements.

SUBMITTALS
Submit shop drawings on items specified herein.

PART 2 - PRODUCTS

PIPE AND FITTINGS
PVC, perforated, ASTM Specification D2729.

PE, plastic corrugated tubing, drainage and footing type, similar to product by Advanced Drainage System (ADS).

Minimum size of 4" inside diameter.

JOINTS
Plastic PVC pipe, solvent cement ASTM Specification D2564.

Plastic corrugated pipe, plastic snap coupling.

FILTER FABRIC
Non-woven polypropylene fiber bonded at crossing points. Equivalent opening size (EOS) shall be 70 to 100 U.S. Standard sieve size.

Fabric to be Typar, Style 3401 by DuPont, Mirafi 140 by Celanese, GSI Systems.

STONE
Drainage stone shall be washed rock or gravel evenly graded with stone smaller than 2 inch size and larger than 3/4-inch size.

CLEANOUTS
Refer to Section 22 14 00.

PART 3 - EXECUTION

INSTALLATION
The subsoil drainage system shall be installed as shown on drawings and details. Placement of the drainage stone shall be done to prevent tearing of the filter fabric. The pipe shall be pitched at a grade of 2 inches per 100 feet.

The jointing systems for pipe shall be installed to accomplish proper pipe alignment and pitch.

Filter fabric shall be handled and stored according to recommendations of the manufacturer.

Only pipe in the stone bedding shall be perforated. Extensions to cleanouts shall be solid pipe material.

Install filter fabric as an envelope around the pipe and stone as follows:

- Lay fabric in the trench.
- Place stone in the filter fabric.
- Level stone to proper grade and set perforated pipe on stone.
- Place remaining stone on side and top of pipe.
- Wrap filter fabric around and close with a minimum 6-inch lap.

The components (fabric, stone, pipe) from the subsoil drain conduit.

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - GENERAL

SCOPE

This section includes specifications for plumbing fixtures, faucets and trim for this project. Included are the following topics:

PART 1 – GENERAL
- Scope
- Related Work
- Description
- Reference Standards
- Quality Assurance
- Submittals

PART 2 – PRODUCTS
- General
- Manufacturers

PART 2 - EXECUTION
- Installation

RELATED WORK

Requirements of Division 01 shall govern work under this Section.

Division 11 - Foodservice Equipment
Section 22 05 00 – Common Work Results for Plumbing
Section 22 05 14 - Plumbing Specialties
Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
Section 22 11 00 - Facility Water Distribution
Section 22 13 00 - Facility Sanitary Sewerage

DESCRIPTION

Furnish and install plumbing fixtures with traps, drains, stops, faucets, flush valves, carriers and hardware.

REFERENCE STANDARDS

ANSI A112.6.1M-88	Supports for Off-the Floor Plumbing Fixtures for Public Use.
ANSI A112.18.1-94	Finished and Rough Brass Plumbing Fixture Fittings.
ANSI A112.19.1-90	Enameled Cast Iron Plumbing Fixtures.
ANSI A112.19.2M-82	Vitreous China Plumbing Fixtures.
ANSI A112.19.5-79(R1990)	Trim for Water Closet Bowls, Tanks and Urinals.
ANSI Z124.1-87	Plastic Bathtub Units.
ANSI Z124.2-87	Plastic Shower Receptors and Shower Stalls.
ARI-1010-94	Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
ASSE 1011-93	Hose Connection Vacuum Breakers.
ASSE 1014-90	Handheld Showers.
ASSE 1035-93	Laboratory Faucet Backflow Preventers.

QUALITY ASSURANCE

Substitution of Materials: Refer to 22 05 00 and Division 01 of the Project Manual.

Plumbing products requiring approval by the State of Wisconsin Dept. of Commerce must be approved or have pending approval at the time of shop drawing submission.

SUBMITTALS

Submit product data sheets in accordance with Division 01 and Section 22 05 00.

Include data concerning sizes, utility sizes, rough in-dimensions, capacities, materials of construction, ratings, weights, trim, finishes, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

PART 2 - PRODUCTS

GENERAL

Fixtures must conform to general requirements given below and to specified requirements for each type.

Vitreous china fixtures shall conform to ANSI A112.19.2M.

Enameled cast iron fixtures shall conform to ANSI A112.19.1M.

Stainless steel fixtures shall conform to ANSI A112.19.3.

Fixtures shall be installed so that parts are accessible for repairs when fixtures are in place. Manufacturer's trademark or name shall be visible on fixtures.

Faucets, traps, exposed fittings and trim shall be polished chrome plated unless otherwise specified. Provide polished chrome plated nipples at all lavatories.

Exposed piping penetrating walls, floors or ceilings shall have chrome plated escutcheons, or flanges of sufficient depth to seal the opening.

Fixture stops shall be heavy duty commercial grade, slow compression angle valves with 1/2" inlet and 3/8" or 1/2" chrome plated flexible riser.

Traps shall be semi-cast 17-gauge brass, chrome plated, with cleanout and escutcheon. Sink traps shall be 1-1/2" minimum.

MANUFACTURERS

Vitreous china and enameled cast iron fixtures shall be manufactured by Kohler, Sloan, Toto, or Zurn. Fixture color shall be white unless specified otherwise.

Flush valves shall be manufactured by Sloan (“G2” series), or Zurn (“Aquasense” series).

Solid plastic toilet seats shall be manufactured by Bemis, Benneke, Centoco, Church, Olsonite, Kohler, or Zurn. Seat color shall match fixture unless specified otherwise.

Carriers for wall-mounted fixtures shall be manufactured by J.R. Smith, Josam, MIFAB, Wade, Watts, or Zurn.

Drinking fountains and electric water coolers shall be manufactured by Acorn Aqua, Elkay, Filtrine, Halsey Taylor, Haws, Oasis, or Sunroc.

Cast terrazzo and molded stone products shall be manufactured by Crane/Fiat, Mustee, or Stern-Williams.

Stainless steel sinks shall be manufactured by Advance-Tabco, Elkay, or Just.

Electronic sensor operated faucets shall be manufactured by Sloan, or Zurn.

Stainless steel shower units shall be manufactured by Acorn, Bradley, Leonard, or Willoughby.

Shower mixing valves and accessories shall be manufactured by American Standard, Chicago Faucet, Kohler, Leonard, Powers, Speakman, Symmons, or Zurn.

Heavy duty stops and supplies shall be manufactured by Chicago Faucet, Dearborn, EBC, Kohler, McGuire, T&S Brass, or Zurn.

Traps shall be semi-cast 17 gauge brass, chrome plated, with cleanout and escutcheon as manufactured by Dearborn, EBC, Keeney, Kohler, McGuire, or Zurn.

Supply, drain and trap insulating kits shall be manufactured by Brocar, EBC, McGuire, Plumberex, or Truebro.

Special traps and solids interceptors shall be manufactured by J.R. Smith, Josam, Wade, Watts, or Zurn.

Fixtures:

See Plumbing Fixture Schedule on drawings for type, manufacturer, and model for fixtures.

PART 3 - EXECUTION

INSTALLATION

Install plumbing fixtures in accordance with manufacturer's instructions. Set level and plumb. Secure in place to counters, floors and walls providing solid bearing and secure mounting. Bolt fixture carriers to floor and wall. Secure rough-in fixture piping to prevent movement of exposed piping.

Install each fixture with trap easily removable for servicing and cleaning. Install fixture stops in readily accessible location for servicing. Individual supplies to fixtures shall be provided with support to prevent movement.

Install barrier free fixtures in compliance with COMM 52, 69 and Federal ADA Accessibility Guidelines. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to avoid contact by wheelchair users.

Seal joints between countertop, wall, floor and fixtures with G.E. Silicone caulk; white, clear or color to match fixture with colored caulk by fixture manufacturer.

Each fixture shall have a stop valve installation to control the fixture. Stop valves shall be heavy duty type with brass stems and screwed or sweat inlet connections. Compression type inlets are not acceptable.

Cover pipe penetrations with escutcheons. Exposed traps, stops, piping and escutcheons to be chrome plated brass, same items in concealed locations may be of rough brass finish.

Set floor mounted water closets, floor mounted service sinks; counter mounted lavs and sinks; lav and sink faucets and drains with full setting bed of flexible non-staining plumber's putty. Cover exposed water closet bolts with bolt covers.

Set mop basins to floor and wall with grout or silicone sealant.

After installation, fixtures shall be protected to prevent scratching or other damage during construction.

Prior to acceptance, fixtures shall be cleaned with compounds recommended by the respective manufacturer.

END OF SECTION

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SECTION 22 42 23
COMMERCIAL SHOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Shower basins.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for shower basins.
   2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For cleaning shower basins.

PART 2 - PRODUCTS

2.1 PRECAST-TERRAZZO SHOWER BASINS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Acorn Engineering
   b. Florestone Products Co., Inc.
   c. Stern-Williams Co., Inc.
   d. Fiat Products.
   2. Source Limitations: Obtain shower basins from single source from single manufacturer.
   3. Description: Precast-terrazzo base for built-up-type shower fixture.
   4. Standard:
      a. CSA B45.8/IAPMO Z403.
      b. IAPMO PS 99.
      c. 2010 ADA Standards for Accessible Design.
   5. Threshold Type: Standard commercial and/or Handicapped/accessible – see Drawings.
   6. Shape: See Drawings.
   7. Nominal Size: See Drawings.
   8. Color: Color selected by Architect from manufacturer's standard color selection.
   9. Outlet: Removable stainless steel grid strainer, NPS 2, no-caulk drain.
   10. Tiling Flange: Integral, stainless steel.
      a. Square or rectangular fixture: Provide for all walls – See Drawings.
      b. Corner Fixture: Left and right.
   11. Rabbeted Joint Shoulders: 1 in. high.
   12. Accessories:
      a. Rubber drain gasket reducer for NPS 2 waste pipe.
      b. Vandal resistant strainer.
      c. Double drain.

2.2 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000 psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.
B. Examine walls and floors for suitable conditions where showers will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble shower basin components in accordance with manufacturers' written instructions.
B. Install shower basins level and plumb.
C. Set shower basins in leveling bed of cement grout.
D. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 CLEANING AND PROTECTION

A. After completing installation of shower basins, inspect and repair damaged finishes.

B. Clean shower basins and fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed fixtures and fittings.

D. Do not allow use of showers for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 230500
COMMON WORK RESULTS FOR HVAC

P A R T 1 - G E N E R A L

SCOPE

This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference Standards
- LEED Certification
- Commissioning
- Quality Assurance
- Abbreviations
- Definitions
- Drawings
- Codes and Standards
- Continuity of Existing Services
- Protection of Finished Surfaces
- Sleeves and Openings
- Sealing and Firestopping
- Equipment Furnished By Others
- Provisions for Future
- Add Alternate Bid
- Submittals
- Specified Materials and Equipment
- Equipment Installation
- Off Site Storage
- Certificates and Inspections
- Operating and Maintenance Instructions
- Closeout Procedures
- Training of Owner Personnel
- Record Drawings

PART 2 - PRODUCTS
- Access Panels and Doors
- Identification
- Sealing and Firestopping

PART 3 - EXECUTION
- Demolition
- Concrete Work
- Cutting and Patching
- Building Access
- Equipment Access
- Coordination
- Identification
- Lubrication
- Sleeves
- Sealing and Firestopping

RELATED WORK

Section 23 05 13 - Common Motor Requirements for HVAC.
Section 23 33 00 - Air Duct Accessories.

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

Abbreviations of standards organizations referenced in other sections are as follows:

AABC	Associated Air Balance Council
ADC	Air Diffusion Council
AGA	American Gas Association
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CGA	Compressed Gas Association
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
MCA	Mechanical Contractors Association
MICA	Midwest Insulation Contractors Association
MSS	Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association. Inc.
UL	Underwriters Laboratories Inc.
ASTM E814	Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
UL1479	Fire Tests of Through-Penetration Firestops
UL723	Surface Burning Characteristics of Building Materials

LEED CERTIFICATION

The project will be LEED Certified thru the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) program. Refer to Section 01 81 13 – Sustainable Design Requirements for additional requirements.

In addition to complying with Division 23 drawings and specifications, equipment and material shall also comply with Section 01 81 13 and LEED requirements.

The Division 23 contractor will be expected to provide all required documentation, submittals, etc. in accordance with prerequisites and credits associated with Division 23 work and LEED Certification.

COMMISSIONING

The systems will be commissioned by an independent third party in accordance with USGBC LEED Energy and Atmosphere Credit C3 – Enhanced Commissioning. Refer to Sections 01 91 00 – Commissioning and 01 95 01 – Monitoring-Based Commissioning for additional requirements.

The Division 23 contractor shall work with the independent third party commissioning agent to complete the required construction verification checklists and assist in the functional performance testing as specified in Section 01 91 00.

QUALITY ASSURANCE

Refer to Division 1, General Conditions, Equals and Substitutions.

Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the performance from the system into which these items are placed. This may include changes found necessary during the testing, adjusting, and balancing phase of the project.

ABBREVIATIONS

A/E	Architect/Engineer
GC	General Contractor
FPC	Fire Protection Contractor
PC	Plumbing Contractor
HC	Heating Contractor

EC Electrical Contractor
TCC Temperature Contractor
DDC Direct Digital Controls
BAS Building Automation System
TCS Temperature Control System

DEFINITIONS

Furnish:
Supply and deliver to Project site ready for unpacking, assembly and installation

Install:
Operations at Site including unpacking, assembling, erecting, placing, anchoring, applying, finishing, cleaning, and connecting related devices required for product fully functional for intended use after installation.

Provide:
Furnish and install, such that product is fully functional for intended use.

DRAWINGS

Drawings show general arrangements of piping, equipment and appurtenances and shall be followed as closely as actual building construction and work of other trades permits. Work shall conform to requirements shown on Drawings. General and structural drawings shall take precedence. Because of the scale of Drawings, it is not possible to indicate all offsets, fittings and accessories required. Investigate structural and finish conditions affecting work and arrange work accordingly, providing offsets, fittings and accessories required to meet constructed conditions.

HVAC equipment and systems, including piping and ductwork shall be installed as high as possible unless otherwise noted on Drawings. Equipment and systems shall also be installed to maintain required operation and maintenance clearances.

CODES AND STANDARDS

Materials and workmanship shall comply with applicable codes, specifications, local ordinances, industry standards and utility company regulations. In case of differences between building codes, specifications, state laws, local ordinances, industry standards and utility company regulations and contract documents, the most stringent shall govern. Promptly notify A/E in writing of differences.

Non-Compliance:
If Contractor installs materials or performs Work that does not comply with above requirements, he shall correct Work and shall bear costs arising from correcting deficiencies.

CONTINUITY OF EXISTING SERVICES

Do not interrupt or change existing services without prior written approval from County Facilities Personnel. When interruption is required, coordinate the down-time with Facilities to minimize disruption to their activities. Unless specifically stated, all work involved in interrupting or changing existing services is to be done during normal working hours.

PROTECTION OF FINISHED SURFACES

Refer to Division 1, General Requirements, Protection of Installed Construction

Furnish one can of touch-up paint for each different color factory finish which is to be the final finished surface of the product. Deliver touch-up paint with other "loose and detachable parts" as covered in the General Requirements.

SLEEVES AND OPENINGS

Refer to Division 1, General Requirements, Cutting and Patching.

SEALING AND FIRESTOPPING

Sealing and firestopping of sleeves/openings between ductwork, piping, etc. and the sleeve, structural or partition opening shall be the responsibility of the contractor whose work penetrates the opening. The contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.

EQUIPMENT FURNISHED BY OTHERS

None.

PROVISIONS FOR FUTURE

(2) future 4” connections shall be provided for future geothermal borefield expansion.

ALTERNATE BID #2

Alternate Bid #2 shall be provided to evaluate the costs associated with providing the building heating load entirely through the heat recovery chiller and relying on the existing boiler as emergency backup.

Remove (1) existing boiler complete, convert the boiler piping from variable primary to a primary / secondary configuration, replace existing boiler isolation valve with inline circulating pump.

Refer to Drawing M502 for additional information regarding Alternate Bid #2.

SUBMITTALS

Refer to Division 1, General Conditions, Submittals.

Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents.

Before submitting electrically powered equipment, verify that the electrical power and control requirements for the equipment are in agreement with the motor starter schedule on the electrical drawings. Include a statement on the shop drawing transmittal to the architect/engineer that the equipment submitted and the motor starter schedule are in agreement or indicate any discrepancies.

Include wiring diagrams of electrically powered equipment.

Provide electronic (PDF) copies of shop drawings for electronic distribution.

SPECIFIED MATERIALS AND EQUIPMENT

Design is based on equipment specified by manufacturer and model number as specified on Drawing schedules. Where certain items are specified by manufacturer or trade name, Contractor's bid shall be based on use of named item. Where one (1) manufacturer/model is described and other makes are listed, comparable models of other named equipment may also be used, provided they meet requirements of Specifications.

When equipment or accessories used differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those on Drawing schedules, Contractor shall be responsible for costs involved in integrating equipment or accessories into system. Contractor shall be responsible for obtaining original design performance from system into which items are placed, regardless of whether manufacturer/model is specified equivalent or substitute. This may include changes found necessary during testing, adjusting, and balancing phase of Project.

If Contractor wishes to use items other than those named in Specifications in base bid, request for approval of substitution must be made in writing to A/E at least 14 days prior to opening of bids. Include complete technical and descriptive data with request. If approved, an Addendum will be issued notifying bidders of approval. Request for approval will be considered only if requested by prime bidding Contractor.

EQUIPMENT INSTALLATION

Drawings show general arrangement and location of equipment and appurtenances. It is Contractor’s responsibility to install equipment in a location and manner that allows for proper service and maintenance access to equipment. Work shall generally conform to requirements shown on Drawings. However, location of equipment may require field adjustments to obtain required service space. DO NOT SCALE OFF PLANS to determine proper location of equipment. Because of scale of Drawings, it is not possible to indicate exact routing of ductwork and piping, and offsets, fittings and accessories required to provide proper service access to equipment. Contractor shall route and install ductwork and piping to provide required service access to equipment.

If, during construction phase of Project, contractor feels inadequate space exists, or equipment locations must be substantially modified to provide proper service and maintenance access, prior to installing equipment, contractor shall notify engineer in writing, outlining general concerns and proposed modifications. Equipment installed without providing manufacturer’s required maintenance and service clearance shall be considered defective. Contractor shall remove and relocate piping, ductwork and equipment, to provide required service clearances at contractor’s expense.

OFF SITE STORAGE

Ductwork, metal for making ductwork, duct lining, sleeves, pipe/pipe fittings and similar rough-in material will not be accepted for off site storage. For material that can be stored off site, no material will be accepted for offsite storage unless shop drawings for that material have been approved.

CERTIFICATES AND INSPECTIONS

Refer also to Division 1, General Requirements, Regulatory Requirements.

Obtain and pay for all required City of Madison installation inspections except those provided by the Architect/Engineer in accordance with Wis Adm Code Section ILHR 50.12. Deliver originals of these certificates to the Owner and A/E. Include copies of the certificates in the Operating and Maintenance Instructions.

OPERATING AND MAINTENANCE INSTRUCTIONS

All operations and maintenance data shall comply with the submission and content requirements specified under this section and under Division 1, General Requirements, Closeout Procedures.
Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:

- Copies of all approved shop drawings.
- Manufacturer's wiring diagrams for electrically powered equipment
- Records of tests performed to certify compliance with system requirements
- Certificates of inspection by regulatory agencies
- Temperature control record drawings and control sequences
- Parts lists for manufactured equipment
- Valve schedules
- Lubrication instructions, including list/frequency of lubrication done during construction
- Warranties
- Additional information as indicated in the technical specification sections

Provide three (3) hardcopies of the Operation and Maintenance Manual. Manuals shall be organized in three ring binders with dividers and reference tabs. Manuals shall be delivered as follows:

- One copy to the building engineer.
- One copy to the tenant (to be kept on site).
- One copy to the Owners Representative.

Provide (3) electronic (Adobe PDF) copies of the Operation and Maintenance Manual.

- Provide each copy on a separate portable USB flash drive.
- Deliver each portable USB flash drive with hard copy manuals to parties listed above.

CLOSEOUT PROCEDURES

Refer to this section and under Division 1, General Requirements, Closeout Procedures.

The Contractor shall complete and provide items and materials, training and start-up associated with project closeout as specified under Division 1 of the Project Manual. In addition to these items, the Contractor shall provide the following items prior to acceptance of the installation as specified in accordance with with 2009 IMC 403.7 and 2009 IECC 503.2.9.1 through 503.2.9.3:

- Final air and water system balancing, completed in accordance with the requirements of Section 23 05 93 and code, including the submission of testing, adjusting and balancing reports. Reports shall indicate the amount of total supply air, return air and outside ventilation air being provided to the spaces and to the air handling system(s).

- Submission of Operating and Maintenance instructions in accordance with the requirements of Division 1, this Section, and code. Operation and Maintenance Manuals shall include a copy of completed testing, adjusting and balancing report for Owner's records.

- Submission of start-up report for temperature control system, signed by technician in responsible charge of control system, indicating system has been adjusted, calibrated and put into operation in accordance with requirements of Sections 23 09 14, 23 09 23, 23 09 93 and code.

TRAINING OF OWNER PERSONNEL

Instruct County Facility Personnel in the proper operation and maintenance of systems and equipment provided as part of this project; video tape all training sessions. Include not less than 4 hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup and shutdown procedures for all equipment.

All training to be during normal working hours.

RECORD DRAWINGS
Refer to Division 1, General Requirements, Record Drawings.

In addition to the data indicated in the General Requirements, maintain temperature control record drawings on originals prepared by the installing contractor/subcontractor. Include copies of these record drawings with the Operating and Maintenance manuals.

Maintain accurate as-built or record drawings throughout the duration of the project. As-built drawings shall be available on site at all times for review by the A/E, owner or owner's representative.

If, during project closeout, the A/E or owner observes installations that are not accurately recorded on the as-built or record drawings, the record drawings will not be accepted and the contractor will be required, at their own expense, to provide updated and accurate record drawings.

P A R T 2 - P R O D U C T S

ACCESS PANELS AND DOORS
LAY-IN CEILINGS:
Removable lay-in ceiling tiles in 2 X 2 foot or 2 X 4 foot configuration provided under Section 09500 are sufficient; no additional access provisions are required unless specifically indicated.

PLASTER WALLS AND CEILINGS:
16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers, and similar wet areas, concealed hinges, screwdriver operated cam latch for general applications, key lock for use in public areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needing service; minimum size is 12" by 12".

IDENTIFICATION
STENCILS:
Not less than 1 inch high letters/numbers for marking pipe and equipment.

SNAP-ON PIPE MARKERS:
Cylindrical self-coiling plastic sheet that snaps over piping insulation and is held tightly in place without the use of adhesive, tape or straps. Not less than 1 inch high letters/numbers and flow direction arrows for piping marking. W. H. Brady, Seton, Marking Services, or equal.

ENGRAVED NAME PLATES:
White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting, Setonply Style 2060 by Seton Name Plate Company or Emedolite- Style EIP by EMED Co., or equal by Marking Services, or W. H. Brady.

VALVE TAGS:
Round brass tags with 1/2 inch numbers, 1/4 inch system identification abbreviation, 1-1/4 inch minimum diameter, with brass jack chains or brass "S" hooks around the valve stem, available from EMED Co., Seton Name Plate Company, Marking Services, or W. H. Brady.

SEALING AND FIRESTOPPING
FIRE AND/OR SMOKE RATED PENETRATIONS:
Manufacturers:
3M, Hilti, Rectorseal, STI/SpecSeal, Tremco, or approved equal.

All firestopping systems shall be provided by the same manufacturer.

Submittals:
Contractor shall submit product data for each firestop system. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgement can be based upon.

Product:
Fire stop systems shall be UL listed or tested by an independent testing laboratory approved by the Department of Commerce.

Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.

Contractor shall use firestop putty, caulk sealant, intumescent wrapstrips, intumescent firestop collars, firestop blocks, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.

NON-RATED PENETRATIONS:
Pipe Penetrations Through Below Grade Walls:
In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated pipe and the cored opening or a water-stop type wall sleeve.

Pipe Penetrations:
At pipe penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required use urethane caulk in annular space between pipe insulation and wall material.

Duct Penetrations:
Pack annular space with fiberglass batt insulation or mineral wool insulation. Provide 4" sheet metal escutcheon around duct on both sides of partition or floor to cover annular space.

P A R T 3 - E X E C U T I O N

DEMOLITION
Perform all demolition as indicated on the drawings to accomplish new work. Where demolition work is to be performed adjacent to existing work that remains in an occupied area, construct temporary dust partition to minimize the amount of contamination of the occupied space. Where pipe or duct is removed and not reconnected with new work, cap ends of existing services as if they were new work. Coordinate work with the user agency to minimize disruption to the existing building occupants.

All pipe, wiring and associated conduit, insulation, ductwork, and similar items demolished, abandoned, or deactivated are to be removed from the site by the Contractor. All piping and ductwork specialties are to be removed from the site by the Contractor unless they are dismantled and removed or stored by the user agency. All designated equipment is to be turned over to the user agency for their use at a place and time so designated. Maintain the condition of material and/or equipment that is indicated to be reused equal to that existing before work began.

CONCRETE WORK
All cast-in-place concrete will be performed by the General Contractor unless otherwise noted. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for support of mechanical equipment.

CUTTING AND PATCHING
Refer to Division 1, General Requirements, Cutting and Patching.

BUILDING ACCESS
Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

EQUIPMENT ACCESS
Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance and service. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Access doors in general construction are to be furnished by the Mechanical Contractor and installed by the General Contractor.

Provide color coded thumb tacks or screws, depending on the surface, for use in accessible ceilings which do not require access panels.

COORDINATION
Verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, diffusers, register, grilles, and recessed or semi-recessed heating and/or cooling terminal units installed in/on architectural surfaces.

Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

Cooperate with the test and balance agency in ensuring Section 23 05 93 specification compliance.
Verify system completion to the test and balance agency (flushing, pressure testing, chemical treatment, filling of liquid systems, proper pressurization and air venting of hydronic systems, clean filters, clean strainers, duct and pipe systems cleaned, controls adjusted and calibrated, controls cycled through their sequences, etc.), ready for testing, adjusting and balancing work. Install dampers, shutoff and balancing valves, flow measuring devices, gauges, temperature controls, etc., required for functional and balanced systems. Demonstrate the starting, interlocking and control features of each system so the test and balance agency can perform its work.

IDENTIFICATION
Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion. Do not label equipment such as cabinet heaters and ceiling fans in occupied spaces.

- Air terminal units to be labeled on bottom and side of each unit.

Where stenciling is not appropriate for equipment identification, engraved name plates may be used.

Identify piping not less than once every 20 feet, not less than once in each room, adjacent to each access door or panel, and on both side of the partition where exposed piping passes through walls, floors or roofs. Use one coat of black enamel against a light background or white enamel against a dark background for stenciling, or provide snap-on pipe markers as specified in Part 2 – Products. At each location, pipe identification shall include:

- Pipe content (HWS, HWR, CWS, CWR, CCC, CS, CR etc.).
- Flow directional arrows.
- Pipe size.

Identify valves with brass tags bearing a system identification and a valve sequence number. Valve tags are not required at a terminal device unless the valves are greater than ten feet from the device or located in another room not visible from the terminal unit. Provide a typewritten valve schedule indicating the valve number and the equipment or areas supplied by each valve; locate schedules in each mechanical room and in each Operating and Maintenance manual. Schedules in mechanical rooms to be framed under clear plastic.

Use engraved name plates to identify control equipment.

Place color coded thumbtack (or equivalent) on ceiling grid at locations of above ceiling air terminals, BAS DDC control equipment and control valves.

LUBRICATION
Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any reason. Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions until the work is accepted by DFD. Maintain a log of all lubricants used and frequency of lubrication; include this information in the Operating and Maintenance Manuals at the completion of the project.

SLEEVES
PIPE SLEEVES:
Provide galvanized sheet metal sleeves for pipe penetrations through interior and exterior walls to provide a backing for sealant or firestopping. Patch wall around sleeve to match adjacent wall construction and finish. Grout area around sleeve in masonry construction. In finished spaces where pipe penetration through wall is exposed to view, sheet metal sleeve shall be installed flush with face of wall.

Pipe sleeves are not required in interior non-rated drywall, plaster or wood partitions and sleeves are not required in existing poured concrete walls where penetrations are core drilled.

Pipe sleeves are not required in cored floor pipe penetrations through existing floors that are not located in mechanical rooms, food service areas or wet locations listed above.

Pipe sleeves in new poured concrete construction shall be schedule 40 steel pipe (sized to allow insulated pipe to run through sleeve), cast in place.

Extend the top of sleeve 1 inch above the adjacent floor in piping floor penetrations located in the upper floor mechanical room and any first floor penetration. In finished areas sleeves shall be flush with rough floor.

In exterior wall openings below grade, place water-stop type wall sleeve before concrete pour or core drill opening after pour. Assemble rubber links to proper size for pipe and tighten in place in accordance with manufacturer's instructions.

DUCT SLEEVES:
Duct sleeves are not required in non-rated partitions or floors.

PENETRATIONS SUBJECT TO WATER INTRUSION
For penetrations (both rated and non-rated) in floors subject to water intrusion or in rooms housing electrical equipment (but not within walls) provide one of the following:

- Pipe penetration where steel pipe sleeve is used extend steel sleeve 2" above the floor.
- Pipe penetration where cast in place fire stopping device/sleeve is used, extend device/sleeve 2" above the floor (provided it meets the device's UL listing).
- Pipe penetration where there is no steel sleeve or cast in place fire stopping device/sleeve, provide 2"x 2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8"on center. Seal corners water tight with urethane caulk.
- Duct penetrations. Provide 2"x 2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8"on center. Seal corners water tight with urethane caulk.

Floors subject to water intrusion or rooms housing electrical equipment include the following locations:

- Mechanical/Plumbing Equipment Rooms
- Restrooms
- Locker/Shower Rooms
- Janitor Rooms w/ Sinks

SEALING AND FIRESTOPPING
NON-RATED PARTITIONS:
At all interior partitions and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.

Duct penetrations through non-rated partitions shall require sheet metal escutcheons with fiberglass or mineral wool insulation fill for spaces that include janitor closets, toilet rooms, mechanical rooms, conference rooms, private offices, and where noted on drawings elsewhere.

END OF SECTION

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SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

P A R T 1 - G E N E R A L

SCOPE

This section includes requirements for single and three phase motors that are used with equipment specified in other sections. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Shop Drawings
- Operating and Maintenance Data
- Electrical Coordination
- Product Criteria

PART 2 - PRODUCTS
- Three Phase, Single Speed Motors
- Single Phase, Single Speed Motors
- Motors Used on Variable Frequency Drives

PART 3 - EXECUTION
- Installation

RELATED WORK

Section 23 05 14 - Variable Frequency Drives
Section 23 09 14 - Electric Instrumentation and Control Devices for HVAC
Section 23 09 23 - Direct Digital Control System for HVAC
Section 23 21 23 – Hydronic Pumps
Section 23 34 00 – HVAC Fans
Section 23 64 23 – Modular Heat Recovery Chillers
Section 23 73 13 – Modular Indoor Central Station Air Handling Units
Section 23 82 00 – Heating and Cooling Terminal Units

Division 26 00 00 - Electrical

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

ANSI/IEEE 112	Test Procedure for Polyphase Induction Motors and Generators
ANSI/NEMA MG-1	Motors and Generators
ANSI/NFPA 70	National Electrical Code

QUALITY ASSURANCE

Also refer to division 1.

SHOP DRAWINGS

Refer to Division 1, General Conditions, Submittals.

Include with the equipment which the motor drives the following motor information: motor manufacturer, horsepower, voltage, phase, hertz, rpm, full load efficiency. Include project wiring diagrams prepared by the contractor specifically for this work.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

ELECTRICAL COORDINATION

All starters, overload relay heater coils, disconnect switches and fuses, relays, wire, conduit, pushbuttons, pilot lights, and other devices required for the control of motors or electrical equipment are furnished and installed by the Electrical Contractor, except as specifically noted elsewhere in this division of specifications or on the mechanical drawings.

Electrical drawings and/or specifications show number and horsepower rating of all motors furnished by this Contractor, together with their actuating devices if these devices are furnished by the Electrical Contractor. Should any discrepancy in size, horsepower rating, electrical characteristics or means of control be found for any motor or other electrical equipment after contracts are awarded, Contractor is to immediately notify the architect/engineer of such discrepancy. Costs involved in any changes required due to equipment substitutions initiated by this contractor will be the responsibility of this contractor. See related comments in Section 23 05 00 - Common Work Results for HVAC, under Shop Drawings.

Electrical Contractor will provide all power wiring and control wiring, except temperature control wiring.

Furnish project specific wiring diagrams to Electrical Contractor for all equipment and devices furnished by this Contractor and indicated to be wired by the Electrical Contractor.

PRODUCT CRITERIA

Motors to conform to all applicable requirements of NEMA, IEEE, ANSI, and NEC standards and shall be listed by U.L. for the service specified.

Select motors for conditions in which they will be required to perform; i.e., general purpose, splashproof, explosion proof, standard duty, high torque or any other special type as required by the equipment or motor manufacturer's recommendations.

Furnish motors for starting in accordance with utility requirements and compatible with starters as specified.

P A R T 2 - P R O D U C T S

THREE PHASE, SINGLE SPEED MOTORS

Use NEMA rated 460 volt, three phase, 60 hertz motors for all motors 1/2 HP and larger unless specifically indicated.

Use NEMA general purpose, continuous duty, Design B, normal starting torque, T-frame or U-frame motors with Class B or better insulation unless the manufacturer of the equipment on which the motor is being used has different requirements. Use open drip-proof motors unless totally enclosed fan-cooled, totally enclosed non-ventilated, explosion-proof, or encapsulated motors are specified in the equipment sections.

Use grease lubricated anti-friction ball bearings with housings equipped with plugged/capped provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at the end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

All open drip-proof motors to have a 1.15 service factor. Other motor types may have minimum 1.0 service factors.

All motors 1 HP and larger, except specially wound motors and inline pump motors 56 frame and smaller, to be high efficiency design with full load efficiencies which meet or exceed the values listed below when tested in accordance with NEMA MG 1.

FULL LOAD NOMINAL MOTOR EFFICIENCY BY MOTOR SIZE AND SPEED

MOTOR	-----Open Drip-Proof Motors------		
	-------Nominal Motor Speed-------		
HP	1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	77.0
1-1/2	86.5	86.5	84.0
2	87.5	86.5	85.5
3	88.5	89.5	85.5
5	89.5	89.5	86.5
7-1/2	90.2	91.0	88.5
10	91.7	91.7	89.5
15	91.7	93.0	90.2
20	92.4	93.0	91.0
25	93.0	93.6	91.7

MOTOR HP	----Totally Enclosed Fan-Cooled---- -------Nominal Motor Speed------ 1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	77.0
1-1/2	87.5	86.5	84.0
2	88.5	86.5	85.5
3	89.5	89.5	86.5
5	89.5	89.5	88.5
7-1/2	91.0	91.7	89.5
10	91.0	91.7	90.2
15	91.7	92.4	91.0
20	91.7	93.0	91.0
25	93.0	93.6	91.7

SINGLE PHASE, SINGLE SPEED MOTORS
Use NEMA rated 115 volt, single phase, 60 hertz motors for all motors 1/3 HP and smaller.

Use permanent split capacitor or capacitor start, induction run motors equipped with permanently lubricated and sealed ball or sleeve bearings and Class A insulation. Service factor to be not less than 1.35.

MOTORS USED ON VARIABLE FREQUENCY DRIVES
In addition to the requirements specified above, the motor must be suitable for use with the drive specified in Section 23 05 14, including but not limited to motor cooling. Motor shall comply with NEMA MG1 Part 31 to provide windings capable to withstand up to 1600 peak Volts with a rise time of 0.1 µs.

Provide bearing protection grounding rings to bleed current from the motor shaft to the motor casing. Manufacturers: Aegis SGR, Inpro/Seal CDR, or equal.

P A R T 3 - E X E C U T I O N

INSTALLATION
Mount motors on a rigid base designed to accept a motor, using shims if required under each mounting foot to get a secure installation.

When motor will be flexible coupled to the driven device, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Using a dial indicator, check angular misalignment of the two shafts; adjust motor position as necessary so that the angular misalignment of the shafts does not exceed 0.002 inches per inch diameter of the coupling hub. Again using the dial indicator, check the shaft for run-out to assure concentricity of the shafts; adjust as necessary so that run-out does not exceed 0.002 inch.

When motor will be connected to the driven device by means of a belt drive, mount sheaves on the appropriate shafts in accordance with the manufacturer's instructions. Use a straight edge to check alignment of the sheaves; reposition sheaves as necessary so that the straight edge contacts both sheave faces squarely.
After sheaves are aligned, loosen the adjustable motor base so that the belt(s) can be added and tighten the base so that the belt tension is in accordance with the drive manufacturer's recommendations. Frequently recheck belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

Verify the proper rotation of each three-phase motor as it is being wired or before the motor is energized for any reason.

Lubricate all motors requiring lubrication. Record lubrication material used and the frequency of use. Include this information in the maintenance manuals.

END OF SECTION

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SECTION 23 05 14
VARIABLE FREQUENCY DRIVES

P A R T 1 - G E N E R A L

Applicable provisions of Division 1 shall govern all work under this Section

SCOPE

This section includes variable frequency drives, bypass starters, and line reactors. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Submittals
- Operating and Maintenance Data
- Equipment Startup
- Warranty

PART 2 - PRODUCTS
- Manufacturers
- Design and Construction
- Performance Requirements
- Control Features
- Protection Features
- Diagnostics
- Quality Assurance Tests
- Bypass Equipment
- AC Input Line Reactors
- Output Line Filters

PART 3 - EXECUTION
- Variable Frequency Drives (VFD)
- Construction Verification
- Functional Performance Testing
- Training

RELATED WORK

Section 23 34 00 - HVAC Fans
Section 23 73 13 – Modular Indoor Central Station Air Handling Units
Section 23 73 23 – Factory Fabricated Custom Air-Handling Units
Section 26 05 26 - Grounding and Bonding for Electrical Systems
Section 26 05 29 - Hangers and Supports for Electrical Systems
Section 26 05 53 - Identification for Electrical Systems
Section 26 27 02 – Equipment Wiring Systems

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

ANSI/IEEE 519 Guide for Harmonic Control and Reactive Compensation of Static Power Converters

SUBMITTALS

Submit shop drawings and product data under provisions of Division 1, General Conditions of the Contract.
Include physical, electrical, and performance characteristics of each variable frequency drive and associated components, including dimensions; weight; input and output performance; voltage, phase, current and overcurrent characteristics; installation instructions; protective features; wiring and block diagrams indicating specified options; electrical noise attenuation equipment where required to meet the criteria specified; line side voltage notch wave form and line side current harmonics; certified efficiency versus load and speed curves; and required operating environment.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

EQUIPMENT STARTUP AND AGENCY TRAINING
Provide the services of a factory trained and certified technician to approve the installation; start-up, test, and adjust for proper operation of the unit(s). Upon completion of the equipment startup, submit a complete manufacturer's field report, including startup and test log, signed by the factory trained technician. Coordinate with the Temperature Control Contractor and the Balancing Contractor. The startup shall be coordinated with Division 26. Electrical and shall be completed within ten (10) working days from the startup date.

WARRANTY
The warranty shall be for a period of twenty-four (24) months from the date of project Substantial Completion. Further, the warranty shall include all parts, labor, travel time, administrative costs, overhead, travel expenses, technical support and any and all other costs to provide the warranty service.

P A R T 2 - P R O D U C T S

MANUFACTURERS
Danfoss. No other manufacturers will be allowed.

DESIGN AND CONSTRUCTION
The unit shall be variable torque, modular design for control of the motors as specified in Division 15 and rated at the motor full load nameplate amps.

The unit shall be U.L. listed, solid state, microprocessor-based with a pulse width modulated (PWM) output wave form (none others are acceptable).

The VFD shall employ a full wave bridge rectifier and capacitors to minimize the ripple of the rectified voltage to maintain near constant DC voltage. Insulated gate bipolar transistors (IGBT's) shall be employed as the output switching device.

The VFD package shall contain the equivalent of 5% impedance to reduce harmonic distortion. The 5% equivalent impedance shall be provided in the form of a DC bus choke, an input AC line reactor in each phase, or a combination of the two methods.

Control circuitry shall be plug-in, plug-out modular basis with a corrosion resistant coating on printed circuit boards.

Units to be suitable for an operating environment from 0°C to 40°C temperature and humidity up to 90% non-condensing.

Electrically and physically isolate control circuitry and conductors from power circuitry and power conductors. Control conductors and power conductors shall not be run in the same pathway.

The unit enclosure shall be NEMA 1 or 12 as required for the specific application minimum and all components shall be fully factory assembled and tested prior to leaving the manufacturing facility.

Include the following operating and monitoring devices mounted on the front cover:

- A disconnect switch or circuit breaker to de-energize both the drive and bypass circuit with door interlocked handle and lock-open padlocking provisions.
- Operating mode selector switch marked "hand-off-auto".
- Manual speed adjustment via keypad, mounted on the door.
- Manual bypass selector switch to select power through drive or bypass.

Provide a manual bypass circuit and bypass starter to transfer from variable frequency drive operation to bypass operation.

PERFORMANCE REQUIREMENTS
Units shall be suitable for input power of electrical system as scheduled on the drawings ±10%, 3 phase, 60 Hertz nominal.

Use a current limiting control device to limit output current to 110% continuous for one minute; also refer to Protection Features in this section. Full load output current available from drive shall not be less than motor nameplate amperage. The full load amp rating of the VFD shall not be less than the values indicated in the NEC Table 430-150.

Output power shall be suitable for driving standard NEMA B design, three phase alternating current induction motors at full rated speed with capability of 6:1 turndown.

Additional performance capabilities to include the following:

Ride through a momentary power outage of 15 cycles,
Start into a rotating load without damage to drive components or motor,
Capable of automatic restart into a rotating load after a preset, adjustable time delay following a power outage
Input power factor: Min 0.95 throughout the speed range
Minimum efficiency: 95% at 100% speed, 85% at 50% speed

CONTROL FEATURES

Use control circuits compatible with input signal from temperature control system in the automatic mode and from manual speed control in the manual mode. Vary motor speed in response to the input control signal. Include components necessary to accept the signal from the temperature control system in the form that it is sent. Refer to Division 23 00 00.

Include the following additional control features:

- Hand-Off-Automatic (HOA) selector switch to select local or remote start/stop and speed control
- Analog input, selectable 0-10v or 4-20 mA, for automatic control from the temperature control system
- Local speed control at the VFD
- Adjustable acceleration and deceleration rate so that the time period from start to full speed and from full speed to stop can be field adjusted
- Adjustable minimum and maximum speed settings for both automatic and manual modes of operation
- Manual transfer bypass circuit
- Field adjustment of minimum and maximum output frequency
- Two (2) sets of programmable form "C" contacts for remote indication of variable frequency drive condition. Note: default programming to be set for "Drive Run & Fault".
- Illuminated display keypad.
- External Fault indicator
- One (1) input for a N.O. dry contact type input for a 2-wire remote start/stop
- One (1) input for a N.C. dry contact type input for external faults: (freezestats, fire alarm, smokes, etc). This input shall be factory wired to prevent both the VFD and bypass starter operation when external fault is present.
- One (1) N.O. dry contact output for proving motor status. This output shall be programmed to detect belt or coupling break that would remove the load from the motor. The dry contact will open on loss of load or VFD being off.
- PID control loop capable of VFD control from an external device connected to a VFD analog input.
- When specified in the 23 09 93 sequence of operations, provide a VFD input and output for shutoff damper control that shall operate as follows: When the fan is remotely or locally commanded to start, VFD contact shall energize the shutoff damper to open the damper. The damper position end switch shall be wired to a run permissive input on the VFD and enable the VFD to start when the damper end switch provides the damper is open. This feature shall be provided for both inverter and bypass operation (if bypass option is provided).

The VFD controller shall convert VFD information into the BAS DDC protocol that will be compatible with the building direct digital energy management system (EMS) supplied on the project. This output shall be through a serial interface port capable of two-way communication with the building EMS provided on this project. Final connection shall not require any additional intermediate gateway devices to provide throughput of data. The following data shall be provided at a minimum:

- Fault condition
- Speed
- Amperage
- Frequency
- Voltage
- Bypass status (if supplied)

PROTECTION FEATURES

Use electronic protection circuitry in the power circuits to provide an orderly shutdown of the drive without blowing fuses or tripping circuit breakers and prevent component loss under the following abnormal conditions:

Activation of any safety device;
Instantaneous overcurrent and/or over voltage of output;
Power line overvoltage and undervoltage protection;
Phase loss;
Single and three phase short circuiting;
Ground faults;
Control circuit malfunction;
Overtemperature; and
Output current over limit.

Provide the following additional protective features:

- Input transient overvoltage protection up to 3000 volts per ANSI 37.90A;

- DC bus fusing or other electronic controls which limit the rate of rise of the DC bus current and de-energizes the drive at a predetermined current level;
- Fusing for the control circuit transformer;
- Grounded control chassis; and
- Devices and/or control circuitry to ensure that the variable frequency drive and bypass starter are not both energized and driving motor simultaneously.
- Drives shall have a 100kA SCCR rating.

DIAGNOSTICS

Provide an English character display (no error codes) with indicators for the following:

Phase loss
Ground fault
Overcurrent
Overvoltage
Undervoltage
Over temperature
Overload
DC bus status

QUALITY ASSURANCE TESTS

Use a factory heat stress test to verify proper operation of all functions and components under full load.

Field performance test of variable frequency drives to determine compliance with this specification will be performed at the DFD's discretion and may include any specified feature, including operation of protective devices through a simulated fault. Contractor will pay for initial testing. Should drive be found deficient by this testing, drive manufacturer will be required to make any and all changes necessary to bring unit(s) into compliance with the specified performance and demonstrate this performance by retesting. Cost of changes and retest will be by this contractor.

BYPASS EQUIPMENT

Bypass Starters:

The bypass starters for 208 volt motors, 20 HP and less; and 480 volt motors, 40 HP and less, shall be across-the-line magnetic starter type.

Bypass Configuration:

Provide one main disconnect switch or circuit breaker to de-energize both the drive and bypass circuit. Provide a drive input disconnect switch or fuse block to allow the drive to be isolated while the bypass circuit is energized. Provide one output drive contactor and one output bypass contactor. The two output contactors shall be electrically interlocked to allow only one contactor to be closed at any one time.

Provide motor overload protection in the bypass circuit.

Provide bypass equipment in a common enclosure with the VFD or, if not available, in a separate enclosure.

AC INPUT LINE REACTORS

When needed to comply with the requirement for 5% equivalent impedance, furnish and factory install AC input line reactors.

Line reactors shall be installed in each phase of the AC input side of the VFD and mounted within a common enclosure with the VFD.

Line reactor shall be a three phase inductor, iron core, 600V, Class H insulation, 115 degree C rise, copper windings with screw type terminal blocks.

PART 3 - EXECUTION

VARIABLE FREQUENCY DRIVES

Install where indicated on drawings and in accordance with approved submittals and manufacturer's published recommendations. Installation to be by the Division 26 00 00 - Electrical contractor.

Input power wiring shall be installed in a separate conduit, output power wiring shall be installed in a separate conduit and control wiring shall be installed in a separate conduit. Do not mix input power, output power, or control wiring in a common conduit. Separate conduits for input and output power wiring shall be provided for each motor. Input and output power wiring for more than one motor shall not share a common conduit. Power wiring shall be furnished and installed by the Div. 26 contractor. If provided, do not mount output line filter above the drive.

Control signal for drive will be provided under Division 23.

Temperature Control Contractor will furnish and install the required temperature control wiring in metal conduit and in accordance with Division 26 00 00 - Electrical of this specification.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

FUNCTIONAL PERFORMANCE TESTING

Contractor is responsible for utilizing the functional performance test forms supplied by the third party commissioning agent in accordance with the procedures defined for functional performance testing in Section 01 91 00.

TRAINING

Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 4 hours.

END OF SECTION

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SECTION 23 05 15
PIPING SPECIALTIES

P A R T 1 - G E N E R A L

SCOPE

This section contains specifications for HVAC piping specialties for all piping systems. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- Thermometers
- Thermometer Sockets
- Test Wells
- P/T (Pressure/Temperature) Test Plugs
- Hose Connection Caps
- Pressure Gauges
- Strainers
- Expansion Tanks
- Buffer Tanks
- Coalescing Air and Dirt Separators
- Air Vents
- Suction Diffusers
- Flow Sensing Devices

PART 3 - EXECUTION
- Thermometers
- Thermometer Sockets
- Test Wells
- P/T (Pressure/Temperature) Test Plugs
- Pressure Gauges
- Strainers
- Expansion Tanks
- Buffer Tanks
- Coalescing Air and Dirt Separators
- Air Vents
- Suction Diffusers
- Flow Sensing Devices
- Construction Verification Items

RELATED WORK

Section 23 05 23 - General-Duty Valves for HVAC Piping
Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment p
Section 23 07 00 - HVAC Insulation
Section 23 21 13 - Hydronic Piping
Section 23 21 26 – Ground Source Vertical Heat Exchanger Field
Section 23 57 00 – Heat Exchangers for HVAC
Section 23 73 12 – Air Handling Unit Coils

REFERENCE

Applicable provisions of Division 1 govern work under this section.

QUALITY ASSURANCE

Refer to Division 1.

SHOP DRAWINGS
Refer to Division 1.

Required for all items in this section. Include materials of construction, dimensional data, ratings/capacities/ranges, pressure drop data where appropriate, and identification as referenced in this section and/or on the drawings.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA
All piping specialties are to be rated for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

P A R T 2 - P R O D U C T S

THERMOMETERS
Manufacturers: Ashcroft, Marsh, Taylor, H. O. Trerice, U. S. Gauge, Weiss, Weksler.

Stem Type, cast aluminum case, nine inch scale, clear acrylic window. adjustable angle brass stem with stem of sufficient length so the end of the stem is near the middle of a pipe without reducing the thickness of any insulation, red indicating fluid, black lettering against a white background, with scale ranges as follows:

Service	Scale Range, °F	Min. Increment, °F
Hot Water	30 - 240	2
Chilled Water	0 - 100	1
Geothermal Water	0-120	1

THERMOMETER SOCKETS
Brass with threaded connections suitable for thermometer stems and temperature control sensing elements in pipeline. Furnish with extension necks for insulated piping systems.

TEST WELLS
Similar to thermometer sockets except with a brass cap that thread into the inside of the test well to prevent dirt from accumulating. Secure cap to body with a short chain. Furnish with extension necks, where appropriate, to accommodate the pipeline insulation.

P/T (PRESSURE/TEMPERATURE) TEST PLUGS
Brass plug with 1/4" NPT threads, EPDM or neoprene valve core, knurled cap with cap strap. Use extended length plugs to clear insulated piping. Adaptors shall have 1/4" FPT connection for standard pressure gauges.

HOSE CONNECTON CAPS
Hose connection caps shall be pressure rated for 150 psig at 180 deg F.

PRESSURE GAUGES
Manufacturers: Ametek/U. S. Gauge Division, Ashcroft, Marsh, Taylor, H. O. Trerice, Weiss, Weksler.

Cast aluminum case of not less than 4.5 inches in diameter, double strength glass window, black lettering on a white background, phosphor bronze bourdon tube with bronze bushings, recalibration from the front of the dial, 99% accuracy over the middle half of the scale, 98.5% accuracy over the remainder of the scale, with scale range as follows:

Service	Scale Range, psig	Min. Increment, psig
Hot Water	0-100	1.0
Chilled Water	0-100	1.0
Geothermal Water	0-100	1.0

PRESSURE SNUBBERS:
Bronze construction, suitable for system working pressure, 1/4" size.

COIL SYPHONS:
Bronze or steel construction, suitable for system working pressure, 1/4" size.

GAUGE VALVES:
Use valves as specified in Section 23 05 23 - General-Duty Valves for HVAC Piping. For water systems, use 1/4" ball valves.

STRAINERS
Manufacturers: Armstrong, Hoffman, Illinois, Keckley, Metraflex, Mueller Steam, or Sarco.

Y type; cast iron body; stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; threaded body in sizes through 2 inch and rated at not less than 175 psi WOG; flanged body in sizes over 2 inch and rated at not less than 125 psi WOG at 240°F. Screen to be 20 mesh for line sizes 2 inch and less, 0.125 inch perforations for line sizes 2-1/2 inch through 4 inch, and 0.25 inch perforations for line sizes 5 inch and larger.

EXPANSION TANKS
Manufacturers:
Amtrol/Thrush, Armstrong Pumps, Bell and Gossett, Taco, or Wessels.

Steel construction with finish coat of rust resistant paint, tested and stamped in accordance with Section 8D of ANSI/ASME Code and furnished with the National Board Form U-1, rated for working pressure of not less than 125 PSIG. Tank shall be pre-charged with air to the initial fill pressure indicated on Drawings and have heavy-duty butyl rubber bladder rated for fluid temperatures up to 240□degrees□F. Tank shall include tank drain connection, system connection, and charging valve connection (standard tire valve), and include integral lifting rings, and floor mounting skirt for vertical installation. Size and capacity of tank shall be as specified on Drawings. Tank and bladder construction must allow field replacement of bladder in event of failure.

BUFFER TANKS
Steel construction with prime coat finish, tested and stamped in accordance with Section 8D of ANSI/ASME Code and furnished with National Board Form U-1, rated for working pressure of not less than 125 PSI. Tank shall have hand hole for inspection of tank, drain valve tapping, system supply and return tappings, and mounting saddles for horizontal tank installations, or ring base or angle legs for vertical installations. Tank shall have internal baffles as specified on Drawings. Size and capacity as specified on Drawings. Refer to Drawings for quantity and locations of tank tappings.

Refer to Section 23 07 00 for tank insulation requirements.

COALESCING AIR AND DIRT SEPARATORS
Manufacturers: Bell & Gossett, Taco, Spirotherm, Inc., Wessels
2 inch and larger: Welded steel construction, ASME Section VIII, Division 1 constructed and stamped for a working pressure not less than 150 psig at 250°F, threaded or flanged connections for 2 inch size, flanged or grooved connections if grooved piping is allowed for all sizes over 2 inch. Provide unit with factory installed automatic air vent on the top, blow down connection at the bottom of the unit, and a skimming connection to remove floating dirt. Unit size shall be suitable for the system flow rates as indicated on the drawings.

Internal coalescing material shall be constructed of copper or 304 stainless steel. Unit shall include internal structured elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% entrained air, and 99% dissolved air at the installed location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes.

Provide removable head to access material for inspection and cleaning.

AIR VENTS
MANUAL KEY TYPE VENTS:
Bell and Gossett Model 4V; Eaton/Dole Model 9, 9B, or 14A.

Bronze body with nonferrous internal parts, screwdriver operated, designed to relieve air from the system when vent is opened, rated at not less than 125 psig at 220°F.

MANUAL BALL VALVE VENTS:
Provide 1/4" ball valves for manual venting of air handling unit coils and where indicated elsewhere on drawings and details. Reference specifications section 23 05 23.

AUTOMATIC VENTS:
Thrush Model 720, Bell and Gossett Model 107, Watson McDaniel Model AV813W

Cast iron body with nonferrous internal parts, designed to vent air automatically with float principle without allowing air to enter the system, rated at not less than 125 psig at 220°F.

SUCTION DIFFUSERS
Manufacturers:
Amtrol, Armstrong Pumps, Bell and Gossett, Mueller or Taco.

Body constructed of cast iron, ductile iron or carbon steel; cast iron, steel or stainless steel straightening vanes; steel or stainless steel strainer; brass or bronze fine mesh startup strainer, strainer blowdown connection, inlet pressure gage connection, provisions for field supplied support foot, and bolted flange for strainer removal and cleaning; rated at not less than 150 PSI working pressure at not less than 250□degrees□F.

FLOW SENSING DEVICES
For water flow sensing devices 2 inch and smaller, use balance valves as specified in Section 23 05 23 - General-Duty Valves for HVAC Piping.

PITOT TUBE FLOW SENSORS:
Dieterich Standard/Annubar, Preso, or approved equal.

Multi-port averaging type flow sensor designed to sense the velocity of a fluid flowing in a pipe and produce a pressure output that is proportional to the fluid velocity. Sensor to consist of a type 316 stainless steel probe with a diamond or elliptical shape of sufficient length to sense flow completely across the pipe section and to accommodate the insulation specified for the pipeline; brass body gate, needle, or ball instrument connection valves with appropriate fitting for connection to a meter; single forged steel weld type installation fitting for pipe sizes through 6 inch, double forged steel weld type installation fittings for use on opposite ends of the sensor for larger pipe sizes if recommended by the manufacturer for the application; accurate within 2% of the actual flow with a turndown ratio of 10:1 or better; permanently stamped nameplate attached to the sensor indicating the flow/differential pressure characteristics of the sensor; suitable for use on systems to 150 psig at 250°F.

Include one differential pressure meter kit that includes a six inch diameter gauge having an accuracy of 3% of full scale or better and suitable for the differential pressures of the valves supplied for this project, color coded hoses not less than ten feet in length with brass connectors suitable for connection to the low and high pressure connections on the balance valves, instrument valving so meter can be vented and drained, pressure and temperature rating at least equal to that of the valves. Provide meter and all accessories in a durable case with carrying handle.

P A R T 3 - E X E C U T I O N

THERMOMETERS
STEM TYPE:
Install in piping systems as indicated on the drawings and/or details using a separable socket in each location.

DIAL TYPE FOR AIR TEMPERATURE MEASUREMENT:
Install in ductwork where detailed or specified. Support capillary inside duct so it measures a uniform sample of air. Mount readout so it is readily visible on a portion of ductwork that is not externally insulated or on a sheet metal angle support secured to a nearby structural element.

THERMOMETER SOCKETS
Install at each point where a thermometer or temperature control sensing element is located in a pipeline.

TEST WELLS
Install in piping systems as indicated on the drawings and/or details wherever provisions are needed for inserting a thermometer at a later date.

P/T (PRESSURE/TEMPERATURE) TEST PLUGS
Install in piping systems as indicated on the drawings and/or details. Do not insulate over test plugs.

PRESSURE GAUGES
Install in locations where indicated on the drawings and/or details, including any gauge piping, with scale range appropriate to the system operating pressures.

PRESSURE SNUBBERS:
Install in gauge piping for all gauges used on water services.

GAUGE VALVES
Install at each gauge location as close to the main as possible and at each location where a gauge tapping is indicated.

STRAINERS
Install all strainers where indicated on the project details, allowing sufficient space for the screens to be removed. Rotate screen retainer where required by the installation so blowdown can remove accumulated dirt from the strainer body.

WATER SYSTEMS:
Install a ball valve for blowdown in the tapped screen retainer; valve to be the same size as the tapping.

EXPANSION TANKS
Install tanks where indicated on Drawings, coordinating concrete base installation with General Contractor or fabricate steel supports to suit application. Install specified tank accessories.

Verify proper air charge and recharge if necessary. Install isolation valve in piping connecting tank to system. In piping between tank and isolation valve, install pressure gage and drain valve with hose adapter. Install a drain valve with hose adapter in drain connection of tank. Make sure all drains are accessible and hose can be attached.

BUFFER TANKS
Install tanks where indicated on Drawings, coordinating concrete base installation with General Contractor. Provide structural supports required, including hanger rods for suspended installations and steel supports for wall mounted installations. Fabricate supports to suit application. Install specified tank accessories.

COALESCING AIR AND DIRT SEPARATORS
Mount in hot and/or chilled water lines as indicated on the drawings/details. Install ball valve with hose adapter in bottom blowdown connection and skimming connection.

Open the drain/blowdown valve after system cleaning and again after 30 days of operation.

AIR VENTS
MANUAL KEY TYPE VENTS:
Install at all high points where air may collect and not be carried by the system fluid. Use a soft Type L copper "pigtail" so the vent can be positioned for venting and collecting any water that might escape.

MANUAL BALL VALVE VENTS:
Install on air handling coils and where indicated elsewhere as shown on drawings and details.

AUTOMATIC VENTS:
Install on the top of air separators on systems using bladder type expansion tanks. Install at other locations as indicated on the drawings or details. All locations to have a ball valve installed upstream of the vent for maintenance purposes.

SUCTION DIFFUSERS
Install at each pump suction connection for end suction pumps where shown on Drawings. Provide space for removal of strainer. Install drain valve in the blowdown connection. Install support below the suction diffuser so the weight of suction piping does not rest on pump suction connection.

Install pressure gage across the suction diffuser, valved so single gage can be used to read pump discharge presssure, inlet pressure at the suction diffuser and the outlet pressure at the suction diffuser. Use gage valves as specified with gages.

Open drain valve and blowdown strainer after system cleaning. If unit is furnished with fine mesh startup strainer, remove strainer after the system has been flushed and cleaned just prior to testing and balancing.

FLOW SENSING DEVICES
Give portable meter to Owner at the completion of all balancing work.

PITOT TUBE FLOW SENSORS:
Install where indicated on the drawings and details for flow sensing in hydronic and/or steam piping systems. Butterfly valves installed at the location of a flow sensing device are to have a memory stop.

CONSTRUCTION VERIFICATION ITEMS
Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

END OF SECTION

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SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

SCOPE

This section includes valve specifications for all HVAC systems except where indicated under Related Work. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Quality Assurance
- Submittals
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- Manufacturers
- Water System Valves
  - Ball Valves
  - Butterfly Valves
  - Globe Valves
  - Balance Valves
  - Drain Valves
- Specialty Valves and Valve Accessories
  - Check Valves
  - Triple Duty Valves
  - Water Relief Valves
  - Gauge Valves
  - Chain Wheel Operators
  - Stem Extensions

PART 3 - EXECUTION
- General
- Shut-off Valves
- Balancing Valves
- Calibrated Balancing Valves
- Drain Valves

RELATED WORK

Section 23 05 15 - Piping Specialties
Section 23 09 14 - Electric Instrumentation and Control Devices for HVAC

REFERENCE

Applicable provisions of Division 1 govern work under this section.

QUALITY ASSURANCE

Refer to Division 1, General Conditions, Equals and Substitutions.

SUBMITTALS

Refer to Division 1, General Conditions, Submittals.
Contractors shall submit a schedule of all valves indicating type of service, dimensions, materials of construction, and pressure/temperature ratings for all valves to be used on the project. Temperature ratings specified are for continuous operation.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA
Where valves are specified for individual mechanical services (i.e. hot water heating, steam, etc.) all valves shall be of the same manufacturer unless prior written approval is obtained from DFD.

P A R T 2 - P R O D U C T S

MANUFACTURERS
Anvil, Apollo, Armstrong, Bell & Gossett, Cash-Acme, Dresser Consolidated, Conval, Crane, Anderson Greenwood and Crosby, Danfoss-Flomatic, DeZurik, Durco, Fisher, Grinnell, Griswold, Hammond, Hancock, Hoffman, Jamesbury, Keystone, Kunkle, Leslie, Lunkenheimer/Cincinnati, Metraflex, Milwaukee, Mueller, Newco, Nexus, Nibco, Powell, RP&C, Sarco, Spence, Stockham, Taco, Tasco, Thrush-Amtrol, Vogt, Watts, or approved equal.

WATER SYSTEM VALVES
All water system valves to be rated at not less than 125 psig water working pressure at 240°F unless noted otherwise.

BALL VALVES:
2" and smaller: Two piece bronze body; threaded or soldered ends, as appropriate to the pipe material; stainless steel or chrome plated brass/bronze ball; conventional port; glass filled teflon seat; threaded packing gland follower; blowout-proof stem; 600 psig WOG.

Valve stems shall allow operators to clear insulation without interference. Provide stem extensions when valve operators interfere with pipe insulation.

Apollo 70-100/200 series, Hammond 8301/8311, Milwaukee BA100/150, Nibco T/S 585-70, Stockham S206/216.

2-1/2" and over: Ball valves will not be accepted in sizes over 2 inch.

BUTTERFLY VALVES
2" and smaller: Use ball valves; butterfly valves will not be accepted in sizes 2 inch and smaller.

2-1/2" and larger: Cast iron body; stainless steel shaft; Teflon, nylatron, or acetal bearings; EPDM resilient seat. Disk to be bronze, aluminum-bronze, nickel plated ductile iron, cast iron with welded nickel edge, or 316 - stainless steel. Pressure rated to 150 psig. Valve assembly to be bi-directionally bubble tight to 150 psig with no downstream flange/pipe attached. Nylon coated ductile iron discs are not acceptable. Polymid or polyamide coated valves are not acceptable.

Valve stems shall allow operators to clear insulation without interference. Provide stem extensions when valve operators interfere with pipe insulation.

Use threaded lug type valves for installation with class 125/150 flanges.

Centerline series 200, DeZurik BOS-CL, Keystone Fig. 222, Nibco LD2000 (2-1/2”-12”)/LD1000 (14” and above), Bray Series 31H, Victaulic 300 series (2-1/2”-12”)/709 series (14”-24”).

Provide ten-position lever actuators for valves 6" and smaller.

Where butterfly valves are indicated or specified to be installed at the location of a flow sensing device, provide the butterfly valves with a memory stop.

GLOBE VALVES:
Do not use globe valves for water service, except in temperature control applications.

BALANCE VALVES:
2" and smaller: Bronze or copper alloy body with calibrated ball, globe or venturi/valve arrangement, integral pointer and calibrated scale to register degree of valve opening, memory stop, drain tapping, threaded or soldered ends, with or without integral unions, P/T or Shraeder pressure taps with integral check valves and seals, adjustable memory stop, suitable for 200 psig water working pressure at 250°F.

Armstrong CBV, Bell & Gossett Circuit Setter Plus, Griswold Quickset, Nexus Orturi, Nibco 1710 Series, Taco Accu-Flo, Tour & Anderson STAS/STAD, Victaulic series 786/787.

2-1/2" and larger: Use butterfly valves as specified in this section along with a flow sensing device as specified in Section 23 05 15.

DRAIN VALVES:
Use 3/4 inch ball valve with threaded hose adapter except strainer blowdown valves to be the same size as the blowdown connection.

SPECIALTY VALVES AND VALVE ACCESSORIES
CHECK VALVES:

Swing Check Valves:
2" And Smaller:
Nibco T413Y; bronze body, threaded ends, regrindable seat, renewable disc, teflon seat, 200 psig WOG, acceptable for installation in horizontal or vertical line with flow upward.

2½" And Larger:
Nibco F918B; cast iron body, flanged ends, bronze trim, bolted cap, renewable bronze seat and disc, non-asbestos gasket, 200 psig WOG, acceptable for installation in horizontal or vertical line with flow upward.

Spring Loaded Check Valves:
2" and Smaller:
Nibco T480; bronze, threaded, bronze trim, stainless steel spring, teflon seat unless only bronze available, 250 psig WOG.

2½" and Larger:
Nibco W910 Series; cast iron or semi-steel body, wafer style disk, bronze trim, bronze or EPDM seat, stainless steel spring, stainless steel stem, and 125 psig WOG. Valves with ductile iron in contact with working fluid will not be accepted.

TRIPLE DUTY VALVES:
2 Inch and Larger:
Bell & Gossett Triple Duty Valve; Cast or ductile iron body, threaded or flanged or grooved end connections, stainless steel spring, bronze disc with EPDM seat, calibrated memory stop, backseating valve stem, inlet and outlet pressure tappings, capable of being repacked under full line pressure, rated for working pressure of 125 PSIG at 240□degrees□F when used in hot water heating systems.

WATER RELIEF VALVES:
Iron or bronze body, direct pressure actuated, teflon seat, stainless steel stem and spring, rated for 125 psig water working pressure at 240□degrees□F and ASME stamped, with rated BTU capacity at required relief pressure. Provide required relief valve pressure as specified on Drawings.

GAUGE VALVES:
Water Service: Use 1/4" ball valves.

CHAIN WHEEL OPERATORS:
Construct of cast or ductile iron, with adjustable sprocket rims and chain guides. Use galvanized or brass chain and chain closure links to form a continuous loop of chain at each operator.

STEM EXTENSIONS:
Provide stem extensions when valve operators interfere with pipe insulation.

P A R T 3 - E X E C U T I O N

GENERAL
Properly align piping before installation of valves in an upright position; operators installed below the valves will not be accepted.

Install valves in strict accordance with valve manufacturer's installation recommendations. Do not support weight of piping system on valve ends.

Install all temperature control valves.

Install all valves with the stem in the upright position. Valves may be installed with the stem in the horizontal position only where space limitations do not allow installation in an upright position. Valves installed with the stems down, will not be accepted.

Where valves 2-1/2" and larger are located more than 12'-0" above mechanical room floors, install valve with stem in the horizontal position and provide a chain wheel operator.
Install stem extensions when shipped loose from valve.

Prior to flushing of piping systems, place all valves in the full-open position.

SHUT-OFF VALVES
Install shut-off valves at all equipment, at each branch take-off from mains, and at each automatic valve for isolation or repair.

WATER SYSTEM:
Butterfly valves installed at the location of a flow sensing device are to have a memory stop.

BALANCING VALVES
Provide balancing valves for all major equipment and at each major branch takeoff and at the discharge of each pump as indicated on drawings and details.

CALIBRATED BALANCE VALVES:
Install where indicated on the drawings and details for balancing of hydronic systems. Retain the shipping container for use as removable insulation.

DRAIN VALVES
Provide drain valves for complete drainage of all systems. Locations of drain valves include low points of piping systems, equipment locations specified or detailed including reheat coils, other locations required for drainage of systems.

SWING CHECK VALVES
Provide swing check valves where specified and detailed on Drawings.

SPRING LOADED CHECK VALVES
Install spring loaded check valve in each pump discharge line.

TRIPLE DUTY VALVES
Contractor may use triple duty combination shut-off, check, and balancing valves where separate shut-off valve, check valve, and balancing valve are specified or detailed in pump discharge piping.

WATER RELIEF VALVES
Provide relief valves for each water system.

Setpoint for water relief valves is indicated on Drawings.

Use air pressure to clean piping prior to installation of safety relief valves.

Install relief valves in locations indicated on Drawings. When not indicated on Drawings, locate relief valves at chiller on chilled water systems, on water side of heat exchangers, and on boilers.

Inlet and outlet piping connecting to valves must be same size as valve connections or larger.

Pipe discharge from water system relief valves full size to nearest glycol fill tank.

END OF SECTION

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

P A R T 1 - G E N E R A L

SCOPE

This section includes specifications for supports of all HVAC equipment and materials as well as piping system anchors. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Description
- Shop Drawings
- Design Criteria

PART 2 - PRODUCTS
- Pipe Hanger and Support Manufacturers
- Structural Supports
- Materials
- Pipe Hangers and Supports
- Beam Clamps
- Concrete Inserts
- Post Installed Concrete Anchors
- Corrosive Atmosphere Coatings

PART 3 - EXECUTION
- Installation
- Hanger and Support Spacing
- Vertical Riser Clamps

RELATED WORK

Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
Section 23 07 00 - HVAC Insulation

REFERENCE

Applicable provisions of Division 1 shall govern work under this section.

REFERENCE STANDARDS

MSS SP-58 Materials, Design, Manufacture, Selection, Application, and Installation

QUALITY ASSURANCE

Refer to Division 1, General Conditions, Equals and Substitutions.

DESCRIPTION

Provide all supporting devices as required for the installation of mechanical equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for pressure piping.

Do not hang any mechanical item directly from a metal deck or run piping so it rests on the bottom chord of any truss or joist.

Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.

Protect insulation at all hanger points; see Related Work above.

SHOP DRAWINGS

Refer to Division 1, General Conditions, Submittals.

Schedule of all hanger and support devices indicating shields, attachment methods, and type of device for each pipe size and type of service. Reference section 23 05 00.

DESIGN CRITERIA

Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 unless noted otherwise.

Piping connected to base mounted pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.

Piping flexible connections and vibration isolation supports are required for piping connected to coils that are in a fan assembly where the entire assembly is mounted on vibration supports; the vibration isolation supports are required for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Piping flexible connection and vibration isolation supports are not required when the fan section is separately and independently isolated by means of vibration supports and duct flexible connections. Standard pipe hangers/supports as specified in this section are required when there are no vibration isolation devices in the piping and beyond the 100 pipe diameter/3 support distance.

Piping supported by laying on the bottom chord of joists or trusses will not be accepted.

Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.

Allow sufficient space between adjacent pipes and ducts for insulation, valve operation, routine maintenance, etc.

P A R T 2 - P R O D U C T S

PIPE HANGER AND SUPPORT MANUFACTURERS

Anvil, B-Line, Fee and Mason, Kindorf, Michigan Hanger, Unistrut, or approved equal. Anvil figure numbers are listed below; equivalent material by other manufacturers is acceptable.

STRUCTURAL SUPPORTS

Provide all supporting steel required for the installation of mechanical equipment and materials, whether or not it is specifically indicated or sized, including angles, channels, beams, etc. to suspend or floor support tanks and equipment.

Contractor shall be responsible for the design of trapeze pipe hangers, structural pipe supports, and equipment supports.

MATERIALS

Aluminum: ASTM B221.

Carbon Steel: ASTM A1011/A1011M.

Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

Stainless Steel: ASTM A240/A240M.

Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications. Nonstaining, noncorrosive, and nongaseous. Design mix shall be 5000-psi, 28-day compressive strength.

PIPE HANGERS AND SUPPORTS

HANGERS FOR STEEL PIPE SIZES 1/2" THROUGH 2":
Carbon steel, adjustable, clevis, black finish. Anvil figure 65 or 260.

HANGERS FOR STEEL PIPE SIZES 2-1/2" AND OVER:
Carbon steel, adjustable, clevis, black finish. Anvil figure 260.

Adjustable steel yoke, cast iron roll, double hanger. Anvil figure 181.

MULTIPLE OR TRAPEZE HANGERS:
Steel channels with welded spacers and hanger rods if calculations are submitted.

WALL SUPPORT:
Welded steel bracket with hanger. B-Line 3068 Series, Anvil 194 Series.

Perforated epoxy painted finish, 16-12 gauge min., steel channels securely anchored to wall structure with interlocking, split type, bolt secured, galvanized pipe/tubing clamps. B-Line type S channel with B-2000 series clamps, Anvil type AS200 H with AS 1200 clamps. When copper piping is being supported, provide flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Anvil cushion clamp assembly.

VERTICAL RISER SUPPORT:
Carbon steel riser clamp, copper plated when used with copper pipe. Anvil figure 261 for steel pipe, figure CT121 for copper pipe.

FLOOR SUPPORT FOR PIPE SIZES THROUGH 4":
Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.

FLOOR SUPPORT FOR PIPE SIZES 5" AND OVER:
Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

COPPER PIPE SUPPORT:
Carbon steel ring, adjustable, copper plated or polyvinylchloride coated.

INSULATION PROTECTION SHIELDS:
Galvanized carbon steel of not less than 18 gauge for use on insulated pipe 2-1/2 inch and larger. Minimum shield length is 12 inches. Equal to Anvil figure 167.

Refer to Section 23 07 00 for additional requirements including required insulation inserts.

STEEL HANGER RODS:
Threaded both ends, threaded one end, or continuous threaded, black finish.

Size rods for individual hangers and trapeze support as indicated in the following schedule.

Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed the limits indicated.

Maximum Load (Lbs.) (650°F Maximum Temp.)	Rod Diameter (inches)
610	3/8
1130	1/2
1810	5/8
2710	3/4
3770	7/8
4960	1
8000	1-1/4

Provide rods complete with adjusting and lock nuts.

BEAM CLAMPS
MSS SP-58 Type 23 malleable black iron clamp for attachment to beam flange to 0.62 inches thick for single threaded rods of 3/8, 1/2, and 5/8 inch diameter, for use with pipe sizes 4 inch and less. Furnish with a hardened steel cup point set screw. Anvil figure 86.

MSS SP-58 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2 inch diameter but limited in application to pipe sizes 8 inch and less without prior approval. Anvil figure 228.

CONCRETE INSERTS
Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor. Hilti, Rawl, Redhead.

POST INSTALLED CONCRETE ANCHORS
Hilti, Mason Industries, Powers Fasteners, Simpson Strong-Tie Co. Cooper B-Line.

Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

Expansion-type anchor bolts are not permitted for equipment more than 10 hp that is not vibration isolated. Undercut expansion anchors are permitted.

CORROSIVE ATMOSPHERE COATINGS

Factory coat supports and anchors used in corrosive atmospheres with hot dip galvanizing after fabrication, ASTM A123, 1.5 ounces/square foot of surface, each side. Mechanical galvanized threaded products, ASTM B695 Class 150, 2.0 mil coating. Field cuts and damaged finishes to be field covered with zinc rich paint of comparable thickness to factory coating.

Corrosive atmospheres include the following locations:

- Exterior locations
- Hazardous storage rooms
- Chemical waste/storage rooms

PART 3 - EXECUTION

INSTALLATION

Install supports to provide for free expansion of the piping and duct system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.

Install pipe hangers in accordance with MSS SP-58.

Piping shall be supported independently from ductwork and all other trades.

Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes for the supporting steel.

Perform all welding in accordance with standards of the American Welding Society. Clean surfaces of loose scale, rust, paint or other foreign matter and properly align before welding. Use wire brush on welds after welding. Welds shall show uniform section, smoothness of weld metal and freedom from porosity and clinkers. Where necessary to achieve smooth connections, joints shall be dressed smooth.

HANGER AND SUPPORT SPACING

Place a hanger within 12 inches of each horizontal elbow, valve, strainer, or similar piping specialty item.

Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.

Support riser piping independently of connected horizontal piping.

Adjust hangers to obtain the slope specified in the piping section of this specification .

Space hangers for pipe as follows:

Pipe Material	Pipe Size	Max. Spacing
Steel	1/2" through 1-1/4"	6'-6"
Steel	1-1/2" through 6"	10'-0"
Steel	8" through 12"	14'-0"
Copper	1/2" through 1-1/4"	5'-0"
Copper	1-1/2" and larger	8'-0"

VERTICAL RISER CLAMPS

Support vertical piping with clamps secured to the piping and resting on the building structure or secured to the building structure below at each floor.

END OF SECTION

SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

P A R T 1 - G E N E R A L

SCOPE

This section includes specifications for vibration isolation material for equipment, piping systems, and duct systems. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Quality Assurance
- Design Criteria
- Shop Drawings

PART 2 - PRODUCTS
- Materials
- Vibration Isolation Manufacturers
- Type 1: Neoprene Pad
- Type 3: Unhoused Spring with Neoprene
- Type 4: Housed Spring with Neoprene
- Type 5: Spring Hanger with Neoprene
- Type 6: Precompressed Spring with Neoprene
- Type IB: Inertia Base
- Flexible Piping Connections
- Performance
- Blower Minimum Deflection Guide

PART 3 - EXECUTION
- Installation
- Packaged Air Handling Units and Centrifugal Fans

RELATED WORK

Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
Section 23 21 23 - Hydronic Pumps
Section 23 33 00 - Air Duct Accessories
Section 23 34 00 - HVAC Fans
Section 23 64 23 – Modular Heat Recovery Chillers
Section 23 73 13 - Modular Indoor Central-Station Air-Handling Units

REFERENCE

Applicable provisions of Division 1 govern work under this section.

QUALITY ASSURANCE

Refer to Division 1, General Conditions, Equals and Substitutions.

DESIGN CRITERIA

Isolate all motor driven mechanical equipment from the building structure and from the systems which they serve to prevent equipment vibrations from being transmitted to the structure. Consider equipment weight distribution to provide uniform isolator deflections.

For equipment with variable speed capability, select vibration isolation devices based on the lowest speed.

Provide flexible piping connections for all piping to rotating or reciprocating equipment mounted on vibration isolators except do not use flexible piping connectors on any type of gas piping or with inline pumps. Piping connected to a coil which is in an assembly mounted on vibration isolators is to have flexible piping connections and piping vibration hangers as specified below. Piping connected to a coil which is in an assembly where the fan is separately isolated by means of vibration isolators and duct flexible connections does not require flexible piping connectors or piping vibration hangers.

Coordinate the selection of devices with the isolator and equipment manufacturers.

SHOP DRAWINGS
Refer to Division 1, General Conditions, Submittals.

Include isolator type, materials of construction, isolator free and operating heights, and isolation efficiency based on the lowest operating speed of the equipment supported.

P A R T 2 - P R O D U C T S

MATERIALS
Use materials that will retain their isolation characteristics for the life of the equipment served. Use industrial grade neoprene for elastomeric materials.

Treat all isolators to resist corrosion. For isolation devices exposed to the weather or used in high humidity areas, hot dip galvanize steel parts, apply a neoprene coating on all steel parts, or use stainless steel parts; include limit stops to resist wind.

Provide pairs of neoprene side snubbers or restraining springs where side torque or thrust may develop.

Use isolators with a ratio of lateral to vertical stiffness not less than 1.0 or greater than 2.0.

VIBRATION ISOLATOR MANUFACTURERS
Mason Industries, Amber/Booth Co., Vibration Mounting & Controls, Peabody Noise Control, or approved equal.

TYPE 1: NEOPRENE PAD:
Neoprene waffle pad, 40 durometer with 16 gauge shims between layers.

TYPE 3: UNHOUSED SPRING WITH NEOPRENE
Combination freestanding, unhoused spring and neoprene with rib molded antifriction base. Include leveling bolts for securing to the equipment. Springs to be laterally stable under load and selected so they have an additional travel to solid equal to 50% of the rated deflection. Use height saving brackets when appropriate to the application.

TYPE 4: RESTRAINED SPRING WITH NEOPRENE
Combination spring and neoprene with rib molded base similar to Type 3 mount above, but with a housing that includes vertical limit stops to prevent spring extension when weight is removed such that the installed and operating heights are the same. Maintain a minimum clearance of 1/2" around restraining bolts, and between the housing and the spring, so as not to interfere with the spring action.
Design isolator so limit stops are out of contact during normal operation.. Use height saving brackets when appropriate to the application.

TYPE 5: SPRING HANGER WITH NEOPRENE
Vibration hanger with a steel spring and 0.3" deflection neoprene element in series. Use neoprene element molded with a rod isolation bushing that passes through the hanger box. Select spring diameters and size hanger box lower holes large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Select springs so they have a minimum additional travel to solid equal to 50% of the rated deflection.

TYPE 6: PRECOMPRESSED SPRING HANGER WITH NEOPRENE
Vibration hanger similar to Type 5 but precompressed to the rated deflection to keep the piping or equipment at a fixed elevation during installation. Design hanger with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load.

TYPE IB: INERTIA BASE:
Rectangular structural beam or channel form, designed to accommodate poured concrete fill for use as floating foundation. Include support for suction and discharge base ells for split case pump bases. Use perimeter steel members with minimum depth equal to 1/12 of longest dimension of base but not less than 6 inches; base depth need not exceed 12 inches unless specifically recommended by base manufacturer for mass or rigidity. Include concrete reinforcements consisting of steel angles or ½ inch bars welded in place on 6 inch centers running in 2 layers perpendicular to each other and 1-1/2 inch above bottom; provide additional steel if required by structural conditions. Furnish form with steel bolting templates and anchor bolt sleeves to receive equipment anchor bolts where anchor bolts fall in concrete locations. Use height saving brackets to maintain base clearance of at least 1 inch above floor or housekeeping pad.

FLEXIBLE PIPING CONNECTIONS

Suitable for pressure, temperature, and fluid involved; minimum pressure rating for any system is 125 psig at the design temperature of the fluid. Use 12 inch minimum line length of flexible hose or length required to absorb 3/4" lateral movement, whichever is greater.

MANUFACTURERS:
Flexonics, Mason, Mercer Rubber, Metraflex, or approved equal.

WATER:
Multiple plies of nylon tire cord fabric reinforced with an EPDM cover and liner. Do not use steel wire or rings as pressure reinforcement. Use threaded or soldered connections for sizes 2" and smaller and floating steel or ductile iron flanges for sizes 2-1/2" and larger; design the steel flange end so the steel flange is recessed to lock a steel wire bead ring in the raised face of the EPDM flange. Construct straight-through connections with twin spheres. Use control rods when recommended by the manufacturer.

PERFORMANCE

Select vibration isolation devices as indicated below or to provide not less than 95% isolation efficiency, whichever is greater.

	Floor Span or Column Spacing							
	On Grade		20 Feet		30 Feet		40 Feet	
TYPE OF EQUIPMENT	Iso. Type	Min. Static Defl. In.	Iso. Type	Min. Static Defl. In.	Iso. Type	Min. Static Defl. In.	Iso. Type	Min. Static Defl. In.
REFRIGERATION MACHINES	1	0.10	4	0.75	4	0.75	4	1.50
PUMPS, CLOSE COUPLED: Thru 5 HP	Grout to Pad		3-IB	0.75	3-IB	0.75	3-IB	0.75
7 ½ HP and Over	Grout to Pad		3-IB	0.75	3-IB	1.5	3-IB	1.5
SQUARE IN-LINE, MIXED FLOW: Suspended	Use Type 4 mount with deflection from blower minimum deflection guide up to 0.75 inch deflection. Over .75 inch deflection, use Type 4-S mount.							
PIPING CONNECTED TO EQUIPMENT:	Flexible piping connections.							

BLOWER MINIMUM DEFLECTION GUIDE

	Required Deflection (Inches)			
Fan Speed (RPM)	On Grade	20' Floor Span	30' Floor Span	40' Floor Span
175-224	0.35	3.50	4.50	4.50
225-299	0.35	3.50	3.50	3.50
300-374	0.35	2.50	2.50	3.50
375-499	0.35	1.50	2.50	3.50
500 and over	0.35	0.75	1.50	2.50

P A R T 3 - E X E C U T I O N

INSTALLATION

Install vibration isolation devices for motor driven equipment in accordance with the manufacturer's installation instructions.

Set steel and inertia bases for one inch clearance between the concrete floor or housekeeping pad and the base.

Do not allow installation practices to short circuit any isolation device.

Install flexible piping connections on the equipment side of shut-off valves.

PACKAGED AIR HANDLING UNITS AND CENTRIFUGAL FANS

Attach horizontal thrust restraints at the centerline of thrust and symmetrically on either side of the unit. Thrust restraints are not required when the fan section in not isolated from the remainder of the air handling unit by means of duct flexible connections.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

P A R T 1 - G E N E R A L

SCOPE

This section includes air and water testing, adjusting and balancing for the entire project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Description
- Quality Assurance
- Pre-Installation Meeting and Scheduling
- Pre-Balance Conference
- Submittals

PART 2 - PRODUCTS
- Instrumentation

PART 3 - EXECUTION
- Preliminary Procedures
- Performing Testing, Adjusting and Balancing
- VAV Supply Duct System Static Pressure Set Point
- Hydronic System Differential Pressure Control Set Point
- Deficiencies
- Functional Performance Testing

RELATED WORK

Section 23 05 00 Common Work Results for HVAC
Section 23 07 00 HVAC Insulation
Section 23 09 14 Electric Instrumentation and Control Devices for HVAC
Section 23 09 24 Direct Digital Control System for HVAC

REFERENCE

Applicable provisions of the General Conditions, Supplementary General Conditions and General Requirements in Division 1 govern work under this section.

REFERENCE STANDARDS

AABC	National Standards for Total System Balance, Sixth Edition, 2002.
ASHRAE	ASHRAE Handbook, 2007 HVAC Applications, Chapter 37, Testing Adjusting and Balancing.
NEBB	Procedural Standards for Testing Adjusting Balancing of Environmental Systems, Seventh Edition, 2005.
TABB	Tab Procedural Guide, First Edition, 2003.

DESCRIPTION

The Contractor will separately contract with an independent test and balance agency to perform all testing, adjusting, and balancing of air and hydronic systems required for this project. Work related to the testing, adjusting, and balancing that must be performed by the installing mechanical contractor is specified in other section of these specifications.
Provide total mechanical systems testing, adjusting and balancing. Requirements include the balance of air and water distribution, adjustment of new and existing systems and equipment to provide design requirements indicated on the drawings, electrical measurement and verification of performance of all mechanical equipment, all in accordance with standards published by AABC, NEBB, or TABB.

Test, adjust and balance all air and hydronic systems so that each room, piece of equipment or terminal device meets the design requirements indicated on the drawings and in the specifications.

Accomplish testing, adjusting and balancing work in a timely manner that allows partial occupancy of major buildings, occupancy of one building when the project involves many buildings, and completion of the entire project in the time stated in the Instruction to Bidders and in accordance with the completion schedule established for this project.

Verify that provisions are being made to accomplish the specified testing, adjusting and balancing work. If problems are found, handle as specified in Part 3 under Deficiencies.

QUALITY ASSURANCE

Qualifications

An independent Firm specializing in the Testing and Balancing of HVAC systems for a minimum of 3 years. A Firm not engaged in the commerce of furnishing or providing equipment or material generally related to HVAC work other then that specifically related to installing Testing and Balancing components necessary for work in this section such as, but not limited to sheaves, pulleys, and balancing dampers.

A certified member of AABC or certified by NEBB or TABB in the specific area of work performed. Maintain certification for the entire duration of the project. If certification of firm or any staff performing work is terminated or expires during the duration of the project, contact DFD immediately.

Technicians on this project must have satisfactorily completed work on a minimum of (3) three projects of at least 50% in size, and of similar complexity. Size is defined as the quantity of each specific individual item requiring testing and balancing such as, but not limited to, equipment, devices, terminal devices, and grilles and diffusers.

PRE-INSTALLATION MEETING AND SCHEDULING

The test and balance agency is required to attend a pre-installation meeting with all other project contractors before the construction process is started. The test and balance agency shall give the Lead Contractor a detailed schedule of testing and balancing tasks for incorporation into the project schedule.

PRE-BALANCE CONFERENCE

90 days prior to beginning testing, adjusting and balancing, schedule and conduct a meeting with the HVAC contractor, General Contractor, Temperature Control Contractor and Architect/Engineer. Provide a complete copy of the TAB plan for the project. The objective is final coordination and verification of system operation and readiness for testing, adjusting and balancing procedures and scheduling procedures with the above mentioned parties. Indicate work required to be completed prior to testing, adjusting, and balancing and identify the party responsible for completion of that work.

SUBMITTALS

See also Related Work in this section.

Submit testing, adjusting and balancing reports bearing the seal and signature of the NEBB, AABC or TABB Certified Test and Balance Supervisor. The reports certify that the systems have been tested, adjusted and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed and are operating; and are an accurate record of all final quantities measured to establish normal operating values of the systems.

Format: Cover page identifying project name, project number and descriptive title of contents. Divide the contents of the report into the below listed divisions:

- General Information
- Summary
- Air Systems
- Hydronic Systems

Contents: Provide the following minimum information, forms and data:

General Information: Inside cover sheet identifying Test and Balance Agency, Contractor, Architect, Engineer, Project Name and Project Number. Include addresses, contact names and telephone numbers. Also include a certification sheet containing the seal and signature of the Test and Balance Supervisor.

Summary: Provide summary sheet describing mechanical system deficiencies. Describe objectionable noise or drafts found during testing, adjusting and balancing. Provide recommendations for correcting unsatisfactory performances and indicate whether modifications required are within the scope of the contract, are design related or installation related. List instrumentation used during testing, adjusting and balancing procedures.

The remainder of the report to contain the appropriate standard NEBB, AABC, or TABB forms for each respective item and system. Fill out forms completely. Where information cannot be obtained or is not applicable indicate same.

P A R T 2 - P R O D U C T S

INSTRUMENTATION

Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements to be in accordance with the requirements of NEBB, AABC, or TABB Standards and instrument manufacturer's specifications.

All instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by the owner or AE upon request. Calibration and maintenance of all instruments to be in accordance with the requirements of NEBB, AABC, or TABB Standards

PART 3 - EXECUTION

PRELIMINARY PROCEDURES

Review preconstruction meeting report, applicable construction bulletins, applicable change orders and approved shop drawings of equipment, outlets/inlets and temperature controls.

Check filters for cleanliness, dampers and valves for correct positioning, equipment for proper rotation and belt tension, temperature controls for completion of installation and hydronic systems for proper charge and purging of air.

Notify General Contractor on a daily basis during balancing. Identify deficiencies preventing completion of testing, adjusting and balancing procedures. Do not proceed until systems are fully operational with all components necessary for complete testing, adjusting and balancing. Installing Contractors are required to provide personnel to check and verify system completion, readiness for balancing and assist Balancing Agency in providing specified system performance.

EXISTING EQUIPMENT

The following shall be tested and balanced:

- Existing Exhaust Fans EF-7
  - Rebalance each exhaust fan airflow.
- AHU-1 (E)
  - Rebalance supply fan airflow.
  - Rebalance minimum and maximum outside airflow.
    - Coordinate outside air dampers positions with temperature controls contractor.
  - Rebalance chilled water coil.
  - Rebalance all grilles, registers, and diffusers associated with this air handling system as noted on the Drawings.
- BC-1 (E) & BC-2 (E)
  - Rebalance hot water coil.
- RF-1 (E)
  - Rebalance return fan airflow.
- AHU-2 (E)
  - Rebalance chilled water coil.
- AHU-3 (E)
  - Rebalance chilled water coil.

PERFORMING TESTING, ADJUSTING AND BALANCING

Perform testing, adjusting and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards except as may be modified below.
Unless specifically instructed in writing, all work in this specification section is to be performed during the normal workday.

In areas containing ceilings, remove ceiling tile to accomplish balancing work; replace tile when work is complete and provide new tile for any tile that are damaged by this procedure. If the ceiling construction is such that access panels are required for the work of this section and the panels have not been provided, inform the owner's project representative.

Cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary for adequate performance of procedures. Patch using materials identical to those removed, maintaining vapor barrier integrity and pressure rating of systems.

In air systems employing filters, blank off sufficient filter area to simulate a pressure drop that is midway between that of a clean filter and that of a dirty filter.

Measure and record system measurements at the fan and/or pump to determine total flow. Adjust equipment as required to yield specified total flow at terminals. Proceed taking measurements in mains and branches as required for final terminal balancing. Perform terminal balancing to specified flows balancing branch dampers, deflectors, extractors and valves prior to adjustment of terminals.

Measure and record static air pressure conditions across fans, coils and filters. Indicate in report if cooling coil measurements were made on a wet or dry coil and if filter measurements were made on a clean or dirty filter. Spot check static air pressure conditions directly ahead of terminal units.

Adjust outside air, return air and relief air dampers for design conditions at both the minimum and maximum settings and record both sets of data. Balance modulating dampers at extreme conditions and record both sets of data. Balance variable air volume systems at maximum air flow rate, full cooling, and minimum flow rate, full heating; record all data.

Adjust register, grille and diffuser vanes and accessories to achieve proper air distribution patterns and uniform space temperatures free from objectionable noise and drafts within the capabilities of the installed system.

Provide fan and motor drive sheave adjustments necessary to obtain design performance. Provide drive changes specifically noted on drawings, if any. If work of this section indicates that any drive or motor is inadequate for the application, advise the owner's project representative by giving the representative properly sized motor/drive information (in accordance with manufacturers original service factor and installed motor horsepower requirements); Confirm any change will keep the duct/piping system within its design limitations with respect to speed of the device and pressure classification of the distribution system.

Required motor/drive changes not specifically noted on drawings or in specifications will be considered an extra cost and will require an itemized cost breakdown submitted to owner's project representative. Prior authorization is needed before this work is started.

Areas or rooms designed to maintain positive, negative or balanced air pressures with respect to adjacent spaces, as indicated by the design air quantities, require special attention. Adjust fan drives, distribution dampers, terminals and controls to maintain indicated pressure relationship.

Final air system measurements to be within the following range of specified cfm:

Fans	0% to +10%
Supply grilles, registers, diffusers	0% to +10%
Return/exhaust grilles, registers	0% to -10%

Final water system measurements must be within the following range of specified gpm:

Heating flow rates	0% to -10%
Cooling flow rates	-5% to +5%

Contact the temperature control Contractor for assistance in operation and adjustment of controls during testing, adjusting and balancing procedures. Cycle controls and verify proper operation and setpoints. Include in report description of temperature control operation and any deficiencies found.

Permanently mark equipment settings, including damper and valve positions, control settings, and similar devices allowing settings to be restored. Set and lock memory stops.

Leave systems in proper working order, replacing belt guards, closing access doors and electrical boxes, and restoring temperature controls to normal operating settings.

Verify and record, in the T&B Report, “K” factors for all VAV air terminal devices and air flow stations.

Coordinate air handling unit minimum outside air set points with the Temperature Control Contractor.

VAV SUPPLY DUCT SYSTEM STATIC PRESSURE SET POINT

For VAV supply systems with VAV air terminal devices, determine the minimum required duct static pressure at the DDC static pressure sensor location(s) needed to ensure that all VAV air terminals are operating at their design airflows with the most demanding VAV terminal wide open. Provide these static pressure numbers to the DDC temperature controls contractor and record them in the T&B report for each system.

HYDRONIC SYSTEM DIFFERENTIAL PRESSURE CONTROL SET POINT

For hydronic systems with variable speed pumping, determine the minimum required system differential pressure set point needed to insure that all terminal devices are operating at their design water flows with the most demanding terminals device control valve wide open. Provide the differential control setting set point to the DDC temperature control contractor and record them in the T&B report for each system.

For HVAC pumps 10 horsepower or less, valve throttling alone may be used for hydronic system balancing.

Throttling of triple-duty valves shall not exceed 50% closed. Where additional throttling would be necessary to achieve the system design flow the impellor shall be trimmed.

Verify Triple duty valve utilized on systems with Variable Frequency Drives are 100% open when balancing work is complete.

The pressure drop across triple duty valves shall not exceed 25 ft. w.g. Where additional throttling would be necessary to achieve the system design flow the impellor shall be trimmed.

For HVAC pumps greater than 10 horsepower through 60 horsepower, trim the impellor where valve throttling will result in a draw that exceeds 3 horsepower.

Future fouling of an open piping system may be considered when determining impellor trim requirements.

Verify butterfly valves utilized for hydronic system balancing are provided with position-lock operators (memory stops) in accordance with Section 23 05 23. The adjustment and marking of lever-lock operators that use throttling notches will not be accepted. Lock all memory stops so the valves can be reopened to their balanced positions if they are used for isolation purposes.

DEFICIENCIES

Division 23 00 00 contractor to correct any installation deficiencies found by the test and balance agency that were specified and/or shown on the Contract Documents to be performed as part of that division of work. All corrective work shall be done at no additional cost to the Owner.

Retest mechanical systems, equipment, and devices once corrective work is complete as specified.

FUNCTIONAL PERFORMANCE TESTING

Contractor is responsible for utilizing the functional performance test forms supplied by the third party commissioning agent in accordance with the procedures defined for functional performance testing in Section 01 91 00.

END OF SECTION

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SECTION 23 07 00
HVAC INSULATION

P A R T 1 - G E N E R A L

SCOPE

This section includes insulation specifications for heating, ventilating and air conditioning piping, ductwork and equipment. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference Standards
- Quality Assurance
- Description
- Definitions
- Shop Drawings
- Operation and Maintenance Data
- Environmental Requirements

PART 2 - PRODUCTS
- Materials
- Insulation Types
- Jackets
- Insulation Inserts and Pipe Shields
- Accessories

PART 3 - EXECUTION
- Examination
- Installation
- Protective Jacket Installation
- Piping, Valve and Fitting Insulation
- Piping Protective Jackets
- Pipe Insulation Schedule
- Duct Insulation
- Ductwork Protective Coverings
- Duct Insulation Schedule
- Equipment Insulation
- Equipment Insulation Schedule
- Construction Verification Items

RELATED WORK

Section 23 05 00 - Common Work Results for HVAC
Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
Section 23 21 13 - Hydronic Piping
Section 23 31 00 - HVAC Ducts and Casings

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

ASTM B209	Aluminum and Aluminum Alloy Sheet and Plate
ASTM C165	Test Method for Compressive Properties of Thermal Insulations
ASTM C177	Heat Flux and Thermal Transmission Properties
ASTM C302	Density of Preformed Pipe Insulation
ASTM C303	Density of Preformed Block Insulation
ASTM C355	Test Methods for Test for Water Vapor Transmission of Thick Materials
ASTM C449	Mineral Fiber Hydraulic Setting Thermal Insulation Cement
ASTM C518	Heat Flux and Thermal Transmission Properties
ASTM C534	Preformed Flexible Elastomeric Thermal Insulation
ASTM C578	Preformed, Block Type Cellular Polystyrene Thermal Insulation
ASTM C591	Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C921	Properties of Jacketing Materials for Thermal Insulation

ASTM C1136	Flexible Low Permeance Vapor Retarders for Thermal Insulation
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension
ASTM D1000	Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
ASTM D1621	Standard Test Method for Compressive Properties Of Rigid Cellular Plastics
ASTM D1622	Standard Test Method for Apparent Density of Rigid Cellular Plastics
ASTM D1940	Method of Test for Porosity of Rigid Cellular Plastics
ASTM D2126	Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
ASTM D2240	Standard Test Method for Rubber Property—Durometer Hardness
ASTM E84	Surface Burning Characteristics of Building Materials
ASTM E814	Standard Test Method for Fire Tests of Penetration Firestop Systems
MICA	National Commercial & Industrial Insulation Standards
NFPA 225	Surface Burning Characteristics of Building Materials
UL 723	Surface Burning Characteristics of Building Materials

QUALITY ASSURANCE

Refer to Division 1, General Conditions, Equals and Substitutions

Label all insulating products delivered to the construction site with the manufacturer's name and description of materials.

Insulation systems shall be applied by experienced contractors. Within the past five (5) years, the contractor shall be able to document the successful completion of a minimum of three (3) projects of at least 50% of the size and similar scope of the work specified in this section.

DESCRIPTION

Furnish and install all insulating materials and accessories as specified or as required for a complete installation. The following types of insulation are specified in this section:

- Pipe Insulation
- Duct Insulation
- Equipment Insulation

Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions.

DEFINITIONS

Concealed: shafts, furred spaces, space above finished ceilings, utility tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

SHOP DRAWINGS

Refer to Division 1, General Conditions, Submittals.

Submit a schedule of all insulating materials to be used on the project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

ENVIRONMENTAL REQUIREMENTS

Do not store insulation materials on grade or where they are at risk of becoming wet. Do not install insulation products that have been exposed to water.

Protect installed insulation work with plastic sheeting to prevent water damage.

P A R T 2 - P R O D U C T S

MATERIALS

Manufacturers: Armacell, Certainteed, Manson, Childers, Dow, Extol, Fibrex, Halstead, H.B. Fuller, Imcoa, Johns Manville, Knauf, Owens-Corning, Partek, Pittsburgh Corning, Rubatex, VentureTape or approved equal.

Materials or accessories containing asbestos will not be accepted.

Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less, with the following exceptions:

Pipe insulation which is not located in an air plenum may have a flame spread rating not over 25 and a smoke developed rating no higher than 450 when tested in accordance with UL 723 and ASTM E84.

INSULATION TYPES

Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.

FLEXIBLE FIBERGLASS INSULATION:
Minimum nominal density of 0.75 lbs. per cu. ft., and thermal conductivity of not more than 0.3 at 75 degrees F, rated for service to 250 degrees F.

RIGID FIBERGLASS INSULATION:
Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F, minimum compressive strength of 25 PSF at 10% deformation, rated for service to 450 degrees F.

BLOCK INSULATION:
Owens-Corning Kaylo 10, Schuller Thermo-12 hydrous calcium silicate, ASTM C533, Type I, acceptable for use to a maximum operating temperature of 1,200□degrees□F. Material to be visually coded or marked to indicate it is asbestos free. Thermal conductivity shall not be more than 0.44 at 300□degrees□F, with dry density 12.5 lbs. per cu. ft. minimum.
Provide jacket of 6 oz. per sq. yd. fiberglass cloth embedded in 2 coats of weatherproof mastic. Field or factory applied stainless steel or aluminum jacket may be substituted for fiberglass cloth jacket at contractors option.

ELASTOMERIC INSULATION:
Flexible closed cell, minimum nominal density of 5.5 lbs. per cu. ft., thermal conductivity of not more than 0.27 at 75 degrees F, minimum compressive strength of 4.5 psi at 25% deformation, maximum water vapor permeability of 0.17 perm inch, maximum water absorption of 6% by weight, rated for service range of -20 degrees F to 220 degrees F on piping and 180 degrees F where adhered to equipment.

EXTRUDED POLYSTYRENE INSULATION:
Rigid closed cell, minimum nominal density of 1.6 lbs. per cu. ft., thermal conductivity of not more than 0.285 at 75 degrees F, minimum compressive strength of 20 psi, maximum water vapor permeability of 1.5 perm inch, maximum water absorption of .5 % by volume, rated for service range of -290 degrees F to 165 degrees F.

POLYISOCYANURATE INSULATION:
Rigid closed cell polyisocyanurate, minimum nominal density of 2.0 lbs. per cu. ft., thermal conductivity of not more than 0.19 at 75 degrees F aged 180 days, minimum compressive strength of 24 psi parallel and 13 psi perpendicular, maximum water vapor permeability of 4 perm inch, maximum water absorption of 2% by volume, rated for service range of -290 degrees F to 300 degrees F.

JACKETS

PVC FITTING COVERS AND JACKETS (PFJ):
White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation, in kitchens or food processing areas or installed outdoors. Jacket thickness to be minimum .02" indoors/.03"outdoors for piping 12" and smaller, .03" indoors/.04" outdoors for piping 15" and larger.

ALL SERVICE JACKETS (ASJ):
Heavy duty, fire retardant material with white kraft reinforced foil vapor barrier, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.

FOIL SCRIM ALL SERVICE JACKETS (FSK):
Glass fiber reinforced foil kraft laminate, factory applied to insulation. Maximum permeance of .02 perms and minimum beach puncture resistance of 25 units.

SELF-ADHERING JACKETS (SAJ):
5-ply, self-adhering multiple laminated waterproofing material with reflective aluminum foil, high density polymer films and cold weather acrylic adhesive providing zero (0.0) permeability. Minimum 6 mils material thickness, 35lb puncture resistance when tested in accordance with ASTM D1000 and flame spread/smoke developed rating of 10/20 when tested in accordance with UL 723.

Vapor retarding tape shall be specifically designed and manufactured for use with the self-adhering jacket specified above. Tape shall be provided by the same manufacturer that provides jacketing. Vapor retarding tapes used with self-adhering jackets shall have a maximum permeance of 0.0 perms.

VAPOR RETARDING JACKETS (VRJ):
Polyvinylidene chloride (PVDC) vapor retarding jacket material with minimum 6 mils material thickness and maximum permeance of 0.01 perms. Material shall not support the growth of mold or mildew. Dow Saran or equivalent.

Vapor retarding tape shall be specifically designed and manufactured for use with the vapor retarding jacket specified above. Tape shall be provided by the same manufacturer that provides jacketing. Vapor retarding tapes used with vapor retarding jackets shall have a maximum permeance of 0.01 perms.

INSULATION INSERTS AND PIPE SHIELDS
Manufacturers: B-Line, Pipe Shields, Value Engineered Products

Construct inserts with polyisocyanurate (service temperatures below 300 degrees F only), minimum 140 psi compressive strength. Piping 12" and larger, supplement with high density 600 psi structural calcium silicate insert. Provide galvanized steel shield. Insert and shield to be minimum 180 degree coverage on bottom supported piping and full 360 degree coverage on clamped piping. On roller mounted piping and piping designed to slide on support, provide additional load distribution steel plate.

Where contractor proposes shop/site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges and lengths for each pipe size to demonstrate equivalency to pre-engineered/premanufactured product described above.
On low temperature systems, high density rigid polyisocyanurate may be substituted for calcium silicate provided insert and shield length and shield gauge are increased to compensate for lower insulation compressive strength.

Precompressed 20# density molded fiberglass blocks, Hamfab or equal, of the same thickness as adjacent insulation may be substituted for calcium silicate inserts with one 1"x6" block for piping through 2-1/2" and three 1"x6" blocks for piping through 4". Submit shield schedule to demonstrate equivalency to pre-engineered/premanufactured product described above.

Wood blocks will not be accepted.

ACCESSORIES
All products shall be compatible with surfaces and materials on which they are applied, and be suitable for use at operating temperatures of the systems to which they are applied.

Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.

Insulation bands to be 3/4 inch wide, constructed of aluminum or stainless steel. Minimum thickness to be .015 inch for aluminum and .010 inch for stainless steel.

Tack fasteners to be stainless steel ring grooved shank tacks.

Staples to be clinch style.

Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool.

Finishing cement to be ASTM C449.

Bedding compounds to be non-shrinking and permanently flexible.

Vapor barrier coatings to have maximum applied water vapor permeance of .05 perms.

Fungicidal water base coating (Foster 40-20 or equal) to be compatible with vapor barrier coating.

P A R T 3 - E X E C U T I O N

EXAMINATION
Verify that all piping, equipment, and ductwork are tested and approved prior to installing insulation. Do not insulate systems until testing and inspection procedures are completed.

Verify that all surfaces are clean, dry and without foreign material before applying insulation materials.

INSTALLATION

All materials shall be installed by skilled labor regularly engaged in this type of work. All materials shall be installed in strict accordance with manufacturer's recommendations, building codes, and industry standards. Do not install products when the ambient temperature or conditions are not consistent with the manufacturer's recommendations. Surfaces to be insulated must be clean and dry.

Locate insulation and cover seams in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.

Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted. Provide neatly beveled and coated terminations at all nameplates, uninsulated fittings, or at other locations where insulation terminates.

Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2 inches.

Use full length material (as delivered from manufacturer) wherever possible. Scrap piecing of insulation or pieces cut undersize and stretched to fit will not be accepted.

All pipe and duct insulation shall be continuous through walls, ceiling or floor openings and through sleeves except where firestop or firesafing materials are required. Vapor barriers shall be maintained continuous through all penetrations.

Provide a continuous unbroken moisture vapor barrier on insulation applied to systems noted below. Attachments to cold surfaces shall be insulated and vapor sealed to prevent condensation.

Provide a complete vapor barrier for insulation on the following systems:

- Cold Water Make-Up
- Chilled Water
- Insulated Duct
- Equipment, ductwork or piping with a surface temperature below 65 degrees F

PROTECTIVE JACKET INSTALLATION

SELF-ADHERING JACKETS (SAJ):
Install according to manufacturer's recommendations. Cut allowing minimum 4" overlap on ends and 6" on longitudinal joints. Align parallel to surface. Remove release paper and press flat to surface to avoid wrinkles. Rub entire surface for full adhesion and sealing at joint overlaps. On exterior applications, provide a bead of compatible caulk along exposed edges.

Piping with self-adhering (SAJ) jackets shall have elbows, fittings, valves and butt joints wrapped with 2 layers of vapor retarding tape. Piping with a PVC jacket (PFJ) installed over the self-adhering (SAJ) jacket may be provided with a single, lapped layer of vapor retarding tape for elbows, fittings and valves under the PVC jacket. Vapor retarding tape shall be compatible with the jacket material used.

VAPOR RETARDING JACKETS (VRJ):
Piping with vapor retarding (VRJ) jackets shall have elbows, fittings, valves and butt joints wrapped with 2 layers of vapor retarding tape. Piping with a PVC jacket (PFJ) installed over the vapor retarding (VRJ) jackets may be provided with a single, lapped layer of vapor retarding tape for elbows, fittings and valves under the PVC jacket. Vapor retarding tape shall be compatible with the jacket material used.

PVC FITTING COVERS AND JACKETS (PFJ):
Lap seams and joints a minimum of 2 inches and continuously seal PVC with welding solvent recommended by jacket manufacturer. Lap slip joint ends 4" without fasteners where required to absorb expansion and contraction. For sections where vapor barrier is not required and jacket requires routine removal, tack fasteners may be used. Secure PVC fitting covers with tack fasteners. For systems requiring a vapor barrier, apply a 1-1/2" band of mastic over ends, throat, seams and penetrations.

PIPING, VALVE, AND FITTING INSULATION

GENERAL:
Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2" lap on jacket seams and 2" tape on butt joints, firmly cemented with lap adhesive unless otherwise noted. Additionally secure with staples along seams and butt joints. Coat staples, longitudinal and transverse seams with vapor barrier mastic on systems requiring vapor barrier.

Install insulation continuous through pipe hangers and supports with hangers and supports on the exterior of insulation. Where a vapor barrier is not required or where roller hangers are not being used, hangers and supports may be attached directly to piping with insulation completely covering hanger or support and jacket sealed at support rod penetration.

Where riser clamps are required to be attached directly to piping requiring vapor barrier, extend insulation and vapor barrier jacketing/coating around riser clamp.

Where insulated piping is installed on hangers and supports, the insulation shall be installed continuous through the hangers and supports. High density inserts shall be provided as required to prevent the weight of the piping from crushing the insulation. Pipe shields are required at all support locations. The insulation shall not be notched or cut to accommodate the supporting channels.

Fully insulate all reheat coil piping, fittings and valves (with the exception of unions) up to coil connection to prevent condensation when coil is inactive during cooling season. Provide a vapor proof seal between the pipe insulation and the insulated coil casing.

INSULATION INSERTS AND PIPE SHIELDS:
Provide pipe shields at all hanger and support locations. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Quantity and placement of inserts shall be according to the manufacturer's installation instructions, however the inserts shall be no less than 12" in length. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required for system.

Provide insulation inserts and pipe shields at all hanger and support locations. Inserts may be omitted on 3/4" and smaller copper piping provided 12" long 22 gauge pipe shields are used.

FITTINGS AND VALVES:
Fittings, valves, unions, flanges, couplings and specialties may be insulated with factory molded or built up insulation of the same thickness as adjoining insulation. Where the ambient temperature exceeds 150 degrees F, cover insulation with fabric reinforcing and mastic. Where the ambient temperatures do not exceed 150 degrees, furnish and install PVC fitting covers.

ELASTOMERIC:
Where practical, slip insulation on piping during pipe installation when pipe ends are open. Miter cut fittings allowing sufficient length to prevent stretching. Completely seal seams and joints for vapor tight installation. For elastomeric insulation, apply full bed of adhesive to both surfaces. For polyeolefin, seal factory preglued seams with roller and field seams and joints with full bed of hot melt polyolefin glue to both surfaces. Cover elastomeric insulation on systems operating below 40 degrees F with vapor barrier mastic.

EXTRUDED POLYSTYRENE AND POLYISOCYANURATE:
Fittings, valves, unions, flanges, couplings and specialties shall be insulated with factory molded insulation of the same thickness as adjoining insulation. Secure insulation sections with two wraps of nylon filament tape 9"-12" on center.
On single insulation layer systems and on the outer layer of double insulation layer systems, apply a thin coat of elastomeric joint sealant rated for system operating temperatures to all longitudinal and butt insulation joints covering entire face of joint. Allow sealant to fully cure before applying protective covering. For piping service below 0^{o}F, use two layers of insulation with inner and outer butt and longitudinal joints staggered and offset 90 degrees. Where two layers of insulation are used, do not use sealant on the inner layer or adhere the inner layer to the outer layer. Apply vapor stop bead of joint sealant between pipe and insulation on both sides of valves, expansion/contraction joints, flanges, thermometers/gauges, attached vent and drain lines. Insulate attached non-circulated lines, control lines, vents, etc. for a minimum distance of 6" from pipe. Cover insulation with a protective jacket as specified below. Do not penetrate protective covering or insulation with mechanical fasteners.

PIPING PROTECTIVE JACKETS
In addition to the jackets specified in the pipe insulation schedule below the following protective jackets are required:

Provide a protective PVC jacket (PFJ) for the following insulated piping:

- All exposed piping in finished areas within 8' of the floor.

Provide a protective PVC (PFJ) jacket for the following insulated piping:

- All piping within mechanical rooms or mechanical spaces.

PIPE INSULATION SCHEDULE:
Provide insulation on new and existing remodeled piping as indicated in the following schedule:

SERVICE	INSULATION	JACKET	INSULATION THICKNESS BY PIPE SIZE				
			< 1"	1" to < 1-1/2"	1-1/2" to < 4"	4" to < 8"	8" and Larger
Heating Hot Water (1)	Rigid Fiberglass	ASJ	1.5"	1.5"	2"	2"	2"
Chilled Water (1)	Polyisocyanurate	VRJ or SAJ	1.5"	1.5"	1.5"	1.5"	1.5"
Cooling Coil Condensate Drain	Rigid Fiberglass	ASJ	0.5"	0.5"	1"	1"	1"
Geothermal Condenser Water	Polyisocyanurate	VRJ or SAJ	1.5"	1.5"	1.5"	1.5"	1.5"

(1) Exposed insulation jacket shall be paintable and field painted by GC.

The following piping and fittings are not to be insulated:

- Hot water piping inside radiation, convector, or cabinet heater enclosures
- Piping unions for systems not requiring a vapor barrier

For systems with fluid temperatures 65° F or less, furnish and install removable elastomeric insulation covers, plugs or caps for all mechanical equipment and devices that require access by balancing contractors or service and maintenance personnel. Examples include but are not limited to: flow sensing devices, circuit setters, manual ball valve air vents, drain valves, blowdown valves, pressure/temperature test plugs, grease fittings, pump bearing caps, equipment labels, etc. Covers shall be tight fitting to ensure a complete vapor barrier.

DUCT INSULATION

GENERAL:

Secure flexible duct insulation on sides and bottom of ductwork over 24" wide and all rigid duct insulation with weld pins. Space fasteners 18" on center or less as required to prevent sagging.

Secure rigid board insulation to ductwork with weld pins. Apply insulation with joints firmly butted as close as possible to the equipment surface. Pins shall be located a maximum of 3" from each edge and spaced no greater than 12" on center.

Install weld pins without damage to the interior galvanized surface of the duct. Clip pins back to washer and cover penetrations with tape of same material as jacket. Firmly butt seams and joints and cover with 4" tape of same material as jacket. Seal tape with plastic applicator and secure with staples. All joints, seams, edges and penetrations to be fully vapor sealed.

Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation or jacket material.

External supply duct insulation is not required where ductwork contains continuous 1" acoustical liner. Provide 4" overlap of external insulation over ends of acoustically lined sections.

Where insulated ductwork is supported by trapeze hangers, the insulation shall be installed continuous through the hangers. Drop the supporting channels required to facilitate the installation of the insulation. Where rigid board or flexible insulation is specified, install high density inserts to prevent the weight of the ductwork from crushing the insulation.

Where insulated low temperature (below 45ºF) ductwork is supported by steel metal straps or wire ropes that are secured directly to the duct, the straps or ropes shall be completely covered with insulation and sealed to provide a complete vapor barrier.

Where insulated duct risers are supported by steel channels secured directly to the duct, extend the insulation and vapor barrier jacketing to encapsulate the support channels.

DUCT INSULATION SCHEDULE:

Provide duct insulation on new and existing remodeled ductwork in the following schedule:

SERVICE	INSULATION TYPE	JACKET	THICKNESS
Outside air ducts	Rigid Fiberglass	FSK	2"
Mixed air ducts	Rigid Fiberglass	FSK	2"
Exposed supply ducts (1)	Rigid Fiberglass	FSK	1.5"
Concealed supply ducts	Flexible Fiberglass	FSK	2.25"
Exhaust and relief ducts downstream of motorized backdraft dampers	Rigid Fiberglass	FSK	2"
Louver blank-off panels	Ext. Polystyrene	SAJ	4"

(1) Exposed supply ducts located in the space they are serving do not require insulation. Exposed supply ducts running through spaces they do not serve shall be insulated as exposed supply ducts scheduled above.

EQUIPMENT INSULATION

GENERAL:

Do not insulate over equipment access manholes, fittings, nameplates or ASME stamps. Bevel and seal insulation at these locations.

EQUIPMENT INSULATION SCHEDULE:

Provide equipment insulation as follows:

EQUIPMENT	INSULATION TYPE	JACKET	THICKNESS
Reheat coil casing in exposed supply ducts	Rigid Fiberglass	FSK	2”
Pumps & Strainers (Chilled & Geothermal Water)	Elastomeric	NA	1”
Air Handling Unit Casings or attached component sections not factory insulated*	Rigid Fiberglass	ASJ	2”
Air Separators	Elastomeric	NA	2”
Buffer Tanks	Elastomeric	NA	1”

* The thickness and type of insulation provided for non-factory fabricated transitions or component sections shall be consistent with the sections constructed at the factory.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

END OF SECTION

SECTION 23 09 14
PNEUMATIC AND ELECTRIC INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

P A R T 1 - G E N E R A L

SCOPE
The work associated with this section be bid as part of the Division 23 scope of work.

This section includes pneumatic control system specifications for all HVAC work. Included are the following topics:

PART 1 - GENERAL
- Scope
- Point List
- Related Work
- Reference
- Work Not Included
- Quality Assurance
- Reference Standards
- System Description
- Submittals
- Design Criteria
- Operation and Maintenance Data
- Material Delivery and Storage

PART 2 - PRODUCTS
- Air Piping
- Control Dampers
- Control Valves
- Control System Instrumentation
- Thermostat Guards
- Electric/Electronic Thermostats
- Duct Smoke Detector and Fire Alarm Interface Modules
- Temperature Control Panels
- Temperature Sensors
- Humidity Sensors
- Pressure Transducers (Air)
- Pressure Transducers (Liquid/Steam)
- Differential Pressure Switches
- Current Status Switches
- Power Supplies

PART 3 - EXECUTION
- Installation
- Wire and Air Piping Conduit and Tubing Installation Schedule
- Control and Smoke Dampers
- Control Valves
- Room Thermostats and Temperature Sensors
- Low Limit Thermostats (Freezestats)
- Pressure Transducers
- Temperature Control Panels
- Differential Pressure Switches
- Air Pressure Safety Switches
- Current Status Switches
- Construction Verification Items

POINT LIST (Section Drawings)

RELATED WORK
Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC - Coordination
Section 23 09 23 - Direct Digital Control System for HVAC
Section 23 09 93 - Sequence of Operation
Section 23 33 00 - Ductwork Accessories (For control damper installation)
Division 23 - HVAC - Equipment provided to be controlled or monitored

REFERENCE
Applicable provisions of Division 1 govern work under this section.

WORK NOT INCLUDED
Control dampers as specified in Section 23 33 00.

QUALITY ASSURANCE
MANUFACTURER:
Installing contractor must be a manufacturer's branch office or an authorized representative of a Direct Digital Control (DDC) equipment manufacturer that provides engineering and commissioning of the DDC equipment. Submit written confirmation of such authorization from the manufacturer. Indicate in letter of authorization that installing contractor has successfully completed all necessary training required for engineering, installation, and commissioning of equipment and systems and that such authorization has been in effect for a period of not less than five years. DDC equipment may or may not be required to be installed by this contractor as part of the project, but the intent of this quality assurance specification is to ensure that the installing contractor has the capabilities to engineer, install, and commission the field devices supplied under this section for temperature control.

Contractor is limited to firms regularly employing a minimum of five full-time temperature control technicians within 50 miles of the job site.

REFERENCE STANDARDS

ANSI B16.22	Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings
ANSI/ASTM B32	Specification for Solder Metal
ASTM B75	Seamless Copper Tube
ASTM D1693	Environmental Stress-Cracking of Ethylene Plastics
ASTM D 635	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
AMCA 500-D	Laboratory Method of Testing Dampers for Rating

SYSTEM DESCRIPTION
System is to use direct digital control with electric actuation for air handling units; direct digital control with electric actuation for room temperature, room humidity, and terminal airflow control; and direct digital control with electric control for other terminal units.

All pneumatic tubing and electrical wiring are to be permanently tagged or labeled (within one inch of terminal strip) with a numbering system to correspond with the "Record Drawings". Tags or labels shall be printed not hand written.

SUBMITTALS
Include the following information:

Manufacturer’s data sheets indicating model number, pressure/temperature ratings, capacity, methods and materials of construction, installation instructions, and recommended maintenance. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked.

Schematic flow diagrams of systems showing fans, pumps, coils, dampers, valves, and other control devices. Label each device with setting or adjustable range of control. Indicate all wiring, clearly, differentiating between factory and field installed wiring. Wiring should be shown in schematics that detail contact states, relay references, etc. Diagrammatic representations of devices alone are not acceptable.

Details of construction, layout, and location of each temperature control panel within the building, including instruments location in panel and labeling. Also include on drawings location of mechanical equipment controlled (room number), horsepower and flow of motorized equipment (when this data is available on plans), locations of all remote sensors and control devices (either by room number or column lines).

Schedule of control dampers indicating size, leakage rating, arrangement, pressure drop at design airflow, and number and size of operators required.

Schedule of control valves indicating system in which the device is to be used, rated capacity, flow coefficient, flow required by device served, actual pressure drop at design flow, size of operator required, close-off pressure, and locations where valves are to be installed.

A complete description of each control sequence for equipment that is not controlled by direct digital controls. Direct digital controlled equipment control sequences will be provided by the DDC control contractor.

Calculations completed to determine size of control air compressor(s) and dryer (s).

Prior to request for final payment, submit record documents which accurately record actual location of control components including panels, thermostats, wiring, and sensors. Incorporate changes required during installation and start-up.

DESIGN CRITERIA

Size all control apparatus to properly supply and/or operate and control the apparatus served.

Provide control devices subject to corrosive environments with corrosion protection or construct them so they are suitable for use in such an environment.

Provide devices exposed to outside ambient conditions with weather protection or construct them so they are suitable for outdoor installation.

Use only UL labeled products that comply with NEMA Standards. Electrical components and installation to meet all requirements of the electrical sections (Division 26) of project specifications.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

MATERIAL DELIVERY AND STORAGE

Provide factory shipping cartons for each piece of equipment and control device. This contractor is responsible for storage of equipment and materials inside and protected from the weather.

P A R T 2 - P R O D U C T S

AIR PIPING

ASTM B75 seamless, hard drawn or annealed copper tubing with ANSI B16.22 wrought copper fittings, except final connections to apparatus may be made with brass compression-type fittings. Use ANSI/ASTM B32, 95/5 tin antimony solder.

Virgin polyethylene plastic tubing classified as flame retardant under UL 94 and conforming to ASTM D1693 stress-crack test.

CONTROL DAMPERS

Control dampers are specified in section 23 33 00.

Acceptable actuator manufacturers: Belimo or Honeywell.

Provide weatherproof NEMA 4 enclosures that have removable covers that have clasps or machine screws (no sheet metal screws) and that do not require removing fasteners from the ductwork to prevent actuator failure or freeze-up when mounting in locations exposed to harsh environments or outdoor locations. Actuators to have V bolt clamp with matching V toothed cradle (single bolt setscrew fasteners are not acceptable).

Size operators for smooth and positive operation of devices served, and with sufficient torque capacity to provide tight shutoff against system temperatures and pressure encountered. For electric modulating actuation, use fully proportional actuators with zero and span adjustments. For terminal unit actuators, stepping motors may be used and zero and span is not required. For two-position electric actuation use 24 VAC for DDC controlled actuators, 120 VAC actuators may be used for hardwire interlocking. See 23 09 15 for specific type of input signal required. Actuator stroke times shall match the requirements of the DDC controllers provided under 23 09 23 and/or the specific system requirements for proper operation. All electric actuators will be provided with overload protection to prevent motor from damage when stall condition is encountered. Equip operators with spring return or stored energy fail-safe return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation. Provide damper end switches with form “C” contacts where control sequences require damper position indication. End switches shall not contain mercury.

All power required for electric actuation shall be provided by this contractor if it is not able to be directly provided from the DDC controller.

Provide operators with linkages and brackets for mounting on device served.

CONTROL VALVES

Provide all control valves as shown on the plans/details and as required to perform functions specified. Spring ranges must be selected to prevent overlap of operation and simultaneous heating and cooling.

Acceptable actuator manufacturers: Belimo or Honeywell.

Provide NEMA rated housings for applicable environment, with enclosures that have removable covers. Actuators to have V bolt clamp with matching V toothed cradle (single bolt setscrew fasteners are not acceptable).

Size operators to allow smooth and positive operation of devices served and to provide sufficient torque capacity for tight shutoff against system temperatures and pressure encountered. For electric modulating actuation, use fully proportional actuators with 0-10VDC inputs and zero and span adjustments unless specified otherwise in the chart below. If TriState with feedback is specified, valve position shall be fed back to the controller and controller shall position valve based on this feedback. For two-position electric actuation use 24 VAC for DDC controlled actuators, 120 VAC actuators may be used for hardwire interlocking. Electric actuators, for applications other than terminal units, shall be provided with a manual override capability. All electric actuators shall be provided with a visible position indicator.

All power required for electric actuation shall be provided by this contractor if it is not able to be directly provided from the DDC controller.

Provide operators that are full proportioning or two-position, as required for specified sequence of operation. Provide spring-return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation. Valves shall move to their fail positions on loss of electrical power or air pressure to the actuator.

Two-position shut-off valves shall be sized for a maximum pressure drop of 2 PSI at design flow and shall be a minimum of line size.

Provide operators with linkages and brackets for mounting on device served.

All valves unless specifically noted on the plans or indicated below shall be globe style valves.

VALVE SERVING	**TYPE** Globe Butterfly (BF) Ball Press Independent Ball (PI Ball)	**SIGNAL** 0-10 VDC TriState (24VAC) 2-Position Elect Pneumatic (Pneu)	**SPRING RETURN** REQUIRED Yes No	**FAIL POSITION** Open (thru Coil) Closed (bypass Coil) Last Position
Reheat Coil	Ball	0-10 VDC	No	Last Position
CUH	Ball	2-Pos Elect	Yes	Open
AHU Htg Coil	Ball	0-10 VDC	Yes	Open
AHU Clg Coil	Ball	0-10 VDC	Yes	Closed

See plan details, notes, and schedules for where two-way and three-way valves should be used.

WATER SYSTEMS:
Use equal percentage valves for two-way control valves; size for a pressure drop not less than 4 psi or more than 6 psi. Note: For low flows, the required minimum Cv size will result in lower pressure drop than 4 psi.

Use three-way valves sized for a maximum pressure drop of 5 psi and that have linear characteristics so that the valve pressure drop remains constant regardless of the valve position.

Ball valves 2" and smaller: Cast bronze or forged brass body, chrome plated brass or stainless steel full port ball, stainless steel stem, PTFE or RTFE seats and seals, screwed ends, suitable for use on water systems at 150 psig and 240° F. Seat leakage with actuator supplied will meet ANSI class IV leakage (0.01%).

Ball valves 2 1/2" and larger: Iron body, stainless steel full port ball, stainless steel stem, PTFE or RTFE seats and seals, flanged ends, suitable for use on water systems at 150 psig and 240° F.

CONTROL SYSTEM INSTRUMENTATION
Manufacturers: Averaging Type - Johnson Controls, or equal; Bulb Type - Johnson Controls, Ashcroft, Marshall, Weksler

PIPE THERMOMETERS:
9 inch stem type with an adjustable swivel mount. Scale graduations of 2°F and mid-range accuracy of ±1°F. Install thermometers in separable brass wells filled with conductive fluid. Thermometer temperature range shall not be more than twice the expected temperature range at installed location.

REMOTE BULB THERMOMETERS:
3 inch or larger dial type with recalibration screw on face. Accuracy within 1% of scale range. Thermometers with sensing elements in air ducts with an area of above 6 square feet to have averaging liquid or gas filled capillary sensing elements. Provide separable wells for all pipeline applications. Thermometer temperature range shall not be more than twice the expected temperature range at installed location.

THERMOSTAT GUARDS
Provide clear plastic locking covers keyed the same. For locations that are subject to physical abuse, provide cast aluminum guard, Johnson Controls GRD10A-601 or equal.

ELECTRIC/ELECTRONIC THERMOSTATS
LOW LIMIT THERMOSTATS (freezestats):
Electric two-position type with temperature sensing element and manual reset for all applications except integral face and bypass steam heating coils which shall have auto-reset freezestats and latching relays (see execution section for details). Unit to be capable of opening control circuit if any one-foot length of sensing element is subject to a temperature below the setpoint. Length of sensing element to be not less than one lineal foot per square foot of coil surface areas. Unless otherwise indicated, set low limit controls at 36°F.

REMOTE BULB THERMOSTATS:
Line voltage type with single pole, double throw switch of adequate rating for the applied load. Thermostat to have adjustable setpoint suitable for controlled load.

IMMERSION TYPE THERMOSTAT SENSORS:
Rod and tube type with linear output. Provide separable wells with heat conductive fluid for installation in pipeline. Units shall be factory calibrated.

DUCT SMOKE DETECTOR AND FIRE ALARM INTERFACE MODULES
Duct smoke detectors and fire alarm control modules shall be provided by others. Provide wiring, conduit, and necessary interface with fire alarm system to perform specified sequence of operation.

TEMPERATURE CONTROL PANELS
Constructed of steel or extruded aluminum, with hinged door, keyed lock, and baked enamel finish. Install controls, relays, transducers and automatic switches inside panels. Label devices with permanent printed labels and provide asbuilt wiring/piping diagram within enclosure. Provide raceways for wiring and poly within panel for neat appearance and to separate high and low voltage wiring. Provide termination blocks and resettable circuit breaker for 120VAC power wiring. Provide label within the panel indicating circuit number of 120VAC serving panel. Label outside of panel with panel number corresponding to plan tags and asbuilt control drawings as well as building system(s) served.

Provide a service shutdown toggle switch for each air handling unit system located inside the temperature control panel that will initiate a logical shutdown of the air handling unit system. Label the switch so it is clear which position is shutdown and which is auto.

TEMPERATURE SENSORS
Use thermistor or RTD type temperature sensing elements constructed so accuracy and life expectancy is not affected by moisture, physical vibration, or other conditions that exist in each application.

RTD's shall be of nickel or platinum construction and have a base resistance of 1000Ω at 70°F and 77°F respectively. 100Ω platinum RTD's are acceptable if used with temperature transmitters.

The temperature sensing device used must be compatible with the DDC controllers used on the project.

Acceptable Manufacturers: Room Temperature Sensor: Honeywell TR71

RTD	
Accuracy (Room Sensor Only)	minimum ± 1.0°F
Accuracy (Averaging)	minimum ± 1.2°F
Accuracy (Other than Room Sensor or Averaging)	minimum ± 0.65°F
Range	minimum -40 - 220°F
Thermistor	
Accuracy (All)	minimum ± 0.36°F
Range	minimum -30 - 230°F
Heat Dissipation Constant	minimum 2.7 mW/°C

Temperature Transmitter

Accuracy	minimum ± 0.1°F or ±0.2% of span
Output	4-20 mA

Provide limited range or extended range sensors if required to sense the range expected for a respective point. Use RTD type sensors for extended ranges beyond -30 to 230°F. If RTD's are incompatible with DDC controller direct temperature input use temperature transmitters in conjunction with RTD's.

Use wire size appropriate to limit temperature offset due to wire resistance to 1.0°F. If offset is greater than 1.0°F due to wire resistance, use temperature transmitter. If feature is available in DDC controller, compensate for wire resistance in software input definition.

Provide sensors in occupied spaces with brushed aluminum or brushed nickel covers unless otherwise noted or features specified will not allow for this. Terminal unit sensors with setpoint adjustments and digital displays may use plastic covers. Provide information to the AE on sensor colors offered by the manufacturer and obtain approval on what color should be provided on the project.

Terminal unit sensors shall be provided with digital displays that indicate room temperature and setpoint and have a manual occupancy override and indication of occupancy status. Provide setpoint adjustment as specified in the DDC Input/Output Summary Table and sequence of operation.

Use averaging elements on duct sensors when the ductwork is ten square feet or larger. All mixed air and heating coil discharge sensors shall have averaging elements regardless of duct size.
In piping systems use temperature sensors with separable wells designed to be used with temperature element.

HUMIDITY SENSORS

Use capacitive thin-film polymer sensor types with a range of 0-100% RH. Accuracy to be no less than [±2%] in the range of 20% RH to 80% RH with a response time of 120 seconds or less. Provide covers for room humidity sensors as specified for temperature sensors.

For outside air applications, use sensor designed for outside air use along with weather enclosure. Provide sensor equal to Vaisala Model HMD60UO w/ DTR503B enclosure and weather resistant mounting hardware.

PRESSURE TRANSDUCERS (AIR)

Provide pressure transducers specified below for the following applications:

- Duct static pressure applications where setpoints are specified to control at greater than 0.1" w.c.
- Terminal unit air flow measurement regardless of the minimum velocity pressure unless otherwise noted in the contract documents.

Provide a transmitter that operates on the capacitance principle and is capable of sensing low positive, negative or differential pressures. Transmitter shall have a minimum of three pressure ranges adjustable by an onboard switch or jumper. Size the transmitter where the middle or high range is suitable for the application. Use a bi-directional transmitter for applications that may have both positive and negative pressure excursions. Transmitter shall be provided with an integral four-digit display of the pressure sensed.

Accuracy (including non-linearity and hysteresis)	± 0.25% FS
Compensated Temperature Range	35°-130° F
Temperature Effect	0-1"wc Range .09% FS/°F; >1"wc Range .02% FS/°F
Output	4-20 MA
Load Impedance (smallest maximum acceptable)	800 Ω max.
Operating Temperature	0°-160° F

Provide pressure transducers specified below for the following applications:

- Duct static pressure applications where setpoints are specified to control at 0.1" w.c. or lower.
- All duct mounted pitot type air flow stations.
- Space/building static control or monitoring.

The airflow transducer shall provide noise filtration and automatic auto-zeroing. The automatic zeroing circuit shall be capable of maintaining the transducer output to within ±0.25% of operating span. The transducer output shall be locked and maintained at the last given output value during the automatic zeroing period so as not to interrupt the automatic control process.

Use a bi-directional transmitter for applications that may have both positive and negative pressure excursions. Transmitter shall be provided with an integral four-digit display of the pressure sensed.

Transducer Span: <2 times the design velocity pressure at maximum flow, single range
Accuracy: ±0.25% of full scale, including non-linearity, hysteresis, deadband, and non-repeatability
Temperature Effect: ±0.15% of full scale/°F
Response: 0.5 sec. for 98% of full span change
Overpressure: 15 PSIG Proof
Power: 24VAC/VDC
Analog Output: 0-5VDC, 0-10VDC, or 4-20mA field adjustable
Auto Zero Frequency: every 1 to 24 hours on 1 hour intervals

PRESSURE TRANSDUCERS (LIQUID/STEAM)

Provide a transmitter that utilizes capacitive or thin film strain gauge sensing. Provide for an analog gauge piped in parallel with the transducer. Gauge shall meet specifications as specified in Section 23 05 15. Coordinate with mechanical contractor to provide and install this gauge. For differential pressure applications provide with bypass valve manifold assembly with valved venting capability.

Accuracy (including non-linearity and hysteresis)	± 0.5% FS
Compensated Temperature Range	32°-150° F
Temperature Effect (over compensated range)	0.03%/°F;
Output	4-20 MA
Load Impedance (smallest maximum acceptable)	600 Ω Minimum
Operating Temperature	0°-175° F
Hysteresis	0.75% of span

DIFFERENTIAL PRESSURE SWITCHES

Differential pressure switches shall sense both inlet and outlet of fans and pumps. Device shall be rated for 150% of maximum system pressures that may be encountered. Provide with pressure differential that will be required to meet specified operation and/or to prevent nuisance "toggling" of the device in the system served.

AIR PRESSURE SAFETY SWITCHES

Air pressure safety switches shall be a differential pressure switch that will sense differential, negative, or positive pressure as required by the sequence of operation specification. Device shall be rated for a minimum of 150% of maximum system pressures that may be encountered. Provide with pressure range that will be required to meet specified operation in the system served.

Provide with a normally closed contact that will open above setpoint and will not close until the manual reset button is depressed. Setpoint shall be manually adjustable.

CURRENT STATUS SWITCHES

Provide a current sensor with adjustable threshold and digital output with LED display, equal to a Veris model H-308. Threshold adjustment must be by a multi-turn potentiometer or set by multiprocessor that will automatically compensate for frequency and amperage changes associated with variable frequency drives. When used on variable speed motor applications, use a current sensor that will not change state due to varying speeds.

POWER SUPPLIES

Provide all required power supplies for transducers, sensors, transmitters and relays. All low voltage transformers shall have a resettable secondary circuit breaker and be listed as class 2 power supplies.

PART 3 - EXECUTION

INSTALLATION

Install system with trained mechanics and electricians employed by the control equipment manufacturer or an authorized representative of the manufacturer. Where installing contractor is an authorized representative of the control manufacturer, such authorization shall have been in effect for a period of no less than three years.

Install all control equipment, accessories, wiring, and piping in a neat and workmanlike manner. All control devices must be installed in accessible locations. This contractor shall verify that all control devices furnished under this Section are functional and operating the mechanical equipment as specified in Section 23 09 93.

Label all control devices with the exception of dampers, valves, and terminal unit devices with permanent printed labels that correspond to control drawings.

Temperature control junction and pullboxes shall be identified utilizing spray painted green covers. Other electrical system identification shall follow the 26 05 53 specification.

All control devices and electrical boxes mounted on insulated ductwork shall be mounted over the insulation. Provide mounting stand-offs where necessary for adequate support. Cutting and removal of insulation to mount devices directly on ductwork is not acceptable. This contractor shall coordinate with the insulation contractor to provide for continuous insulation of ductwork.

Mounting of electrical or electronic devices shall be protected from weather if the building is not completely enclosed. This Contractor shall be solely responsible for replacing any equipment that is damaged by water that infiltrates the building if equipment is installed prior to the building being enclosed.

Provide all electrical relays and wiring, line and low voltage, for control systems, devices and components. Install all high voltage and low voltage wiring (includes low voltage cable) in metal conduit, Electrical Non-metallic Tubing (ENT), or Electrical Metallic Tubing (EMT), as scheduled below and hereafter referred to generically as conduit. See Wire and Air Piping Conduit Installation Schedule below for specific conduit or tubing to be used. All conduit must be installed in accordance with electrical sections (Division 26) of this specification and the National Electrical code.

Conduit shall be a minimum of 1/2 " for low voltage control provided the pipe fill does not exceed 40%.

Minimum low voltage wiring gauge to be 18 AWG for outputs and 20 AWG for inputs. All low voltage wiring to be stranded.

Low voltage wiring can be run without conduit above accessible lay-in tile ceilings. All wiring in mechanical rooms, above inaccessible hard ceilings, exterior locations, and in any exposed areas, and in all other locations should be in conduit. Wire for wall sensors must be run in conduit. Wiring for radiation valves shall be run in conduit where routed through walls.

Where wiring is installed free-air, installation shall consider the following:

- Wiring shall utilize the cable tray wherever possible.
- Wiring shall run at right angles and be kept clear of other trades work.
- Wiring shall be supported utilizing "J" or "Bridal-type" steel mounting rings anchored to ceiling concrete, piping supports, walls above ceiling or structural steel beams. Mounting rings shall be of open design (not a closed loop) to allow additional wire to be strung without being threaded through the ring. For mounting rings that do not completely surround the wire, attach the wire to the mounting ring with a strap.
- Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If wiring "sag" at mid-span exceeds 6-inches; another support shall be used.
- Wiring shall never be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires.
- Wall penetrations shall be sleeved.

Wiring shall not be attached to existing cabling, existing tubing, plumbing or steam piping, ductwork, ceiling supports or electrical or communications conduit.
This contractor shall be responsible for all 120VAC power, not provided in the Division 26 specifications, required for equipment provided under this section. Power shown for temperature control panels on plans may be utilized by the 23 09 24 and/or 23 09 23, and 23 09 14 contractors.

Provide communication trunk wiring to integrated devices (i.e. VFD's, Flow Meters, Chillers, Lighting Panels, Electrical Meters, etc.) that are specified to be connected to the building automation system. Communication trunk wiring shall be as required by the equipment specified under the 23 09 24 or 23 09 23 Sections and shall be routed to the DDC panel designated for that equipment as shown on the plans or the closest DDC panel if not designated. If communication trunks required daisy chained style wiring, provide two communication cables to the DDC panel so that the communication trunk is not dead ended.
Install "hand/off/auto" selector switches on systems where automatic interlock controls are specified and "hand/off/auto" selector switches are not supplied with the equipment controlled. Control panel power will not be required for "hand" switch to operate. When switch is in "hand" position, allow manual operation of the selected device without operating the interlocked motors but allowing all unit safety devices to stay in the circuit.

All wiring in control panels shall be terminated on a terminal strip. Wire nuts are not acceptable. A maximum of two wires shall be terminated under any one terminal.

All pneumatic tubing and electrical wiring are to be permanently tagged or labeled within one inch of terminal strip with a numbering system to correspond with the "Record Drawings".

After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.

WIRE AND AIR PIPING CONDUIT AND TUBING INSTALLATION SCHEDULE

The following conduit schedule shall apply to both polyethylene tubing and wire in conduit where conduit is specified for air tubing or wiring. Conduit and tubing referenced below shall meet specifications in Section 26 05 33 and as defined below.

Conduit other than that specified below for specific applications shall not be used.

Concealed in Concrete and Block Walls: Rigid steel conduit. Schedule 40 PVC conduit. Electrical Nonmetallic Tubing (ENT).

Concealed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.

Exposed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.

CONTROL DAMPERS

All control dampers are furnished and installed by the Mechanical Contractor under the coordinating control and supervision of the Control Contractor in locations shown on plans or where required to provide specified sequence of control.

Coordinate installation with the sheetmetal installer to obtain smooth duct transitions where damper size is different than duct size. Blank off plates will not be accepted.

Each operator shall serve a maximum damper area of 36 square feet. Where larger dampers are used, provide multiple operators.

CONTROL VALVES

All temperature control valves furnished by the control manufacturer are to be installed by the Mechanical Contractor under the coordinating control and supervision of the Control Contractor in locations shown on plans or where required to provide specified sequence of control.

ROOM THERMOSTATS AND TEMPERATURE SENSORS

Check and verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate room thermostats and sensors 44 inches above floor. Align with light switches and humidistats. For drywall installations, thermostat mounting shall use a back-box attached to a wall stud, drywall anchors are not acceptable.

Any room thermostats or sensors mounted on an exterior wall shall be mounted on a thermally insulated sub-base. Subbase to provide a minimum of one half inch of insulation.

Where thermostats or sensors are mounted on exterior walls or in any location where air transfer will affect the measured temperature or humidity seal the conduit and any other opening that will effect the measurement.

Provide guards on thermostats and sensors in entrance hallways, other public areas, or in locations where thermostat is subject to physical damage.

LOW LIMIT THERMOSTATS (Freezestats)

Install low limit controls where indicated on the drawings or as specified. Unless otherwise indicated, install sensing element on the downstream side of heating coils.

Mount units using flanges and element holders. Provide duct collars or bushings where sensing capillary passes through sheetmetal housings or ductwork; seal this penetration to eliminate air leakage. Mount the units in an accessible location as to allow for resetting after low limit trips while still meeting manufacturer's installation requirements for proper function.

Distribute (serpentine) sensing element horizontally across the coil to cover every square foot of coil; on larger coils this may require more than one instrument. Install controls at accessible location with mounting brackets and element duct collars where required.

PRESSURE TRANSDUCERS AND HIGH LIMIT PRESSURE SWITCHES

Install capped tees in air piping at air pressure transducers for connection of calibration equipment. Capped tee shall consist of two inch poly tubing capped with a brass plug. Rubber caps are not acceptable. Install Petes Plugs fittings at each take-off from main piping for liquid pressure transducers for connection of calibration equipment. Install differential pressure transducers for filter monitoring at the filter section of the air handling unless otherwise specified. All other differential or static pressure transducers and differential or static pressure high limit switches for air applications should be mounted in the temperature control panel serving the equipment being controlled or monitored.

All devices mounted on equipment shall be mounted in a location that is at a maximum of five feet above the floor. For steam and liquid applications, provide shutoff valves at piping takeoff points.

TEMPERATURE CONTROL PANELS

Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. All control panel openings shall be plugged. Conduits and other penetrations on the top of the cabinets shall be sealed on the exterior of the cabinet with silicone caulk to resist water penetration.

One cabinet may accommodate more than one system in same equipment room. Provide permanent printed labeling for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of panel cover. Provide a protective cover or envelope for drawings.

DIFFERENTIAL PRESSURE SWITCHES

Provide for each fan or pump specified, or shown on point list. Provide shutoff valves at piping takeoff points. Readjust pressure and/or differential setpoints for proper operation after final balancing is completed.

CURRENT STATUS SWITCHES

Provide for each fan or pump specified, or shown on point list. Set threshold adjustment to indicate belt or coupling loss. Readjust threshold for proper operation after final balancing is completed. Use the variable frequency drive (VFD) integrated relay output for motor status, if provided on the VFD, in lieu of a discrete current switch. A separate current switch provided under this Section shall be wired in parallel with the VFD motor status relay when a bypass starter is provided on the VFD to prove motor status in the bypass mode.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

END OF SECTION

SECTION 23 09 24
DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

P A R T 1 - G E N E R A L

SCOPE

The work associated with this section be bid as part of the Division 23 scope of work.

Work in this section includes Direct Digital Control (DDC) panels, main communication trunk, software programming, and other equipment and accessories necessary to constitute a complete Direct Digital Control (DDC) system. This system interfaced with pneumatic/electric controls (Section 23 09 14) utilizing Direct Digital Control signals to operate actuated control devices will meet, in every respect, all operational and quality standards specified herein.

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Warranty
- Submittals
- LEED Requirements
- Software License Agreement
- Operation and Maintenance Data
- Material Delivery and Storage

PART 2 - PRODUCTS
- General
- Local Control Panels
- Direct Digital Controls (DDC)
- Networking/Communications
- BACnet Requirements
- Supervisory Controllers
- System Software Features
- Programmable Controllers
- Application Specific Controllers - HVAC
- Operator Interface Requirements
- Web Based HTML Browser Interface
- Training

PART 3 - EXECUTION
- General
- Installation
- Training
- Commissioning, Verification and Closeout

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC – Coordination
Section 23 09 14 - Electric Instrumentation and Control Devices for HVAC
Section 23 09 93 – Sequence of Operations for HVAC Controls
Division 23 - HVAC - Equipment provided to be controlled or monitored

Division 26 - Electrical - Equipment provided to be controlled or monitored

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

FCC Part 15, Subpart J, Class A - Digital Electronic Equipment to Radio Communication Interference

QUALITY ASSURANCE

MANUFACTURER:

Acceptable manufacturer shall be Honeywell WEBs-AX.

INSTALLER:

A firm specializing and experienced in DDC control system installation for no less than 5 years. All engineering and commissioning work shall be done by qualified employees of this manufacturer, or qualified employees of an Authorized Representative of that manufacturer that provides engineering and commissioning of the manufacturer's control equipment. Where installing contractor is an authorized representative of the control equipment manufacturer, submit written confirmation of such authorization. Indicate in letter of authorization that the installing contractor has successfully completed all necessary training required for the engineering, installation, and commissioning of equipment and systems to be provided for the project and that such authorization has been in effect for a period of not less than three years. The letter of authorization should also indicate that the installing contractor is authorized to install the manufacturer's DDC equipment at the project location at the time the project is bid. Installation of the equipment shall be done by qualified mechanics and/or electricians in the direct employ or be directly subcontracted and under the supervision of the manufacturer or Authorized Representative. The contractor providing and installing the equipment under this specification section shall be the same contractor providing and installing equipment under the 23 09 14 specification section.

Contractor is limited to firms regularly employing a minimum of five full-time temperature control technicians within 50 miles of the job site.

RESPONSE TIME:

During warrantee period, four (4) hours or less, 24-hours/day, 7 days/week.

ELECTRICAL STANDARDS:

Provide electrical products, which have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.

DDC Standards: DDC manufacturer shall provide written proof with shop drawings that the equipment being provided is in compliance with F.C.C. rules governing the control of interference caused by Digital Electronic Equipment to Radio Communications (Part 15, Subpart J, Class A).

WARRANTY

Provide all services, materials and equipment necessary for the successful operation of the entire system for a period of one year after acceptance. The adjustment, required testing, and repair of the system includes all computer equipment, transmission equipment and all sensors and control devices.

The on-line support services shall allow the system supplier to dial out to monitor and control the facility's BAS. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverall shall be extended to include normal business hours, after business hours, weekends and holidays.

SUBMITTALS

Include the following information:

Details of construction, layout, and location of each temperature control panel within the building, including instruments location in panel and labeling. Indicate which piece of mechanical equipment is associated with each controller and what area within the building is being served by that equipment. For terminal unit control, provide a room schedule that would list mechanical equipment tag, room number of space served, address of DDC controller, and any other pertinent information required for service.

EQUIPMENT COORDINATION

The Controls Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.

Control valve selections shall be based on flow rates shown in approved shop drawings.

Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.

SHOP DRAWINGS

Submit shop drawings per Section 23 05 00. In addition, submit an electronic copy of the shop drawings in Adobe Acrobat (.pdf) format to the Owner for review.

Cross-reference all control components and point names in a single table located at the beginning of the submittal with the identical nomenclature used in this section.

Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.

System Architecture:
Provide riser diagrams of wiring between central control unit and all control panels. This shall include specific protocols associated with each level within the architecture. Identify all interface equipment between CPU and control panels. The architecture shall include interface requirements with other systems including, but not limited to, security systems, lighting control, fire alarm, elevator status, and power monitoring system.

Diagrams shall include:

Wiring diagrams and layouts for each control panel showing all termination numbers.

Schematic diagrams for all control, communication, and power wiring.

Provide a schematic drawing of the central system installation.

Label all cables and ports with computer manufacturers' model numbers and functions.

Show all interface wiring to the control system.

Identification of all control components connected to emergency power.

Schematic diagrams for all field sensors and controllers.

A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.

A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.

A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.

All installation details and any other details required to demonstrate that the system will function properly.

All interface requirements with other systems.

The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.

Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. The wording of the control sequences in the submittal shall match verbatim that included in the construction documents to ensure there are no sequence deviations from that intended by the Architect/Engineer. Clearly highlight any deviations from the specified sequences on the submittals.

Points List Schedule: Submit a complete points list of all points to be connected to the TCS and FMCS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history, archive, totalization, graphic points, and all mapped points from other systems (security systems, lighting control, fire alarm, etc.). Provide points lists, point naming convention, and factory
support information for systems provided and integrated into the FMCS.

Damper Schedule: Schedule shall include a separate line for each damper and a column for each of the damper attributes:

Damper Identification Tag.
Location.
Damper Type.
Damper Size.

Duct Size.
Arrangement.
Blade Type.
Velocity.
Pressure Drop.
Fail Position.
Actuator Identification Tag.
Actuator Type.
Mounting.

Valve Schedule: Valve manufacturer shall size valves and create a valve schedule. Schedule shall include a separate line for each valve and a column for each of the valve attributes:

Valve Identification Tag.
Location.
Valve Type.
Valve Size.
Pipe Size.
Configuration.
Flow Characteristics.
Capacity.
Valve C_V.
Design Pressure Drop.
Pressure Drop at Design Flow.
Fail Position.
Close-off Pressure.
Valve and Actuator Model Number and Type.

Product Data Sheets: Required for each component that includes: unique identification tag that is consistent throughout the submittal, manufacturer's description, technical data, performance curves, installation/maintenance instructions, and other relevant items. When manufacturer's literature applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.

Provide PICS files indicating the BACnet® functionality and configuration of each device.

Provide documentation of submitted products that have been tested and listed by the BACnet Testing Laboratory (BTL), or provide a letter on the manufacturer's company letterhead indicating the anticipated date by which testing is expected to be completed. If, for any reason, BTL testing and listing has not been completed, a written commitment to upgrade installed controls to a version that meets BTL testing and listing requirements in the event that problems are found during BTL testing is required.

Graphic Display: Include a sample graphic of each system and component identified in the points list with a flowchart (site map) indicating how the graphics are to be linked to each other for system navigation.

Software: A list of operating system software, operator interface software, color graphic software, and third-party software.

Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.

Clearly identify work by others in the submittal.

Quantities of items submitted may be reviewed but are the responsibility of the Contractor to verify.

PRODUCT DATA

Submit manufacturer's specifications for each control device furnished, including installation instructions and startup instructions.

General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked. Annotated software program documentation shall be submitted for system sequences, along with descriptive narratives of the sequence of operation of the entire system involved. Submit wiring diagram for each electrical control device along with other details required to demonstrate that the system has been coordinated and will function as a system.

MAINTENANCE DATA

Submit maintenance data and spare parts lists for each control device. Include this data in maintenance manual.

RECORD DRAWINGS

Prior to request for final payment provide complete composite record drawings to incorporate the DDC and Pneumatic/Electric field work. All software addressing for device communication shall be noted for all devices provided under this section and the communication addressing required for devices provided by others that are integrated into the direct digital control system provided under this section. Coordinate with the supplier of the equipment specified to be interfaced through digital communications for communication addressing. Provide circuit number of 120VAC panel power circuit(s) feeding each control panel on record drawings. Label circuit number(s) inside the panel served.

LEED REQUIREMENTS

This project shall meet the requirements of the U.S. GREEN BUILDING COUNCIL LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN (LEED) program.

The project will attempt to achieve the U.S. Green Building Council's LEED Version 4.0 certification level: Silver.

This Contractor shall carefully examine the LEED portion of this specification for full compliance with the following LEED points:

> "Energy & Atmosphere": Prerequisite 1, "Fundamental Building Systems Commissioning," Prerequisite 2 - "Minimum Energy Performance," Credit 3 - "Additional Commissioning," and Credit 5 - "Measurement and Verification," as described by LEED.
>
> "Indoor Environmental Quality": Prerequisite 1 - "Minimum IAQ Performance," Credit 1 - "Outdoor Air Delivery Monitoring," Credit 2 - "Increased Ventilation," Credit 6 - "Controllability of Systems," Credit 6.1 - "Lighting Control," and Credit 6.2 - "Thermal Comfort."

All labor and materials required for these and any other LEED initiatives shall be provided without additional cost to the Owner.

SOFTWARE LICENSE AGREEMENT

The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job-specific configuration documentation, data files, configuration tools, and application-level software developed for the project. This shall include, but is not limited to, all custom, job-specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS Server(s), and any related LAN/WAN/intranet and/or Internet connected routers and devices. Provide the Owner with all required IDs and passwords for access to any component or software program. The Owner shall determine which organizations shall be named in the SI organization ID ("orgid") of all software licenses. Owner shall be free to direct the modification of the "orgid" in any software license, regardless of supplier.

JOB CONDITIONS

Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is this Contractor's responsibility to check the Contract Documents for possible conflicts between the Work of this section and that of other crafts in equipment location; pipe, duct and conduit runs; electrical outlets and fixtures; air diffusers; and structural and architectural features.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

MATERIAL DELIVERY AND STORAGE

Provide factory shipping cartons for each piece of equipment and control device. This contractor is responsible for storage of equipment and materials inside and protected from the weather.

P A R T 2 - P R O D U C T S

GENERAL

Provide DDC control products in sizes and of capacities as required, conforming to manufacturer's standard materials and components as published in their product information, designed and constructed as recommended by the manufacturer and as required for application indicate.

System shall be capable of operating with 120 VAC power supply, fully protected with a shutdown-restart circuit, and associated hardware and software.

LOCAL CONTROL PANELS

Use control panels with suitable mounting brackets for each supply fan system. Locate panel adjacent to system served.

Fabricate panels of 14 gauge furniture grade steel or 6063-T5 extruded aluminum alloy, totally enclosed on six sides, hinged door and keyed lock, with manufacturer's standard shop painted finish and color.

Provide UL listed cabinets for use with line voltage devices.

Plastic control enclosures will be approved provided all conduits are bonded and grounded.

Provide control panels for all DDC Controllers, ASC's and associated function modules. All controls to be in panels except for terminal unit controllers mounted within the terminal unit equipment enclosure or VAV box controllers designed to be directly mounted on air terminals. Provide terminal unit equipment enclosures with removable cover for all terminal units located in exposed ceilings that completely enclose the DDC controller and allow for conduit terminations.

Permanently label all controls; tag all control wiring.

DIRECT DIGITAL CONTROLS

System to be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection.

DDC to consist of Supervisory Controllers, Programmable Controllers, stand-alone Application Specific Controllers (ASC's), Operators Terminals, Operator Workstations, DDC system servers, and other operator interface devices.

The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASC's, and operator devices.

The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

NETWORKING/COMMUNICATIONS

The design of the DDC shall be networked. The highest level networking shall use Ethernet and the sub-level networking shall use serial communications. Inherent in the system's design shall be the ability to expand or modify the highest network either via a local area network (LAN), wide area network (WAN), or a combination of the two schemes.

The highest-level DDC communications network shall be capable of direct connection to and communication with a high-speed LAN or WAN utilizing an Ethernet connection. Communication protocol used shall be BACnet/IP.

The supervisory controller shall directly oversee a local network such that communications may be executed directly to and between programmable controllers and ASC's. All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all points and application reports on the network.
Provide serial communication ports on all ASC's for operator's terminal communications with the DDC Controller.

Access to system data shall not be restricted by the hardware configuration of the DDC system.

Global data sharing or global point broadcasting shall allow point data to be shared between programmable controllers and ASC's when it would be impractical to locate multiple sensors.

Network design shall include the following provisions:

- Data transfer rates for alarm reporting and quick point status from multiple programmable controllers and ASC's. The minimum baud rate shall be 9600 baud.
- Support of any combination of programmable controllers and ASC's. A minimum of 32 programmable controllers and ASC's shall be supported on a single local network. The buss shall be addressable for up to 32 ASC's.
- Detection of single or multiple failures of ASC's or the network media.

- Error detection, correction, and re-transmission to guarantee data integrity.
- Use commonly available, multiple-sourced, networking components.
- Use of an industry standard communication transport, such as, ARCNET, Ethernet, and IEEE RS-485 communications interface.

BACNET REQUIREMENTS

BACnet of highest level network communications will utilize BACnet/IP over Ethernet and field level communications shall utilize BACnet MSTP. No other communication protocol is acceptable.

All controllers shall provide a Protocol Implementation Conformance Statement (PICS) and BACnet Interoperability Building Blocks (BIBB"S) as required by the American National Standards Institute/American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ANSI/ASHRAE) Standard 135-2001, BACnet protocol.

In general all devices shall support the following:

Segmentation Capability
Segmentation requests supported
Segmentation responses supported

Standard Object Types Supported

- Analog input
- Analog output
- Analog value
- Binary input
- Binary output
- Binary value
- Calendar
- Device
- Event enrollment
- Group
- Multistate input
- Multistate output
- Multistate value
- Notification class
- Schedule

Character Sets supported

- ANSI X3.4
- ISO 10646 Universal Character Set-2

All highest level networked supervisory devices shall support the following:

Data Link Layer Option

- BACnet Internet Protocol (IP) (Annex J)

Networking Options

BACnet/IP Broadcast Management Device (BBDM)

SUPERVISORY CONTROLLERS

Supervisory controllers shall be microprocessor-based, multi-tasking, multi-user and digital control processors.

Each supervisory controller shall have sufficient memory to support its own operating system and databases including:

- Control processes
- Energy management application
- Alarm management
- Trend data
- Maintenance support applications
- Operator I/O
- Dial-up communications
- Manual override monitoring

The system shall be modular in nature, and shall permit easy expansion through the addition of field controllers, sensors, and actuators.

Supervisory controllers shall provide at least two RS-232C or USB serial communication ports or Ethernet ports for simultaneous operation of multiple operator I/O devices, such as laptop computers, personal computers, and video display terminals.

Supervisory controllers shall monitor the status of all overrides and include this information in the logs and summaries to inform the operator that automatic control has been inhibited.

Each supervisory controller shall continuously perform self-diagnostics, communications diagnostics, and diagnostics of all subsidiary equipment. Supervisory controllers shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each supervisory controller.

Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high to allow all signal wiring to be run in the same conduit as high voltage wiring acceptable by electrical code.

In the event of the loss of normal power, there shall be an orderly shutdown of the supervisory controller to prevent the loss of data base or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

Upon restoration of normal power, the supervisory controller shall automatically resume full operation without manual intervention.

Should supervisory controller memory be lost for any reason, the supervisory controller shall have the capability of reloading it's programming via high speed local area network from the control system archive workstation or server, the local RS-232C port, or telephone line dial-in.

SYSTEM SOFTWARE FEATURES

All necessary software to form a complete operating system, as described in this specification, shall be provided as an integral part of the supervisory controller, and shall not be dependent upon higher level computer for execution.
Control software shall include a provision for limiting the number of times that each piece of equipment may be cycled within any one-hour period.

The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

Supervisory controllers shall have the ability to perform any or all of the following energy management routines:

- Time of day scheduling
- Calendar based scheduling
- Holiday scheduling
- Optimal start
- Optimal stop
- Demand limiting
- Load rolling
- Heating/cooling interlock

All programs to be executed automatically without the need for operator intervention, and be flexible enough to allow user customization. Programs shall be applied to building equipment described in Section 23 09 93 of this specification.

Supervisory controllers shall be able to execute configured processes defined by the user to automatically perform calculations and control routines.

It shall be possible to use any of the following in a configured process:

- Any system-measured point data or status
- Any calculated data
- Any results from other processes
- Boolean logic operators (and, or)

Configured processes may be triggered based on any combination of the following:

- Time of day
- Calendar date

- Other processes
- Events (e.g., point alarms)

A single process shall be able to incorporate measured or calculated data from any and all other ASC's.

A single process shall be able to issue commands to points in any and all other programmable controllers and ASC's on the local network.

Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each supervisory controller shall perform distributed; independent alarm analysis and filtering to minimize network traffic and prevent alarms from being lost. At no time shall the ability of supervisory controllers to report alarms be affected by either operator activity at the local I/O device or communications with other ASC's on the network.

All alarm or point change reports shall include the English language description of each point and the time and date of the occurrence.

The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Users shall have the ability to manually inhibit alarm reporting for each point.

The user shall also be able to define conditions under which point changes need to be acknowledged by an operator and/or logged for analysis at a later date.

Alarms reports and messages shall be directed to an operator device.

In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 60-character alarm message to more fully describe the alarm condition or direct operator response.

Each supervisory controller shall be capable of storing a library of at least 100 messages. Each message may be assignable to any number of points in the panel.

A data collection utility shall be provided to automatically sample, store, and display system data.

Measured and calculated analog and binary data shall be assignable to user definable trends for the purpose of collecting operator specified performance data over extended periods of time. Sample intervals of 1 minute to 24 hours, in one minute or one hour intervals, shall be provided. Each supervisory controller shall have a dedicated buffer for trend data and shall be capable of storing 16 trend logs. Each trend log shall have up to four points trended at 48 data samples each. Data shall be stored at the supervisory controller and up-loaded to the DDC system server when archiving is desired.

Supervisory controllers shall automatically accumulate and store runtime hours for binary input and output points specified in Section 23 09 14 of this specification.

Supervisory controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis, user defined, for user-selected analog and binary pulse input type points.

Totalization shall provide calculation and storage accumulations of up to 9,999,999 units (e.g., KWH, gallons KBTU, tons, etc.).

The totalization routine shall have a sampling resolution of one minute.

The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.

The information available from pulse totalization shall include, but not be limited to, the following:

- Peak demand, with date and time stamp
- 24-hour demand log
- Accumulated KWH for day
- Sunday through Saturday KWH usage
- Demand KW annual history for past 12 periods
- KWH annual history for past periods

Supervisory controllers shall have the ability to count events, such as the number of times a pump or fan system is cycled on and off.

The event totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

PROGRAMMABLE CONTROLLERS

Programmable controllers shall be provided with a software program that shall allow the user to design flexible software algorithms for the control sequences as described in Sections 23 09 14 and 23 09 93 portions of this specification.

Programmable controllers shall support all necessary point inputs and outputs to perform the specified control sequence in a totally stand-alone fashion.

Each programmable controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

Each programmable controller shall support the use of a locally mounted status and adjust panel interface to allow for the local adjustment of all setpoints, temporary override of any input or output points and status of all points directly at the controller. The capabilities of the locally mounted status and adjust panel shall include, but not be limited to, the following information for the programmable controllers to which:

- Display temperatures
- Display status
- Display setpoints
- Display control parameters
- Override binary output control
- Override analog output control
- Override analog setpoints
- Modification of gain and offset constants

All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the programmable controller.
Programmable controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in Sections 23 09 14 and 23 09 93 portions of this specification, and for future expansion of air handling units:

- Mixed air handling units
- 100 percent outside air handling units
- Boiler or chiller plants with pump logic
- Zone pressurization of labs
- Smoke control systems
- Generic system interlocking through hardware

APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS

Each supervisory controller shall be able to extend its monitoring and control through the use of stand-alone application specific controllers (ASC's).

Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor based, multi-tasking, real-time digital control processor.

Each ASC shall have sufficient memory to support its own operating system and databases including:

- Control Processes
- Energy Management Applications
- Operator I/O (Portable Service Terminal)

The operator interface to any ASC point or program shall be through the supervisory controller connection to any ASC on the network.

ASC's shall directly support the temporary use of a portable service terminal that can be connected to the ASC via zone temperature or directly at the controller. The capabilities of the portable service terminal shall include, but not be limited to, the following information for the:

- Display temperatures
- Display status
- Display setpoints
- Display control parameters
- Override binary output control
- Override analog output control
- Override analog setpoints

- Modification of gain and offset constants

All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.

ASC's shall support, but not be limited to, the following configurations of systems to address current requirements as described in Sections 23 09 14 and 23 09 93 portions of this specification, and for future expansion of air handling units:

- Variable Air Volume Terminals
- Reheat Terminals
- Fan Coils
- Packaged Air Handling Units

For butterfly type Variable Air Volume (VAV) Terminals, provide differential pressure transducers and damper actuators for flow measurement and actuation of the VAV terminal damper. Pressure transducers shall be Ashcroft - Model CXLdp High Accuracy Differential Pressure Transmitter.

Provide filter on high side of flow pickups if flow measurement device requires airflow through the device.

Terminal unit temperature sensors shall be furnished under this Section. Provide with digital displays with setpoint adjustments and/or manual occupancy override and indication of occupancy status. Provide information to the Owner on sensor colors offered by the manufacturer and obtain approval on what color should be provided on the project. Provide setpoint adjustment as specified in the DDC Input/Output Summary Table and sequence of operation.

Provide a method to view and print a summary of current K-factors for flow correction for each VAV terminal through the DDC system. The summary shall have a minimum of 50 K-factors per group of VAV terminals.

OPERATOR INTERFACE REQUIREMENTS

COMMAND ENTRY/MENU SELECTION PROCESS:
Operator interface software shall minimize operator training through the use of English language prompting and English language point identification.

TEXT-BASED DISPLAYS:
The operator interface shall provide consistent text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.

GRAPHIC-BASED DISPLAYS:
The operator interface shall provide graphic based displays of each system. The point data associated with each system shall dynamically update at a minimum of every 30 seconds. Graphic displays shall be linked to each other to provide a "drill down" capability from main graphic displays to more specific system based displays. Provide a building level graphic display that links to system graphics. For systems that have ASC controlled terminal unit controls, provide a building floor plan with dynamic temperatures shown on the graphic that can be drilled into for more specific terminal information. Points provided in the graphic shall have the override and adjust capability specified under operator commands.

Update existing graphics for existing systems with new floor plans, air terminal locations and other changes as a result of this project.

Provide new graphics for all new systems.

PASSWORD PROTECTION:
Multiple-level password access protection shall be provided to allow the user/manager to limit control, display, and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.

Passwords shall be exactly the same for all operator devices.

A minimum of three levels of access shall be supported:

- Level 1: Data access and display
- Level 2 = Level 1 + operator overrides and commands
- Level 3 = Level 2 + database generation and modification

A minimum of 4 passwords shall be supported at each supervisory controller.

Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device shall be limited to only those items defined for the access level of the password used to log-on.

Provide user definable, automatic log-off timers of from 1 to 60 minutes to prevent operators from inadvertently leaving devices on-line.

OPERATOR COMMANDS:

The operator interface shall allow the operator to perform commands including, but not limited to, the following:

- Start-up or shutdown selected equipment
- Adjust setpoints
- Override analog and binary outputs
- Add/modify/delete time programming
- Enable/disable process execution
- Lock/unlock alarm reporting for each point
- Enable/disable totalization for each point
- Enable/disable trending
- Enter temporary override schedules
- Define holiday schedules
- Change time/date
- Enter/modify analog alarm limits
- Enable/disable analog alarm limits
- Enable/disable demand limiting
- Enable/disable duty cycle

LOGS AND SUMMARIES:

Reports shall be generated manually, and directed to the displays. As a minimum, the system shall allow the user to easily obtain the following general listing of all points in the system that shall include, but not be limited to:

- Points currently in alarm
- Off-line points
- Points currently in override status
- Points in weekly schedules
- Holiday programming

Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration on the facility management system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

SYSTEM CONFIGURATION AND DEFINITION:

All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

The system shall be provided complete with all equipment, software, and documentation necessary to allow an operator to independently perform the following functions:

- Add/delete/modify application specific controllers
- Add/delete/modify points of any type, and all associated point parameters, and tuning constants
- Add/delete/modify alarm reporting definition for each point
- Add/delete/modify energy management applications
- Add/delete/modify time and calendar-based programming
- Add/delete/modify totalization for every point
- Add/delete/modify historical data trending for every point
- Add/delete/modify configured control processes
- Add/delete/modify dial-up telecommunication definition
- Add/delete/modify all operator passwords
- Add/delete/modify alarm messages

PROGRAMMING DESCRIPTION:

Definition of operator device characteristics, ASC's, individual points, and shall be performed through fill-in-the-blank templates.

NETWORK-WIDE STRATEGY DEVELOPMENT:

Inputs and outputs for any process shall not be restricted to a single ASC, but shall be able to include data from any and all other ASC's to allow the development of network-wide control strategies.

SYSTEM DEFINITION/CONTROL SEQUENCE DOCUMENTATION:
All portions of system definition shall be self-documenting and be capable of providing hardcopy printouts of all configuration and application data.

WEB BASED HTML BROWSER INTERFACE
Provide a HTML based browser interface (Web Server) for accessing the DDC system. This shall include all hardware and software to provide an Ethernet twisted pair connection to the owners local or wide area network (LAN or WAN) that can be used to access the DDC system through a standard internet browser.

All information shall be provided to the owners IT staff to facilitate connection through the owners LAN/WAN.

At a minimum, this interface shall be capable of all functions described under the Operator Interface section, Password Protection, Operator Commands, and Logs and Summary subsections of this specification.

P A R T 3 - E X E C U T I O N

GENERAL
All electronic work required as an integral part of the Direct Digital Control system work is the responsibility of this section unless specifically indicated otherwise in this section, Section 23 09 14, or in Division 26.

This contractor shall provide all labor, materials, engineering, software, permits, tools, checkout and certificates required to install a complete Direct Digital Control system as herein specified.

Any and all points added with this project shall be grouped for display purposes into the system such that all points associated with a new or existing DDC system can appear together on the CRT display or printed log. Assignment of points to a group shall not be restricted by hardware configuration of the points of direct digital control. It shall be possible to assign a point to appear in more than one system. An English descriptor and an alpha/numeric identifier shall identify each system.

This Direct Digital Control system as herein specified shall be fully integrated and completely installed by this section. It shall include all required computer CPU software and hardware. Include the engineering, installation, supervision, calibration, software programming, and checkout necessary for a fully operational system.

INSTALLATION
All work and materials are to conform in every detail to the rules and requirements of the National Electrical Code and present manufacturing standards. All wiring and cable installation shall conform with the wiring installation as specified in the installation section of Section 23 09 14. All material shall be UL approved.

Install system and materials in accordance with manufacturer's instructions, rough-in drawings and details on drawings.

Line voltage wiring to power the DDC Controllers, not provided by the Division 26 contractor, to be by this contractor.

Provide uninterruptable power supplies where necessary to provide proper startup of equipment or to accomplish power restart control sequences specified.

Mount control panels adjacent to associated equipment on vibration-free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.

Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of panel cover. Provide a protective cover or envelope for drawings.

Cable tray routing of the communication trunks is acceptable.

Provide all necessary routers and or repeaters to accomplish connection to the BAN via the panel-mounted port provided.

Provide two data jacks in control panels housing supervisory controllers and allocate 6”x6” for each data jack in the panel. The first jack will be used for connecting the supervisory controller to the BAN. The second jack will be used as a spare for connecting to the BAN by service personnel.

Provide an input for a service shutdown toggle switch for each air handling unit system provided inside the temperature control panel that will initiate a logical shutdown of the air handling unit system.

All tubing, cable and individual wiring is to be permanently tagged, with numbers corresponding with "Record Drawings", spares are to be labelled as "Spare".

Provide technician to work with air balancing contractor and/or provide balancing contractor with necessary hardware to over-ride DDC controllers for air balancing.

TRAINING

Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 20 hours.

Provide two follow-up visits for troubleshooting and instruction, one six months after substantial completion and the other at the end of the warranty period. Length of each visit to be not less than 3 hours or the time necessary to provide required information and complete troubleshooting and inspection activity for all controls installed under 23 09 23, 23 09 14, and 23 09 93. Coordinate the visit with the owner and provide an inspection report to the owner of any deficiencies found.

COMMISSIONING, VERIFICATION, AND CLOSEOUT

Provide technicians to work with mechanical contractor, balancing contractor and owner to assist with balancing, air pressurization set-up, project set-up and closeout.

Prior to owner involvement, provide documentation to demonstrate that all points, input and output, have been checked out and verified operational, note any points not operating properly with notation of reason. All points to be operational prior to owner involvement with project set-up and commissioning.

Prior to owner involvement, the temperature control contractor shall self-commission all systems to verify (at minimum):

All systems are calibrated, under control and functioning as specified and designed.
Verification that all points, alarms and equipment are integrated into the BAS and are graphically represented (accurately).
Air terminals operate and are under control.
Dampers operate and are under control.
Temperature control valves operate and are under control.
Setpoints and deadbands.
Sensor integration and calibration
Equipment interlocks

Contractor to provide written documentation that all systems have been self-commissioned, verified to be in working order and are suitable for owner commissioning and system set-up.

END OF SECTION

SECTION 23 09 93
SEQUENCE OF OPERATION FOR HVAC CONTROLS

P A R T 1 - G E N E R A L

SCOPE

The work associated with this section will be bid as part of the Division 23 scope of work.

This section includes control sequences for HVAC equipment as well as equipment furnished by others that may need monitoring or control. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Description of Work
- Submittals
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- Not Applicable

PART 3 - EXECUTION
- General Control Sequences
- Project Specific Control Sequences

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC – Coordination
Section 23 09 14 - Pneumatic and Electric Instrumentation for HVAC Control
Section 23 09 24 – Direct Digital Control System for HVAC
Division 23 - HVAC - Equipment provided to be controlled or monitored
Division 26 - Electrical - Equipment provided to be controlled or monitored

REFERENCE

Section 23 09 14 work includes furnishing and installing all field devices, including electronic sensors for the DDC of this section, equipment, and all related field wiring, interlocking control wiring between equipment, pneumatic tubing, sensor mounting, etc., that is covered in that section.

Motorized control dampers and actuators, thermowells (temperature sensing wells), automatic control valves and their actuators are also covered in Section 23 09 14.

DESCRIPTION OF WORK

Control sequences are hereby defined as the manner and method by which automatic controls function. Requirements for each type of operation are specified in this section.

Operation equipment, devices and system components required for automatic control systems are specified in other Division 23 control sections of these specifications.

All temperature, humidity, and pressure sensing, and all other control signal transportation for the control sequences shall be furnished under Section 23 09 14. All pneumatic, electronic, and electric input/output signals shall be extended under Section 23 09 14, with adequate lead length for termination within the appropriate control panel being provided under Section 23 09 23.

Sequences for equipment controlled by Direct Digital Controls (DDC) as specified are accomplished by hardware and software provided under Section 23 09 23. Sequences for equipment controlled by pneumatic or electric self-contained controls are accomplished by hardware provided under Section 23 09 14.

SUBMITTALS

Refer to Division 1, General Conditions, Submittals, Section 23 05 00, Sections 23 09 14, and 23 09 23 for descriptions of what should be included in the submittals.

Shop drawings shall be provided by contractor(s) providing equipment under Sections 23 09 24 and 23 09 14. The contractor providing the DDC equipment shall provide a complete narrative of the sequence of operations for equipment that is controlled through the DDC system. The contractor providing the 23 09 14 equipment shall provide a complete narrative of the sequence of operation for equipment that is controlled directly from that equipment (without control logic through the DDC system). The narrative of the sequence of operation shall not be a verbatim copy of the sequences contained herein, but shall reflect the actual operation as applied by the contractor.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA

Reference Section 23 09 14.

P A R T 2 - P R O D U C T S

Not applicable to this Section – reference Sections 23 09 23 and 23 09 14 for product descriptions.

P A R T 3 - E X E C U T I O N

GENERAL CONTROL SEQUENCES

BACNET OBJECTS:

All hardwired points listed and any setpoints, timers, or other control elements that are specified to be adjustable (adj.) in the following control sequences shall be mapped as BACnet objects and be available on the user interface to be adjusted. Consult with the user agency HVAC and/or DDC personnel prior to programming to determine if there are any items that they do not want to have mapped as BACnet objects. This is especially important for DDC controlled items that are duplicative, i.e., air terminal units.

BACNET ADDRESSING:

BACnet instance ID's shall be coordinated with the agencies established BACnet instance ID addressing scheme. If there is not such a scheme in place, the contractor(s) providing BACnet DDC controllers shall work with the agency to establish such a scheme and document this in the asbuilt control drawings. BACnet/IP addressing shall be coordinated with the agency prior to installation. BACnet MSTP addressing shall be addressed to provide for consecutive addressing to provide for the best speed of response. Max Master address shall be set appropriately for speed of response.

USER INTERFACE/FEATURE SOFTWARE:

Consult with the user agency HVAC and/or DDC personnel prior to programming to determine BACnet object naming conventions, user views, graphic layout, security matrix, alarming, trending, and scheduling preferences desired by the agency. Failure to consult and come to agreement prior to programming shall require the DDC contractor to make changes in the above listed items as desired by the user agency to the system at no cost.

SETPOINTS:

All setpoints indicated in the control specification are to be adjustable. The setpoints shall be readily available to be modified in the mechanical system software system summary (either textual or graphic based) and under the same software level as hardware points. Some less used setpoints may be provided on a lower software level, if requested by the user Agency for clarity. The setpoints indicated herein are only specified as a calculated starting point (or initial system operation).

It is expected that setpoint adjustments and control loop tuning shall be required to provide optimum system operation based on requirements of the building.

The control contractor shall work with the balancing contractor and the user Agency to provide the final system setpoint adjustments and control loop tuning after the system is in operation and building is in use. Document all final setpoints on the as-built control drawings. Any questions regarding the intended operation of the HVAC equipment and control systems shall be referred to the HVAC design engineer through the appropriate construction communication process. The following setpoints should be used as initial setpoints unless otherwise specified in the individual control sequences:

Occupied Room Space Terminal Unit Heating: 68º F
Occupied Room Space Terminal Unit Cooling: 75º F
Entry Way and Stair Heating: 60° F
Mechanical or Unoccupied Space Ventilation: 82º F
Mechanical or Unoccupied Space Heating: 60º F

ANTI-CYCLING:
When HVAC equipment or a sequence is specified to be started and stopped by a temperature, humidity, pressure setpoint or any other controlled variable, there shall be an adjustable differential setpoint that shall be set to prevent short cycling of the systems and equipment due to minor changes in the controlled variable. Temperature differential setpoints shall be set at 2º F and non-temperature setpoints shall be set at 10% of the controlled range unless otherwise specified. Setpoints shall indicate at when the process should be turned on. Heating and cooling differentials shall be set for above setpoint and will be used to turn the process off. For example, an economizer sequence called to switch at 68º F, would turn on at 68º F and off at 70º F since it is a cooling function. A heating lockout setpoint of 50º F would turn on heating control at 50º F and off at 52º F Non-temperature differentials shall be set above setpoint if the setpoint is indicating a minimum value or below setpoint if the setpoint is indicating a maximum value. Provide minimum runtime timers for loads that are cycled to prevent over-cycling. Timers shall be set as specified or as needed to prevent damage or excessive wear to the equipment. Unless otherwise specified in the individual control sequences, fans and pumps shall have a minimum runtime on timers of 15 minutes (adj.) and off timers of 5 minutes (adj.). Safeties shall override runtime timers.

DEADBANDS:
Provide deadbands for all DDC control loops to prevent constant hunting of output signals to controlled devices. Deadbands shall be set to provide adequate control around setpoint as follows unless otherwise specified in the individual control sequences:

ALARMS:
Provide all alarmed points with adjustable time delays to prevent nuisance tripping under normal operation and on equipment start-up. For all commanded outputs that have status feedback, provide an alarm that will indicate the commanded output is not in its commanded state. Provide alarms on all points as indicated on point charts. For existing campus automations systems, add/delete what is called on the point charts for after consultation with user Agency to provide consistent alarming throughout the automation system.

TREND DATA:
Trends shall be provided for all hardware I/O points and integrated points listed as having trending in the DDC point charts and for analog and binary data points mapped to the user interface as specified below. Interval trending with sample intervals of 10 minutes shall be provided on analog process variables (this includes both analog inputs and calculated process variables) and process outputs. In addition, provide Change of Value (CoV) trending for all binary input and output points, binary data points mapped to the user interface, and for all analog inputs and process variables. Analog inputs and process variables and setpoints shall be set at 5% CoV of setpoint. Analog process outputs shall have CoV set at 5% of the output range. Other analog data points mapped to the user interface shall have CoV trends of 5% of their range. Consult with the user agency specific standard values for interval and CoV trends for different points and control types. Data shall be stored at the supervisory controller or in the field controller and up-loaded to the DDC system server when archiving is desired. Consult with the user agency to determine which trends should be archived. Trending shall be in place for a minimum of 24 hours prior to functional testing by the commissioning provider.

EQUIPMENT START/STOP FAILURE STATES:
All start/stop points for equipment shall utilize normally open contacts unless called out specifically in the individual control sequences.

LEAD/STANDBY SEQUENCING:
For sequences that call for lead/lag of equipment connected to building automation systems, the lead device shall be able to be chosen through a selectable day of the week and time of day through the building automation system. Coordinate with the user Agency for scheduling switchover and frequency. Unless otherwise directed, switchover shall occur at 10AM Tuesday and shall rotate the lead device on a weekly cycle rotating through all devices sequentially. For standalone lead/lag sequence controllers (non-DDC), the lead device shall be selected by a switch on the panel face.

VARIABLE FREQUENCY DRIVE (VFD) MOTOR RUN STATUS:
Use the VFD programmable relay dry contact output specified to be provided with the VFD under Section 23 05 14 to prove motor run status and detect belt loss or coupling break. If a bypass contactor is provided with the VFD, provide an adjustable current switch and wire it in parallel with the VFD output for proving motor status.

VFD MINIMUM SPEED & RAMP TIMERS:
The VFD start-up technician shall work with the DDC Temperature Control Contractor determine the minimum speed required for the motor controlled by the VFD to provide cooling of the motor as installed to prevent heat related problems. This minimum speed shall be set in the VFD controller. The VFD start-up technician shall work with the DDC Temperature Control Contractor to set the acceleration and deceleration timers in the VFD controller at 30 seconds for motors less than 40 HP and 60 seconds for motors 40 HP and greater.

CURRENT SWITCH SETUP:
When current switches are used for proving fan or pump status, they shall be set up so that they will detect belt or coupling loss by the reduction in current draw on loss of coupled load. The current switch set up shall be redone by the 23 09 14 contractor after the balancer is complete.

FAN INTERLOCKING:
Provide interlocks between supply and return or exhaust fan systems as scheduled on the plans or called out in individual control sequences. If DDC controlled, interlocks shall be done through DDC start/stop points unless otherwise specified in individual control sequences. If not DDC controlled, interlocks shall be accomplished via hardwire interlocks between fan starters or VFD's.

THERMOSTATS AND SENSORS:
All devices and equipment including terminal units, specified to be controlled in a control sequence by a thermostat or sensor, shall be provided with a thermostat or sensor, whether or not the device is indicated on the plans. Consult the HVAC design engineer for the thermostat or sensor location.

WEEKLY SCHEDULING
Provide scheduling of DDC terminal units in groups based on occupancy. Work with the user Agency to determine how many groups are required and which zones should be included. Individual terminal units shall be able to receive temporary schedules that shall override the group schedules. Temporary override buttons at the zone sensor (where specified on point charts) shall override the scheduling to occupied. When groups that consist of more than 20% of terminal units are indexed to occupied, the associated air handling unit shall start if not already running.

CONTROLLED VARIABLE REQUIREMENTS
All controlled variables, i.e., static pressure, differential pressure, temperature, humidity, etc., shall be wired directly to the DDC controller in which the software PID loop or other similar software loop resides unless the control sequence specifically allows the controlled variable to be routed over the network. Where a controlled variable is used for reset of a PID loop, the controlled variable shall be allowed to be shared over the network unless specified to be directly wired to the DDC controller.

ORIGINAL EQUIPMENT MANUFACTURER (OEM) CONTROLLER DDC INTEGRATION:
Provide DDC programming to define all equipment integral input/output points, setpoints, data points, calculations, etc. that are available through the manufacturers communication interface. Consult with the Agency DDC operations personnel to determine if some of the points should be omitted (for clarity or lack of value). The following equipment shall be integrated into the DDC system:

- Variable Frequency Drives
- Heat Recovery Chiller

PROJECT SPECIFIC CONTROL SEQUENCES
Refer to Airflow and Control Diagram Drawings for Sequences of Operation.

END OF SECTION

SECTION 23 21 13
HYDRONIC PIPING

P A R T 1 - G E N E R A L

SCOPE

This section contains specifications for all HVAC hydronic pipe and pipe fittings for this project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Shop Drawings
- Quality Assurance
- Delivery, Storage, and Handling
- Design Criteria
- Welder Qualifications

PART 2 - PRODUCTS
- Heating Hot Water
- Chilled Water
- Geothermal Water (Aboveground)
- Makeup Water
- Chemical Treatment
- Vents and Relief Valves
- Cooling Coil Condensate
- Unions and Flanges
- Gaskets
- Unions and Flanges
- Mechanical Grooved Pipe Connections

PART 3 - EXECUTION
- Preparation
- Erection
- Welded Pipe Joints
- Threaded Pipe Joints
- Mechanical Grooved Pipe Connections
- Copper Pipe Joints
- Water Systems
- Makeup Water
- Chemical Treatment
- Vents and Relief Valves
- Cooling Coil Condensate
- Unions and Flanges
- Gaskets
- Piping System Leak Tests
- Hydronic Piping System Flushing
- Construction Verification Items
- Piping System Test Report

RELATED WORK

Section 23 05 23 - General-Duty Valves for HVAC Piping
Section 23 05 15 - Piping Specialties
Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
Section 23 07 00 - HVAC Insulation
Section 23 25 00 - HVAC Water Treatment.

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

ANSI B16.3	Malleable Iron Threaded Fittings
ANSI B16.4	Cast Iron Threaded Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.22	Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
ASTM A74	Cast Iron Soil Pipe and Fittings
ASTM A105	Forgings, Carbon Steel, for Piping Components
ASTM A126	Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A181	Forgings, Carbon Steel for General Purpose Piping
ASTM A197	Cupola Malleable Iron
ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A380	Practice for Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems
ASTM B75	Seamless Copper Tube
ASTM B88	Seamless Copper Water Tube

SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.

TYPE F STEEL PIPE:
Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

TYPE E OR S STEEL PIPE:
Mill certification papers, also known as material test reports, for the pipe furnished for this project, in English. Heat numbers on these papers to match the heat numbers stencilled on the pipe. Chemical analysis indicated on the mill certification papers to meet or exceed the requirements of the referenced ASTM specification.

COPPER TUBE:
Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

QUALITY ASSURANCE

Order all Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on the size of the pipe, and in accordance with the appropriate ASTM specification.

Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

DELIVERY, STORAGE, AND HANDLING

Promptly inspect shipments to insure that the material is undamaged and complies with specifications.

Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

Offsite storage agreements will not relieve the contractor from using proper storage techniques.

Storage and protection methods must allow inspection to verify products.

DESIGN CRITERIA

Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.

Construct all piping for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

Where weld fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.

Where ASTM A53 type F pipe is specified, ASTM A53 grade A type E or S, or ASTM A53 grade B type E or S may be substituted at Contractor's option. Where ASTM A53 grade A pipe is specified, ASTM A53 grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.

Where ASTM B88, type L hard temper copper tubing is specified, ASTM B88, type K hard temper copper tubing may be substituted at Contractor's option.

WELDER QUALIFICATIONS

Before any metallic welding is performed, the Contractor shall submit his Standard Welding Procedure Specifications, Procedure Qualification Records and Qualification Test Records for each Welder along with associated continuity records to demonstrate compliance with ASME Section IX, paragraph QW-322.

The Contractor shall maintain a complete set of welder qualification documents at the jobsite, including Test Records and Continunity Records for each welder.

The A/E or owner reserves the right to test the work of any welder employed on the project, at the Contractor's expense. Testing will include a visual examination of the pipe and weld and may include radiography of any suspect welds. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project. Any welds deemed unacceptable will be repaired at the contractor’s expense.

P A R T 2 - P R O D U C T S

HEATING HOT WATER

2" and Smaller: ASTM A53, type F, standard weight (schedule 40) black steel pipe with ASTM A126/ANSI B16.4, class 125, standard weight cast iron threaded fittings.

2-1/2" and Larger: ASTM A53, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

Contractor may use ASTM B88 seamless, type L, hard temper copper tube with ANSI B16.22 wrought copper solder-joint fittings in lieu of steel pipe for all sizes. Mechanically formed tee fittings may be used in lieu of wrought copper solder-joint tee fittings for branch takeoff up to one-half (1/2) the diameter of the main.

CHILLED WATER

2" and Smaller: ASTM A53, type F, standard weight (schedule 40) black steel pipe with ASTM A126/ANSI B16.4, class 125, standard weight cast iron threaded fittings.

2-1/2" and Larger: ASTM A53, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

Contractor may use ASTM B88 seamless, type L, hard temper copper tube with ANSI B16.22 wrought copper solder-joint fittings in lieu of steel pipe for all sizes. Mechanically formed tee fittings may be used in lieu of wrought copper solder-joint tee fittings for branch takeoff up to one-half (1/2) the diameter of the main.

GEOTHERMAL WATER (ABOVE GROUND)

2" and Smaller: ASTM A53, type F, standard weight (schedule 40) black steel pipe with ASTM A126/ANSI B16.4, class 125, standard weight cast iron threaded fittings.

2-1/2" and Larger: ASTM A53, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

Contractor may use ASTM B88 seamless, type L, hard temper copper tube with ANSI B16.22 wrought copper solder-joint fittings in lieu of steel pipe for all sizes. Mechanically formed tee fittings may be used in lieu of wrought copper solder-joint tee fittings for branch takeoff up to one-half (1/2) the diameter of the main.

MAKEUP WATER

Extend from where left by the Plumbing Contractor with the same materials.

CHEMICAL TREATMENT

Use pipe and pipe fittings as specified for the system to which the chemical treatment piping is connected. Plastic pipe furnished with the chemical treatment materials may also be used if its pressure/temperature rating is acceptable for the service.

VENTS AND RELIEF VALVES

Use pipe and pipe fittings as specified for the system to which the relief valve or vent is connected.

COOLING COIL CONDENSATE
ASTM B88, type L hard temper copper tubing with ASTM B145/ANSI B16.23 cast red bronze or ASTM B75/ANSI B16.29 wrought solder-type drainage fittings.

UNIONS AND FLANGES
2" and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use ANSI B16.18 cast copper alloy unions on copper piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.

2-1/2" and Larger: ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2-1/2" may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

GASKETS
Water and Glycol Systems: Branded, compressed, non-asbestos sheet gaskets. Klingersil C4401, Garlock 3000, JM Clipper 978 or approved equal.

MECHANICAL GROOVED PIPE CONNECTIONS
The use of mechanical grooved pipe connections will not be accepted.

P A R T 3 - E X E C U T I O N

ERECTION
Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job site immediately. Excluding minor surface rust, piping that exhibits significant oxidation or corrosion will be rejected.

Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.

Remove all lose dirt, scale, oil, chips, burrs and other foreign material from the internal and external surfaces of all pipe and piping components prior to assembly, including debris associated with cutting, threading and welding.

During fabrication and assembly, remove slag and weld spatter from internal pipe surfaces at all joints by peening, chipping and wire brushing.

During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item of the system. Use plugs, caps, blind flanges or other items designed for this purpose.

Furnish and install all flanges, caps, bypasses, drains, valves, etc. required to facilitate flushing and draining all heating and cooling system piping.

Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.

Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.

"Weldolets" and "Threadolets" will not be accepted.

Install drains throughout the systems to permit complete drainage.

Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.

Install all valves, control valves, and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

WELDED PIPE JOINTS

Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.

All pipe welding shall be completed by Qualified Welders in accordance with the Contractor's Procedure Specifications.

Contractor will ensure that these steps are followed where pipe sections will be joined by welding:

1. Cleaning – Welding surfaces will be clean and free of defects.
2. Alignment – Inside diameter of piping components will be aligned as accurately as possible. Internal misalignment shall not exceed 1/16".
3. Spacing – Pipe sections will be spaced to allow deposition of weld filler material through the entire weld joint thickness.
4. Girth Butt Welds:
    a. Girth butt welds shall be complete penetration welds.
    b. Concavity will not exceed 1/32"
    c. Under cuts will not exceed 1/32"
    d. As welded surfaces are permitted however surfaces will be free from coarse ripples, grooves, abrupt ridges and valleys.

Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

THREADED PIPE JOINTS

Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

MECHANICAL GROOVED PIPE CONNECTIONS

The use of mechanical grooved pipe connections will not be accepted.

COPPER PIPE JOINTS

Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux, and assemble joint. Use 95-5 solder or brazing to secure joint as specified for the specific piping service.

Where mechanically formed tee fittings are allowed, form mechanically extracted collars in a continuous operation, consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. Use an adjustable collaring device. Notch and dimple the branch tube. Braze the joint, applying heat properly so that pipe and tee do not distort; remove distorted connections.

WATER SYSTEM

Run water mains level or pitch horizontal mains up 1 inch in 40 feet in the direction of flow. Install manual air vents at all high points where air may collect. If vent is not in an accessible location, extend air vent piping to the nearest code acceptable drain location with vent valve located at the drain.

Main branches and runouts to terminal equipment may be made at the top, top 45 degree, side, and/or bottom 45 degree of the main provided that there are drain valves suitably located for complete system drainage and manual air vents are located at all top and top 45 degree connections. Bottom connections are not acceptable unless approved by the AE or owner.

Use top or top 45 degree connection to main for upfeed risers and bottom 45 degree connection to main for downfeed risers. Bottom connections are not acceptable unless approved by the AE or owner.

Use a minimum of two elbows in each pipe line to a piece of terminal equipment to provide flexibility for expansion and contraction of the piping systems. Offset pipe connections at equipment to allow for service, such as removal of the terminal device.

Use eccentric fittings for changes in horizontal pipe sizes with the fittings installed for proper air venting. Concentric fittings may be used for changes in vertical pipe sizes.

MAKEUP WATER

Install where indicated and/or specified, including all valves, piping specialties and dielectric unions required for a functional system.

CHEMICAL TREATMENT
Install chemical treatment piping as indicated on the drawings, as detailed, and as recommended by the supplier of the chemical treatment equipment.

VENTS AND RELIEF VALVES
Install vent and relief valve discharge lines as indicated on the drawings, as detailed, and as specified for each specific valve or piping specialty item. In no event is a termination to occur less than six feet above a roof line.

COOLING COIL CONDENSATE
Trap each cooling coil drain pan connection with a trap seal of sufficient depth to prevent conditioned air from moving through the piping. Extend drain piping to nearest code approved drain location. Construct trap with plugged tee for cleanout purposes as detailed.

UNIONS AND FLANGES
Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement.
Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

GASKETS
Store horizontally in cool, dry location and protect from sunlight, water and chemicals. Inspect flange surfaces for warping, radial scoring or heavy tool marks. Inspect fasteners, nuts and washers for burrs or cracks. Replace defective materials.

Align flanges parallel and perpendicular with bolt holes centered without using excessive force. Center gasket in opening. Lubricate fastener threads, nuts and washers with lubricant formulated for application.

Draw flanges together evenly to avoid pinching gasket. Tighten fasteners in cross pattern sequence (12 – 6 o'clock, 3 – 9 o'clock, etc.), one pass by hand and four passes by torque wrench at 30% full torque, 60% full torque and two passes at full torque per ASME B16.5.

PIPING SYSTEM LEAK TESTS
Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.

Provide all piping, fittings, blind flanges, and equipment to perform the testing.

Conduct pressure test with test medium of air or water unless specifically indicated. Minimum test time is indicated in the table below; additional time may be necessary to conduct an examination for leakage. Each test must be witnessed by the Division's representative. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.

Do not insulate pipe until it has been successfully tested.

For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking. After testing is complete, slowly release the pressure in a safe manner.

System	Pressure	Medium	Duration
Heating hot water	100 psig	Water	8 hr
Chilled water	100 psig	Water	8 hr
Geothermal water (Above grade)	100 psig	Water	8 hr

All pressure tests are to be documented.

Refer to Section 23 21 26 for below grade geothermal piping testing requirements.

HYDRONIC PIPING SYSTEM FLUSHING

All new chilled water and heating hot water system piping shall be flushed thoroughly before the systems are put in to operation. Subsequent to executing the chemical cleaning processes specified in Section 23 25 00 – HVAC WATER TREATMENT, and prior to adding scale and corrosion inhibitors, flush all piping and components with a clean source of water until the discharge from the system is clean. Discharge shall be from drains provided at all low points in the piping, ends of headers and as otherwise necessary to flush and drain the entire system.

A clean water source shall be tapped into the system downstream of the main circulation pump(s). Provide minimum 2" connection between water source and hot water/chilled water systems including taps with ball valves (or line size tap and ball valve for piping systems smaller than 2").

Provide minimum 2" taps (or line size if mains are smaller than 2") at the ends of headers, the low pint of each of the mains on each floor and as otherwise necessary to flush and drain the entire system. Contractor shall identify proposed clean water source along with the method/location of drain discharge and review with the A/E and owner prior to installing flushing connections to water source and drain outlets. Provide code required temporary backflow prevention for the clean water source if needed. Provide all temporary taps, valves, piping, bypasses and hoses as needed to accomplish flushing procedures.

After flushing operations are complete, drain and/or blow out any residual water, clean and replace all strainers, and add scale and corrosion inhibitors as specified in Section 23 25 00. Leave flushing connections/valves in place and cap.

All flushing procedures shall be documented by completing and submitting the report form included at the end of this Section.

INITIAL FILL AND VENT

Fill hydronic systems with appropriate working fluids as specified. All system fluids shall be chemically treated as specified in Section 23 25 00 – HVAC WATER TREATMENT.

For closed piping systems, all air trapped at high points shall be relieved through the manual air vents

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

END OF SECTION

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PIPING SYSTEM LEAKAGE TEST REPORT

Date Submitted: _____

Project Name: _____

Contractor: _____

System: _____

Test Medium: □ **Air** □ **Water** □ **Other** _____

Specified Test Duration _____ **Hours** **Specified Test Pressure** _____ **PSIG**

System Identification: _____

Describe Location / Section of Piping: _____

_____

Test Date: _____

Start Test Time: _____ **Initial Pressure:** _____ **PSIG**

Stop Test Time: _____ **Final Pressure:** _____ **PSIG**

Tested By: _____ **Witnessed By:** _____

Title: _____ **Title:** _____

Signed: _____ **Signed:** _____

Date: _____ **Date:** _____

Comments: _____

_____

_____

PIPING SYSTEM FLUSHING REPORT (Page 1)

Date Submitted: _____

Project Name: _____

Contractor: _____

System Identification (check one):

- ❒ **Chilled Water**
- ❒ **Heating Hot Water**
- ❒ **Geothermal Water**

Describe procedure: _____

_____

_____

_____

_____

Flush Date: _____ **Start Time:** _____ **Stop Time:** _____

Pressure of Water Source: _____ **PSIG Describe water source and method of connection to source :**
_____

_____

Flushed By: _____ **Witnessed By:** _____

Title: _____ **Title:** _____

Company: _____ **Agency:** _____

Signed: _____ **Signed:** _____

Date: _____ **Date:** _____

Describe results: _____

SECTION 23 21 23
HYDRONIC PUMPS

P A R T 1 - G E N E R A L

SCOPE
This section includes specifications for water pumps used for HVAC applications. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- Base Mounted Centrifugal Pumps
- In-Line Centrifugal Pumps
- In Line Circulation Pumps

PART 3 - EXECUTION
- Installation
- Construction Verification Items
- Functional Performance Testing

RELATED WORK
Section 23 05 13 - Common Motor Requirements for HVAC Equipment

REFERENCE
Applicable provisions of Division 1 shall govern work under this section.

QUALITY ASSURANCE
Refer to division 1, General Conditions, Equals and Substitutions.

SHOP DRAWINGS
Also refer to division 1.

Include data concerning dimensions, capacities, materials of construction, ratings, weights, pump curves with net positive suction head requirements, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

Pump curves shall identify design point of operation.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA
Pump sizes, capacities, pressures and operating characteristics shall be as scheduled.

Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard, and other accessories specified. Statically and dynamically balance all rotating parts. Provide flanged connections on all pumps unless specified otherwise. Service or repair of base mounted pumps shall not require breaking piping connections or removal of motor.

Furnish each pump and motor with a nameplate giving the manufacturer's name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current.

Test all pumps, clean and paint before shipment. The manufacturer shall certify all pump ratings.

All pumps to operate without excessive noise or vibration.

PART 2 - PRODUCTS

BASE MOUNTED CENTRIFUGAL PUMPS
MANUFACTURERS:
Bell and Gossett Series 1510, Taco Series FI

Description:
Type: Horizontal shaft, single stage, single or double suction, split casing, 175 PSIG working pressure at operating temperature of 225 degrees F continuous, 250 degrees F intermittent. Pump shall be back pull-out design to allow for servicing without disturbing piping, motor or requiring shaft realignment.

Casing: Cast iron with suction and discharge gage ports, renewable bronze wear rings, vent and drain plugs, flanged suction and discharge connections.

Impeller: Bronze, hydraulically and dynamically balanced, keyed and locked to pump shaft, and protected by replaceable bronze shaft sleeve.

Bearings: Oil or grease lubricated ball or roller bearings.

Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.

Seal: Carbon rotating against stationary ceramic seat, 225 degrees F maximum continuous operating temperature.

Drive: Flexible spacer type coupling or coupling with extended hub to allow for pump service. Provide and OSHA approved guard for shaft/coupling assembly.

Baseplate: Cast iron or fabricated steel with provisions for grouting.

IN-LINE CENTRIFUGAL PUMPS
MANUFACTURERS:
Bell and Gossett Series 80, Taco Series KV

Description:
Factory assembled and tested, centrifugal, overhung impeller, close-coupled, inline pump designed for installation with pump and motor shafts mounted horizontally or vertically.

Casing: Radially split cast iron; flanged suction and discharge connection; with plugged taps for vent, drain, suction and discharge gages, and replaceable bronze wear rings.

Impeller: Cast bronze, keyed to shaft, secured with a stainless steel locking cap screw, hydraulically and dynamically balanced.

Pump shaft sleeve shall be bronze or stainless steel with stainless steel stub shaft.

Bearings: 2 oil lubricated bronze sleeves or ball bearings capable of being greased.

Seal: Mechanical type, carbon rotating against a stationary ceramic seat, 225 degrees□F maximum continuous operating temperature.

IN-LINE CIRCULATION PUMPS
MANUFACTURERS:
Bell and Gossett, Armstrong, Thrush, Taco, Grundfos, Aurora, or approved equal.

Permanently lubricated circulation pump.

Pump shall be rated to operate at maximum 225°F and 150psi pressure.

Pump shall have iron body, stainless steel shaft, glass filled PPS impellor and permanently lubricated and sealed ball bearings. Mechanical seal faces shall be carbon on silicon carbide.

Pump motor shall be a drip proof split capacitor with thermal overload protection.

PART 3 - EXECUTION

INSTALLATION

Install all pumps in strict accordance with manufacturer's instructions. Access/service space around pumps shall not be less than minimum space recommended by pump manufacturer.

For base mounted pumps located on 2nd floor and within new mechanical room, set pumps on concrete pads and concrete inertia bases as specified in Section 23 05 48. Fill entire base with non-shrinking grout when required by manufacturer's installation instructions. Level and bolt down pump prior to grouting of pump base. Base mounted pumps not mounted on inertia bases shall be mounted on concrete pads. Fill entire base with non-shrinking grout when required by manufacturer's installation instructions. Level and bolt down pump prior to grouting of pump base.

Support piping adjacent to pump such that no weight is carried on pump casings.

All valves and piping specialties must be full line size as indicated on the drawings.

Install per plan details.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agency in accordance with the procedures defined for construction verification in Section 01 91 00.

FUNCTIONAL PERFORMANCE TESTING

Contractor is responsible for utilizing the functional performance test forms supplied by the third party commissioning agent in accordance with the procedures defined for functional performance testing in Section 01 91 00.

END OF SECTION

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SECTION 23 21 26
GROUND SOURCE CLOSED CIRCUIT VERTICAL EXCHANGER FIELD

PART 1 – GENERAL

SCOPE

This design has been prepared in accordance with the materials standards and accepted installation practices of the (IGSHPA). The loopfield contractor shall comply with these standards and practices as well as all State and local regulations pertaining to the installation.

The loopfield contractor is responsible for all aspects involved with the complete geothermal loopfield installation. All materials, drilling, excavation, hauling of backfill, pumping, soil compaction and labor required shall be included in the bid price.

The loopfield contractor shall take note: there is no guarantee to the loopfield contractor that the location of any existing utilities are exactly as indicated on the plans. Some areas may require hand digging to locate that utility. The loopfield contractor must include in the bid price, the repair of any domestic water, electrical, communication or any service line that may be damaged during the construction of this project. Any offsets required to route over or under existing lines shall also be included in the bid price of the project.

PART 1 - GENERAL
- Scope
- Related Work
- Quality Assurance
- Design Criteria
- Shop Drawings

PART 2 - PRODUCTS
- Pipe
- Fittings
- U-Bend Pipe Separators
- Bentonite Grout
- Location Tape
- Field Location

PART 3 - EXECUTION
- Drilling
- U-Bend Pipe Assembly
- Grouting Procedure
- Heat Fusion Pipe Joining
- Excavation and Backfill
- Pipe Installation
- Coordination of Work
- Testing and Cleaning
- Construction Verification Items

Division 23 work as specified shall be provided by HVAC Contractor unless otherwise specified on Bid Form.

RELATED WORK

Applicable provisions of Division 01 govern work under this section.

Section 00 31 32 Geotechnical Data & Geothermal Testing Boring Information

QUALITY ASSURANCE

Substitution of Materials: Refer to Division 01 and the General Conditions of the Contract.

The loopfield contractor must have on this project a certified International Ground Source Heat Pump Association (IGSHPA) installer. The loopfield contractor performing this work must have a minimum of two years experience in performing underground closed circuit vertical heat exchanger work of this project's size or larger.

Vertical heat exchanger fabricators must be heat fusion certified by an authorized high density polyethylene (HDPE) pipe manufacturer's representative of the brand of pipe used.

Certification must include: successful completion of a written heat fusion exam as well as demonstrating proper heat fusion techniques under the direct supervision of the authorized HDPE pipe manufacturer's representative.

Loopfield contractor shall review his own work for compliance with Construction Documents. Prior to punch list activity by A/E, contractor shall provide documentation to A/E that a review has taken place and shall issue a letter indicating that Work has been performed in compliance with Construction Documents.

In the event Contractor does not satisfactorily review his own work and results in additional site visits by A/E, Contractor shall reimburse A/E for additional time required to close out Project.

DESIGN CRITERIA

Below is a summary of the geothermal loopfield design:

- 500 foot vertical heat exchanger depth with minimum 6 foot trench depth
- 54 total vertical heat exchangers split into (3) 18 vertical heat exchanger fields
    - (3) 4" supply / return circuits to the building
- 20 foot nominal spacing between vertical bores
- 25% propylene glycol percentage in water
- 40F and 85F shall be the minimum and maximum design supply water termperatures
- Geological Conditions:
    - Soil Formation Thermal Conductivity: 2.15 Btu/hr-ft-°F
    - Soil Formation Thermal Diffusivity: 1.45 ft² / day
    - Soil Undisturbed Formation Temperature: 51.2 – 52.2°F
    - Borehole Thermal Resistance: 0.248 hr-ft-°F/Btu
- Loopfield designed for the building block heating load at 20% outside airflow on all air handling units at 10F.
- The intent of the heat recovery chiller and borefield is to provide cooling for the entire building and the building heating load down to 25F.

SHOP DRAWINGS

Refer to Division 01 and General Conditions of the Contract.

PART 2 - PRODUCTS

PIPE

The pipe shall be PE3408 HDPE with a minimum cell classification of 45434C per ASTM D3035-93 and a DR11 rating for u-bends.

Header pipe 2 inches or smaller and a minimum of DR11 for header pipe greater than 2 inch in diameter. This pipe will carry a warranty of no less than 25 years.

Each pipe shall be permanently indent marked with the manufacturer's name, nominal size, pressure rating, relevant ASTM standards, cell classification number and date of manufacture.

All piping used will have factory hot-stamped lengths impressed on the side of the piping indicating the length at that point. The length stamp shall read zero on one end and the actual total length on the other end.

Only factory fused u-bend with pipe lengths long enough to reach grade from the bottom of the bore will be allowed. No field fusions are required below header level.

FITTINGS

Pipe fittings shall meet the requirements of ASTM D2683 (for socket fusion fittings) or ASTM D3261 (for butt/saddle fusion fittings). Each fitting shall be identified with the manufacturer's name, nominal size, pressure rating, relevant ASTM standards and date of manufacturer.

U-BEND PIPE SEPARATORS

The u-bend pipe separators used to position the u-bend pipes against the borehole wall directly across from one another. These separators will be positioned every ten feet on the u-bend pipe.

BENTONITE GROUT

The thermally enhanced bentonite grout used to seal the vertical heat exchanger shall have a minimum thermal conductivity of 1.0 Btu/hr-ft°F and a minimum of 32% solids. This grout will also have a permeability rate of less than 1X10-7cm/sec.

LOCATING TAPE
Locating tape must be foil backed, two inches wide or greater, with a continuous message printed every 36 inches or less reading: "CAUTION GEOTHERMAL PIPELINE BURIED BELOW". The tape shall be highly resistant to alkalis, acids, and other destructive agents found in the ground.

FIELD LOCATION
The four outside grid bores of each circuit should be surveyed after drilling is complete, but before horizontal trenching is done and provided as a record drawing of the installation.

PART 3 - EXECUTION

DRILLING
The vertical boreholes will be drilled to a depth that allows complete insertion of the u-tube assembly to its specified depth. The maximum borehole diameter will be six inches. If a larger diameter is required, it must be approved by the design engineer.

The wells will be cased during drilling and the casing removed during grouting operations.

U-BEND PIPE ASSEMBLY
The u-bend pipe shall be filled with water and pressured to 100 psi to check for leaks before insertion. If necessary, an iron (sinker) bar can be attached at the base of each u-bend to overcome bouncy. This iron bar will have all sharp edges adequately taped to avoid scarring and/or cutting of the polyethylene pipe. No driving rod that is pulled out after u-bend insertion will be allowed. U-bend pipe separators (GeoClips) will be attached at ten feet intervals to the u-bend along with the grouting tremie as per manufacturer's recommendations. The entire u-bend pipe assembly is inserted to the specified depth in the borehole.

GROUTING PROCEDURE
Each bore shall be grouted from the bottom up, in a continuous fashion, using a one inch HDPE tremie pipe. The tremie pipe will be pulled out during the grouting procedure maintaining the pipe's end just below grout level within the borehole. Bore casing shall be removed during the grouting process. All State regulations will be met for borehole grouting.

HEAT FUSION PIPE JOINING
All underground pipe joining will be heat fused by socket, butt or saddle (sidewall) fusion in accordance to ASTM D2610, ASTM D2683 and the manufacturer's heat fusion specifications. The operator shall be heat fusion certified and experienced in executing quality fusion joints.

EXCAVATION AND BACKFILL
Perform all excavation and backfill work to accomplish indicated mechanical systems installation in accordance with Division 31 Earthwork. Blasting will not be allowed without written permission of the Architect/Engineer and the user agency.

Install lines passing under foundations with minimum of 1-1/2 inch clearance to concrete and insure no disturbance of bearing soil.

Before burying piping, mark up Record Drawings and dimensionally locate piping. Deliver information to A/E Field Representative.
Unless otherwise specifically indicated on Drawings, trenches for utilities shall be of depth that provides the following minimum depths of cover from existing grade or from indicated finish grade, whichever is lower:

- Geothermal (direct buried): 6’-0” foot minimum cover

Existing utility lines to be retained shown on Drawings or locations of which are made known to Contractor prior to excavation, as well as utility lines uncovered during excavation operations, shall be protected from damage during excavation and backfilling and if damaged, shall be repaired by Contractor at his expense.

General:
The loopfield contractor shall do all excavating, backfilling, shoring, bailing and pumping for the installation of his work and perform necessary grading to prevent surface water from flowing into trenches or other excavations. Sewer lines shall not be used for draining trenches.

All pipe and conduit ends shall be kept sealed and lines left clean and unobstructed during construction. Only material suitable for backfilling shall be piled a sufficient distance from banks of trenches to avoid overloading. Unsuitable backfill material shall be removed and replaced.

Excavation shall comply with OSHA regulations. Review soil boring information for soil information. During excavation, material for backfilling shall be piled in an orderly manner a safe distance from banks of trench to avoid overloading and to prevent slides or cave ins. Excavated materials not required or acceptable for backfill shall be removed and wasted as requested by A/E.

Grading shall be done as necessary to prevent surface water from flowing into trenches or excavations. Water accumulating shall be removed by pumping or by other acceptable methods.

Sheeting or shoring shall be done as necessary for protection of Work and for safety of personnel. Comply with OSHA regulations.

Comply with Department of Labor (OSHA) 29 CFR, Part 1926 Occupational Safety and Health Standards. Specific mention of this Section however shall in no way imply, suggest or infer that compliance with other sections or regulations is not required.

Excavation shall be by open cut except short sections of a trench may be tunneled if, in the opinion of Soils Engineer, pipe or duct can be safely and properly installed and backfill can be properly tamped in tunnel sections per OSHA regulations.

Each excavation shall comprise required materials and shall include clay, silt, sand, rock, muck, gravel, hardpan, loose shale and loose stone.

Open trench ahead of pipe laying to reveal obstructions.

Provide trench crossings to accommodate public travel.

Contractor shall file written "Notification Of Excavation" with utility companies and Digger's Hotline at least 3 days prior to excavating.

The loopfield contractor shall install geothermal locating tape 18 inches above all horizontal/header piping.

Prior to drilling or trenching, the loopfield contractor shall be responsible for reviewing with the general contractor the location of underground utilities. Existing utility lines uncovered during excavation shall be protected from damage during excavation and backfilling.

Trench Excavating:
Trenches shall be of necessary width or proper laying of pipe but not more than 16 inches wider than pipe diameter at base, and banks shall be provided per OSHA regulations. In particular, comply with the Department of Labor (OSHA) 29 CFR, Part 1926 Occupational Safety and Health Standards. Specific mention of this Section however, shall in no way imply, suggest or infer that compliance with other sections or regulations is not required.

Bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of pipe on undisturbed soil at points along its entire length. Except where rock is encountered, care shall be taken not to excavate below the depths indicated.

Where rock excavations are required, rock shall be excavated to a minimum overdepth of 4 inches below trench depths indicated on Drawings or specified. Overdepths in rock excavations and unauthorized overdepths shall be backfilled with loose granular material properly compacted.

Whenever wet or otherwise unstable soil incapable of properly supporting pipe, as determined by Soils Engineer, is encountered in bottom of trench, soil shall be removed to depth required and trench backfilled to proper grade with coarse sand, fine gravel or other material as specified.

Keep trenches free from water while construction is in progress. Pipe or appurtenances shall not be laid in water. Pump or bail water from bell holes to permit proper jointing of pipes. Pipe discharge from trench dewatering to drains or natural drainage channels.

Grading Trench Bottom:
Shape bottom of trench for Class C bedding except as otherwise noted. Perform final grading of trench bottoms by hand tools. Grade bottom of trenches evenly to insure bearing for pipes. Cut holes for joints and joint making.

Backfilling of Trenches:
Backfill trenches only after piping has been inspected, tested and locations of pipe lines have been recorded. Comply with OSHA regulations for work. In particular, comply with Department of Labor (OSHA) 29 CFR, Part 1926 Occupational Safety and Health Standards.

Specific mention of this Section however, shall in no way imply, suggest or infer compliance with other Sections or regulations is not required.

For depth of 12 inches above top of pipe, backfill by hand with material specified for compacted backfill. Tamp backfill thoroughly in layers not exceeding 6 inches in thickness, taking care not to disturb the pipe.

For the remaining trench backfill and compact with material as specified in the following paragraphs.

Jetting the backfill with water will not be permitted unless approved in writing by the A/E.

Normal Backfill:
Where compacted backfill is not specified, trenches shall be carefully backfilled with excavated materials acceptable for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale or other acceptable materials, free from large clods of earth or stones over 2-1/2 inch maximum dimension, deposited in 12 inch layers and compacted.

Surface shall be graded to reasonable uniformity and mounding over trenches left in uniform and neat condition.

Compacted Backfill:
Compacted backfill shall be used under slab on grade, slabs within building structure, concrete paving and asphaltic concrete paving. Soils used in fill shall be granular in nature and not contain roots, sod, rubbish or stones over 2-1/2 inch maximum dimension. A/E may reject on site or borrowed materials he considers unsuitable for intended use of fill.

Compaction Density For Backfill
Fills shall be compacted to dry density equal to at least 95percent of maximum density determined in accordance with Procter Test, ASTM D698 66T or modified D1557 66T. Maximum density and optimum moisture content shall be determined by A/E on basis of laboratory test conducted on materials used in fill.

Control Test:
Field density tests for determining compaction of fill in place shall be performed by a qualified Geotechnical Engineer in accordance with standard recognized procedures for making required tests.
Contractor shall arrange and pay for tests and extend full cooperation to Geotechnical Engineer in obtaining soil samples for field and lab testing. A minimum of 1 test per 50 lineal feet for each 2 foot lift. Contractor shall pay for density tests and submit reports.

Adequacy of compaction shall be determined on basis of in-place density determinations to be conducted while fills are being placed. Results of tests shall be basis on which satisfactory completion of work is judged. If fills fail to meet specified densities, Contractor shall remove and recompact soils until specified densities are achieved.

PIPE INSTALLATION
The u-bend pipe ends will be sealed with fusion caps or tape prior to insertion into the borehole. Reasonable care shall be taken to ensure that the geothermal loopfield pipe is not crushed, kinked, or cut. Should any pipe be damaged, the damaged section shall be cut out and the pipe reconnected by heat fusion.

Piping must be connected as indicated on the plans. The header design accounts for balanced flow as well as flushing and purging flow rates. No variations can be made in the circuit hookup or the pipe sizes that are indicated without approval from the design engineer.

The minimum bend radius for each pipe size shall be 25 times the nominal pipe diameter or the pipe manufacturer's recommendations, whichever is greater. The depth of all headers and supply and return piping is indicated on the plans and must be maintained.

Circuits will be pressure tested before any backfilling of the header trenches is executed. The individual circuits will be pressure tested with water at 120 psi, however, not to exceed DR 11 pipe working pressure at bottom of the u-bend pipe.

COORDINATION OF WORK
Coordinate work with other contractors prior to installation. Installed work not coordinated and that interferes with other contractor's work shall be removed or relocated at installing contractor's expense.

TESTING AND CLEANING
Cleaning
During installation, all debris, and small animals shall be kept out of the pipe. Ends of the HDPE pipe shall be sealed until the pipe is joined to the circuits.

Flushing and Purging

Each supply and return circuit shall be flushed and purged with a water velocity of two feet per second. The lines shall be left filled with clean water and then pressure tested. If connection to the manifold is not immediate, piping must be capped.

The loopfield contractor must coordinate with the mechanical contractor on propylene glycol antifreeze installation. The mechanical contractor is responsible for the propylene glycol antifreeze. See mechanical specifications for antifreeze.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

END OF SECTION

SECTION 23 25 00
HVAC WATER TREATMENT FOR CLOSED LOOP HYDRONIC SYSTEMS

P A R T 1 - G E N E R A L

SCOPE

This section includes specifications for chemical treatment of all water, steam, and condensate systems. Included are the following topics:

PART 1 - GENERAL
- Scope
- Reference
- Related Work
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data
- Design Criteria
- Maintenance Service

PART 2 - PRODUCTS
- Manufacturers
- System Cleaner
- System Inhibitor
- Closed Water System Treatment
- Glycol Solution
- Glycol Fill Equipment

PART 3 - EXECUTION
- Preparation
- Cleaning Sequence
- Closed Water System Treament
- Glycol Water Systems
- Test Equipment
- Construction Verification Items
- Pipe Cleaning and Treatment Report

REFERENCE

Applicable provisions of Division 1 shall govern work under this Section.

RELATED WORK

Section 23 05 15 - Piping Specialties

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions.

SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Required for all equipment and chemicals specified including data concerning dimensions, capacities, materials of construction, weights, operating sequence, composite wiring diagrams and appropriate identification. Chemical data to include the description of the chemical, its composition, its function, and the associated material safety data sheet.

OPERATION AND MAINTENANCE DATA

Provide for the services of the manufacturer's trained representative to approve the installation and instruct the user agency in the operation of each system.

Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

DESIGN CRITERIA

Recommend and implement a periodic test procedure and chemical treatment program for each of the following systems:

- Chilled water
- Hot water

Glycol water

All (3) water systems will utilize a 25% propylene glycol solution.

Existing hot water terminal equipment connected to the existing boiler plant shall be 100% water.

Provide initial chemical treatment for systems based on complete system fluid analysis prior to equipment installation and operation. Initial chemical treatment supply of chemicals for each system shall be adequate for start-up and testing period, for time systems are being operated by Contractor for temporary heating and cooling, and for 1 year after start-up of system.

Provide electrical devices, motors, wiring and conduit in accordance with applicable Sections of Electrical Specifications.

Electric devices shall be UL listed and bear UL label indicating approval.

MAINTENANCE SERVICE
Service and maintenance of steam, chilled water and hot water will be via the agency and their existing maintenance program.

PART 2 - PRODUCTS

MANUFACTURERS
Betz Entac, Dearborn Div. - W. R. Grace & Co., Fremont Industries, Mitco Water Labs, Mogul Corporation, Nalco Chemical Co., Western Water Management, or approved equal.

SYSTEM CLEANER
Blend of organic alkaline penetrants, emulsifiers, surfactants and corrosion inhibitors that remove grease and petroleum products from the interior of piping systems. Cleaners that contain trisodium phosphate are specifically not acceptable.

Cleaner needs to be compatible with propylene glycol solution.

SYSTEM INHIBITOR
Scale and corrosion inhibitor consisting of boron nitrite, benzol thiazol, benzotriazole, mercapto-benzo-thiazole, and tolyltrizole silicates.

CLOSED WATER SYSTEM TREATMENT
Sequestering agent to reduce deposits and adjust pH: polyphosphate.

Corrosion inhibitors: boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
Conductivity enhancers: phosphates or phosphonates.

GLYCOL SOLUTION
25% Propylene glycol based material specifically designed for use in closed heat transfer systems. Dow Chemical Dow Frost or equal.

TREATMENT EQUIPMENT FOR CLOSED WATER SYSTEMS
Bypass Feeder: 5 gallon minimum capacity, 125 PSIG working pressure, either screw type cover or a valved funnel opening to feed chemical into system, prime coat of paint.

GLYCOL FILL EQUIPMENT
Provide glycol make-up unit with integral pump and reservoir.

Refer to Drawings Schedules for manufacturer and model.

PART 3 - EXECUTION

CLEANING SEQUENCE
GENERAL:
Systems are to be cleaned before they are used for any purpose except conduct pressure test before cleaning. Add cleaner to closed systems at concentrations as recommended by the manufacturer. Remove water filter elements from the system before starting circulation. For steam systems, fill boilers only, using the water and cleaner solution.

Use neutralizer agents on recommendation of the system cleaner supplier and approval of the Architect/Engineer.

Remove, clean, and replace strainer screens.

Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

Use form within this section to document system cleaning, flushing, and proper startup.

HOT WATER HEATING SYSTEMS:
Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Apply heat while circulating, slowly raising temperature to 160°F and maintain for 12 hours minimum; vent all high points to assure 100% system circulation. Remove heat and circulate to 100°F or less; drain system as quickly as possible and refill with clean water. Circulate for 6 hours at design temperature, vent air at all high points, then drain. Refill with clean water and repeat until the system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system and install clean filter elements in water filters. Treat with scale and corrosion inhibitors before using the system for building heating or cooling.

CHILLED WATER SYSTEMS:
Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Circulate for 48 hours, then drain system as quickly as possible. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water and repeat until system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system and install clean filter elements in water filters. Treat with scale and corrosion inhibitors before using the system for building heating or cooling.

GLYCOL WATER SYSTEMS:
Clean and flush as above for water systems. Verify complete drainage by measuring amount of water used for initial fill versus amount actually drained to verify complete removal of cleaning solution. Remove traces of chloride from the system; test to verify removal and submit test results.

CLOSED WATER SYSTEM TREATMENT
Install separate bypass type feeder at pumps for each closed water system. Provide separate set of supply and return lines from each pump in system and install isolation and balancing valves in each line. Locate system connection that supplies feeder upstream of discharge shutoff valve for pump. Locate the system connection that returns treatment back to the system at convenient point downstream of pump suction shutoff valve. Provide drain valve at bottom of the feeder. Refer to Drawings and Plan Details for additional piping arrangement information.

GLYCOL WATER SYSTEMS
All water systems utilize glycol water. Fill and charge this system as specified herein.

Completely flush traces of cleaning chemicals before adding glycol water mixture to system. Verify by chemical test.

Premix glycol water solution in 50 gallon polyethylene drum to concentration of 30 percent by volume. Use city water to make solution. Use hand pump to fill system from mixing tank. Circulate fluid for 24 hours, vent high points where air may collect, add more solution to system if needed.

After 48 hours, using sample test kit provided by glycol manufacturer, obtain sample and submit sample to manufacturer to test for proper concentration of glycol, and level of inhibitors (if applicable). Submit a copy of test report to Engineer and include a copy of the test report in Operating and Maintenance Manuals.

TEST EQUIPMENT
Locate test cabinet in convenient location.

CONSTRUCTION VERIFICATION ITEMS
Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

END OF SECTION

PIPE CLEANING AND TREATMENT REPORT

Date Submitted: _____

Project Name: _____

Contractor: _____

System Tested: **Hot Water___** **Heat Pump Loop___** **Chilled Water___**
Steam___ **Condensate___**

System Volume: _____

Materials Used (Provide MSDS for each)
Cleaner:_____ **Quantity Used:**_____
Inhibitor:_____ **Quantity Used:**_____
Sequestering Agent:_____ **Quantity Used:**_____
Neutralizer:_____ **Quantity Used:**_____
Glycol:_____ **Quantity Used:**_____
Glycol Solution Water Source:_____ **Percent glycol by volume:**_____

M Alkalinity
Prior to Cleaning:_____**During Cleaning:**_____**After Flushing:**_____

System Temperature
Prior to Cleaning:_____ **During Cleaning:**_____

Duration	**Date/Time Start**	**Date/Time Stop**
Initial Circulation	_____	_____
Draindown	_____	_____
System Refill	_____	_____
Final Circulation	_____	_____
Heating system Warmup	_____	_____

Component Checklist (Describe procedures performed at each)
Strainers:_____
Filters:_____
Vents:_____
Drains:_____
Branch Lines:_____
TerminalUnits:_____
Boilers:_____
Chillers:_____
Traps:_____
Comments:_____
_____
_____

END OF SECTION

SECTION 23 31 00
HVAC DUCTS and CASINGS

P A R T 1 - G E N E R A L

SCOPE

This section includes specifications for all duct systems used on this project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Shop Drawings
- Design Criteria

PART 2 - PRODUCTS
- General
- Materials
- High Temperature Flexible Duct
- High Pressure Ductwork (Pressure class 3 inch and over)
- Low Pressure Ductwork (Maximum 2 inch pressure class)
- Exhaust Duct (Moisture laden air)
- Duct Sealant
- Gaskets

PART 3 - EXECUTION
- Installation
- High Pressure Duct (Pressure class 3 inch and over)
- Low Pressure Duct (Maximum 2 inch pressure class)
- Exhaust Duct (Moisture laden air)
- Cleaning
- Construction Verification Items
- Leakage Test

APPENDIX
- Duct Leakage Test Report

RELATED WORK

Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC
Section 23 33 00 – Air Duct Accessories

REFERENCE

Applicable provisions of Division 1 govern work under this Section.

REFERENCE STANDARDS

ANSI SS-EN 485-2	Aluminum and Aluminum Alloys-Sheet, Strip and Plate-Part 2: Mechanical Properties
ASTM B209	Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM A90	Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles
ASTM A623	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM A527	Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
ASTM 924	Standard Specification for General Requirements for Sheet Steel, Metallic-coated by the Hot-dip Method
ASTM C 1071	Specification for Fibrous Glass Duct Lining Insulation
ASTM C 411	Test Method for Hot Surface Performance of High Temperature Thermal Insulation
ASTM E 84	Test Method for Surface Burning Characteristics of Building Materials
ASTM C 1338	Test Method for Determining Fungal Resistance of Insulation Materials and Facings
ASTM G 21	Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

ASTM C 916	Standard Specification for Adhesives for Duct Thermal Insulation
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems
UL 181	Standard for Safety for Factory Made Air Ducts and Air Connectors.
NAIMA	Fibrous Glass Duct Liner Standard

QUALITY ASSURANCE
Refer to Division 1, General Conditions, Equals and Substitutions.

SHOP DRAWINGS
Refer to Division 1, General Conditions, Submittals.

Include manufacturer's data and/or Contractor data for the following:

- Schedule of duct systems including material of construction, gauge, pressure class, system class, method of reinforcement, joint construction, fitting construction, and support methods, all with details as appropriate.
- Duct sealant and gasket material.
- Duct liner including data on thermal conductivity, air friction correction factor, and limitation on temperature and velocity.

DESIGN CRITERIA
Construct all ductwork to be free from vibration, chatter, objectionable pulsations and leakage under specified operating conditions.

Use material, weight, thickness, gauge, construction, and installation methods as outlined in the following SMACNA publications, unless noted otherwise:

- HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005
- HVAC Air Duct Leakage Test Manual, 1st Edition, 1985
- HVAC Systems - Duct Design, 4th Edition, 2006
- Rectangular Industrial Duct Construction Standard, 2nd Edition, 2004
- Round Industrial Duct Construction Standards, 2nd Edition, 1999

Use products which conform to NFPA 90A, possess a flame spread rating of not over 25 and a smoke developed rating no higher than 50.

DELIVERY, STORAGE AND HANDLING
Promptly inspect shipments to ensure that Ductwork is undamaged and complies with the specification.

Protect Ductwork against damage.

Protect Ductwork by storing inside or by durable, waterproof, above ground packaging. Do not store material on grade. Protect Ductwork from dirt, dust, construction debris and foreign material. Where end caps/packaging are provided, take precautions so caps/packaging remain in place and free from damage.

Offsite storage agreements do not relieve the contractor from using proper storage techniques.

Storage and protection methods must allow inspection to verify products.

P A R T 2 - P R O D U C T S

GENERAL
All sheet metal used for construction of duct shall be 24 gauge or heavier except for round and spiral ductwork and spiral duct take-offs 12” and below may be 26 gauge where allowed in SMACNA HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005.

Duct sizes indicated on plans are net inside dimensions; where duct liner is specified, dimensions are net, inside of liner.

All exposed ductwork shall be furnished in a “paint grip” galvanized finish suitable for final finish painting.

DUCTWORK PRESSURE CLASS
Minimum acceptable duct pressure class, for all ductwork except transfer ductwork, is 2 inch W.G. positive or negative, depending on the application. Transfer ductwork minimum acceptable duct pressure class is 1 inch W.G. positive or negative, depending on the application. Duct system pressure classes not indicated on the drawings to be as follows:

(AHU-1 (E)):

Supply duct upstream of VAV boxes	3 in. pressure class
Supply duct downstream of VAV terminals	2 in. pressure class
Outside Air ducts	3 in. pressure class
Mixed Air ducts	3 in. pressure class
Return ducts	3 in. pressure class
Relief Air ducts	2 in. pressure class

(AHU-4):

Supply air ducts	3 in. pressure class
Outside Air ducts	3 in. pressure class
Mixed Air ducts	3 in. pressure class
Return ducts	3 in. pressure class
Relief Air ducts	2 in. pressure class

(General – All Other Ductwork):

Supply duct	2 in. pressure class
Return duct	2 in. pressure class
Exhaust duct	2 in. pressure class
Transfer duct	2 in. pressure class

MATERIALS

GALVANIZED STEEL SHEET:
Use ASTM A 653 galvanized steel sheet of lock forming quality. Galvanized coating to be 1.25 ounces per square foot, both sides of sheet, G90 in accordance with ASTM A90. Provide "Paint Grip" finish or galvanneal sheetmetal for ductwork that will be painted.

ALUMINUM SHEET (EXHAUST OUT OF RESTROOMS, LOCKER ROOMS, AND SHOWERS):
Use ANSI/ASTM B209 aluminum sheet, alloy 3003H-14, capable of double seaming without fracture.

HIGH PRESSURE DUCTWORK (Pressure class 3 inch and over)

Manufacturers: Ajax, Semco, United Sheet Metal, Sheet Metal Connectors or approved equal.

Machine formed round and/or flat oval spiral lock seam duct constructed of galvanized steel.

Rectangular high pressure duct using a transverse joint system as manufactured by Ductmate, Nexus, TDC, TDF, or approved equal, may be used at contractor's option. Duct to be flanged, gasketed and sealed.

Contractor fabricated ductwork meeting specified construction standards is acceptable with prior approval of Architect/Engineer. Submit construction details, a description of materials to be used, type of service, reinforcing methods, and sealing procedures.

Use a perforated inner liner on double wall high-pressure duct. Annular space between inner liner and outer duct to be filled with 1 inch glass fiber insulation.

Use cemented slip joints with 2 inch minimum overlap, flanged connections, or welded/brazed connections, unless noted otherwise for special applications. Prime coat welded joints.

Provide standard 90 degree conical tee takeoffs except for exhaust at velocities over 2000 feet per minute, use 45° lateral connections; straight taps or bullhead tees are not acceptable.

Internal bracing will not be accepted on ductwork below 48 inches.

Use turning vanes as specified in Section 23 33 00.

Provide bellmouth fittings or expanded fittings at each duct connection to air plenums.

Provide pressure relief fittings as indicated on the plans and/or details.

Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.

LOW PRESSURE DUCTWORK (Maximum 2 inch pressure class)

Fabricate and install ductwork in sizes indicated on the drawings and in accordance with SMACNA recommendations, except as modified below.

Construct so that all interior surfaces are smooth. Use slip and drive or flanged and bolted construction when fabricating rectangular ductwork. Use spiral lock seam construction when fabricating round spiral ductwork. Sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if the screw does not extend more than 1/2 inch into the duct.

Use elbows and tees with a center line radius to width or diameter ratio of 1.5 wherever space permits. When a shorter radius must be used due to limited space, install single wall sheet metal splitter vanes in accordance with SMACNA publications, Type RE 3. Where space will not allow and the C value of the radius elbow, as given in SMACNA publications, exceeds 0.31, use rectangular elbows with turning vanes as specified in Section 23 33 00. Square throat-radius heel elbows will not be acceptable. Straight taps or bullhead tees are not acceptable.

Where rectangular elbows are used, provide turning vanes in accordance with Section 23 33 00.

Provide expanded take-offs or 45 degree entry fittings for branch duct connections with branch ductwork airflow velocities greater than 700 fpm. Square edge 90-degree take-off fittings or straight taps will not be accepted.

Button punch snaplock construction will not be accepted on any ducts.

Round ducts may be substituted for rectangular ducts if sized in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission of the Architect/Engineer.

Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

DUCT SEALANT

Manufacturer: Tremco Dymonic, 3M 800, 3M 900, H.B. Fuller/Foster, Hardcast, Hardcast Peal & Seal, Lockformer cold sealant, Mon-Eco Industries, United Sheet Metal, or approved equal.

Duct sealant shall be equal to Tremco Dymonic FC, high-performance, fast curing, single-component, hybrid sealant.

Silicone sealants are not allowed in any type of ductwork installation.
Install sealants in strict accordance with manufacturer's recommendations, paying special attention to temperature limitations. Allow sealant to fully cure before pressure testing of ductwork, or before startup of air handling systems.

GASKETS

2 INCH PRESSURE CLASS AND LOWER:
Soft neoprene or butyl gaskets in combination with duct sealant for flanged joints.

3 INCH PRESSURE CLASS AND HIGHER:
Butyl gaskets.

PART 3 - EXECUTION

INSTALLATION

Verify dimensions at the site, making field measurements and drawings necessary for fabrication and erection. Check plans showing work of other trades and consult with Architect in the event of any interference.

Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Transform, divide or offset ducts as required, in accordance with SMACNA HVAC Duct Construction Standards, Figure 4-7, except do not reduce duct to less than six inches in any dimension and do not exceed an 8:1 aspect ratio. Where it is necessary to take pipes or similar obstructions through ducts, construct easement as indicated in SMACNA HVAC Duct Construction Standards, Figure 4-8, Fig. E. In all cases, seal to prevent air leakage. Pipes or similar obstructions may not pass through high pressure or fume exhaust ductwork.

Test openings for test and balance work will be provided under Section 23 05 93.

Provide frames constructed of angles or channels for coils, filters, dampers or other devices installed in duct systems, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets and screws or nut, bolts and washers.

Install duct to pitch toward outside air intakes and drain to outside of building. Solder or seal seams to form watertight joints.

Where two different metal ducts meet, the joint shall be installed in such a manner that metal ducts do not contact each other by using proper seal or compound.

Install all motor operated dampers and connect to or install all equipment furnished by others. Blank off all unused portions of louvers, as indicated on the drawings, with 1-1/2 inch board insulation with galvanized sheet metal backing on both sides.

Do not install ductwork through dedicated electrical rooms or spaces unless the ductwork is serving this room or space.

Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

Provide adequate access to ductwork for cleaning purposes.

Provide temporary capping of ductwork openings to prevent entry of dirt, dust and foreign material.

Protect diffusers, registers and grilles with plastic wrap or some other approved form of protection to maintain dirt and dust free and to prevent entry of dirt, dust and foreign material into the Ductwork.

During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

DUCTWORK SUPPORT

Support ductwork in accordance with SMACNA HVAC Duct Construction Standards, Figure 5-5, except supporting ductwork with secure wire method is not allowed.

Support with 3/32 inch, 7 x 7, stainless steel air-craft cable, with matching fastener rated for 50% of actual load, will be allowed on round ductwork under 12 inches if installed as detailed, with cable double looped on duct and at point of support.

HIGH PRESSURE DUCT (Pressure class 3 inch and over)

Seal all duct in accordance with SMACNA seal class "A"; all seams, joints, and penetrations shall be sealed.

LOW PRESSURE DUCT (Maximum 2 inch pressure class)

Seal all duct, with the exception of transfer ducts, in accordance with SMACNA seal class "A"; all seams, joints, and penetrations shall be sealed.

Install a manual balancing damper in each branch duct and for each diffuser or grille. The use of splitter dampers, extractors, or grille face dampers will not be accepted for balancing dampers.

Hangers must be wrapped around bottom edge of duct and securely fastened to duct with sheetmetal screws or pop rivets. Trapeze hangers may be used at contractor's option.

CLEANING

Remove all dirt and foreign matter from the entire duct system and clean diffusers, registers, grilles and the inside of air-handling units before operating fans.

Clean duct systems with high power vacuum machines where systems have been used for temporary heat, air-conditioning, or ventilation purposes during construction. Protect equipment that may be harmed by excessive dirt with filters, or bypass during cleaning.

LEAKAGE TEST

Test all ductwork in accordance with test methods described in Section 5 of SMACNA HVAC Air Duct Leakage Test Manual. Do not insulate ductwork until it has been successfully tested. Test pressure shall be equal to the duct pressure class.

If excessive air leakage is found locate leaks, repair the duct in the area of the leak, seal the duct, and retest.

Leakage rate shall not exceed more than 5% of the system air quantity for low and high pressure ductwork, determined in accordance with Appendix C of the SMACNA HVAC Air Duct Leakage Test Manual.

Leakage testing method used shall be of the more stringent of two standards (% of airflow or cfm/100 square-feet), by discretion of third party testing agent and/or the Owners preference.

Submit a signed report to the A/E and Owner, indicating test apparatus used, results of the leakage test, and any remedial work required to bring duct systems into compliance with specified leakage rates.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

END OF SECTION

DUCT LEAKAGE TEST REPORT

Project	**Name:**_____		
	Location:_____		
	Contractor:_____		
Date	_____		
System Data	**Fan ID:**_____	**Leakage Class (C_L):**_____	
	Fan Design CFM:_____	**Duct Pressure Class (P_C):**_____	
		Test Pressure (P_T):_____	
Test Equipment	**Manufacturer:**_____	**Model No:**_____	**Serial No:**_____

For large systems, use the reverse side for a simple sketch of the entire duct system. Then use letter designations to indicate the various duct sections being tested at one time. Also use the reverse side for test comments.

Design Data					Field Test Data							
			Allowable Leakage		Diameter		Pressure (in. wc.)					
Duct Section	Duct Shape	Duct Surface (Ft^2)	Leakage Factor ($P^{.65}C_L$)	CFM for Section	Tube (D_1)	Orifice (D_2)	In Duct (P)	Across Orifice (P_{drop})	Date	Performed By	Observed By	Actual CFM
TOTAL												

END OF SECTION

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SECTION 23 33 00
AIR DUCT ACCESSORIES

P A R T 1 - G E N E R A L

SCOPE

This section includes accessories used in the installation of duct systems. Included are the following topics:

PART 1 - GENERAL
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data

PART 2 - PRODUCTS
- Manual Volume Dampers
- Turning Vanes
- Control Dampers
- Smoke Detectors
- Access Doors
- Flexible Duct
- Duct Lining
- Flashings
- Duct Flexible Connections
- Louvers

PART 3 - EXECUTION
- Manual Volume Dampers
- Turning Vanes
- Control Dampers
- Smoke Detectors
- Access Doors
- Flashings
- Duct Flexible Connections
- Sound Attenuators
- Louvers
- Construction Verification Items

RELATED WORK

Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment
Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment
Section 23 31 00 – HVAC Ducts and Casings

REFERENCE

Applicable provisions of Division 1 govern work under this Section.

REFERENCE STANDARDS

NFPA 90A	Standard for Installation of Air Conditioning and Ventilating Systems
SMACNA	HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition, 1995
UL 214	

QUALITY ASSURANCE

Also refer to Division 1.

SHOP DRAWINGS

Refer to Division 1, General Conditions, Submittals.

Submit for all accessories and include dimensions, capacities, ratings, installation instructions, and appropriate identification.

Include certified test data on dynamic insertion loss, self-noise power levels, and aerodynamic performance of sound attenuators.

Submit manufacturer's color charts where finish color is specified to be selected by the Architect/Engineer.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

MANUAL VOLUME DAMPERS
Manufacturers: Ruskin, Vent Products, Air Balance, or approved equal.

Dampers must be constructed in accordance with SMACNA Fig. 2-12, Fig. 2-13, and notes relating to these figures, except as modified below.

Reinforce all blades to prevent vibration, flutter, or other noise. Construct dampers in multiple sections with mullions where width is over 48 inches. Use rivets or tack welds to secure individual components; sheet metal screws will not be accepted. Provide operators with locking devices and damper position indicators for each damper; use an elevated platform on insulated ducts. Provide end bearings or bushings for all volume damper rods penetrating ductwork constructed to a 3" w.c. pressure class or above.

TURNING VANES
Manufacturers: Aero Dyne, Anemostat, Barber-Colman, Hart & Cooley, or approved equal.

Construct turning vanes and runners for square elbows in accordance with SMACNA Fig. 2-3 and Fig. 2-4 except use only airfoil type vanes. Construct turning vanes for short radius elbows and elbows where one dimension changes in the turn in accordance with SMACNA Fig. 2-5 and Fig. 2-6.

CONTROL DAMPERS
Control damper actuators are specified in section 23 09 14.

Provide control dampers shown on the plans and schedules and as required to perform the specified functions. Dampers shall be rated for velocities that will be encountered at maximum system design and rated for pressure equal or greater than the ductwork pressure class as specified in Section 23 31 00 of the ductwork where the damper is installed.

Use only factory fabricated dampers with mechanically captured replaceable resilient blade seals, stainless steel jamb seals and with entire assembly suitable for the maximum temperature and air velocities encountered in the system.

All dampers in aluminum ductwork shall be constructed of stainless steel or aluminum.

Dampers in galvanized ductwork shall be constructed of galvanized steel and/or aluminum.

All dampers, unless otherwise specified, to be rated at a minimum of 180º F working temperature. Leakage testing shall be certified to be based on latest edition of AMCA Standard 500-D and all dampers, unless otherwise specified, shall have leakage ratings as follows:

Damper Class	Differential Pressure	Leakage
Class IA	1” w.g.	≤3 CFM/ft^2
Class I	4” w.g.	≤8 CFM/ft^2
Class I	8” w.g.	≤11 CFM/ft^2
Class I	12” w.g.	≤14 CFM/ft^2

Leakage rate dampers for differential pressures that they will encounter at maximum system design pressures.

Steel framed dampers: Nailor models 2010 & 2020; Greenheck models VCD-33 & VCD-42; Johnson Controls model V-1330; Ruskin Models CD60 & CD40; other approved equal.

Aluminum frame and blade dampers: Nailor models 2010EAF & 202EAF; Greenheck model VCD-43; Ruskin model CD50; Arrow model AFD-20; other approved equal.

Dampers used for directed mixing of airstreams, i.e. outside air and return air, to be parallel blade type and sized for an air velocity of 1800 to 2000 fpm with the damper blades shall be arranged so that the air streams are directed at one another to facilitate mixing. Dampers used for throttling or modulating applications other than air stream mixing to be opposed blade type. Two position dampers may be parallel or opposed blade type.

Dampers used for isolation on the discharge of centrifugal fans shall have damper blades perpendicular to the fan shaft to minimize system effect. Dampers mounted with blades vertically shall be designed for vertical blade orientation.

Dampers to have frames of not less than 16 gauge galvanized steel or 12 gauge extruded aluminum. Blades to be two-ply steel airfoil of not less than 2 x 20 gauge galvanized steel (14 gauge equivalent) or extruded aluminum airfoil, with stainless steel, acetal, Celcon, bronze, or nylon bearings. Maximum allowable blade width is 8 inches. Use plated steel linkage hardware.

Maximum damper width is 48 inches; where required width exceeds 48 inches, use multiple damper sections. Inside frame free area shall be a minimum of 90% of total inside duct area.

Multiple width damper sections shall utilize jack shaft linkages unless noted below. Sections over 144 inches wide shall be actuated from two locations on the jack shaft. Double width damper sections for two-position operation may be actuated without jack shafts if each damper section is actuated separately.

Dampers that have multiple width and multiple vertical sections shall have a jackshaft for each vertically stacked set of dampers and be provided with crossover linkages between jack shafts to transfer uneven loading.

Jack shafts shall be extended outside of the ductwork for external actuator mounting. Provide bearings on the point of exit for support of damper shafts to prevent wear on the shaft and the ductwork. If locating actuators out of the air stream is impossible, obtain mounting location approval from the designer unless the contract documents indicate in air stream mounting is acceptable. In no cases shall damper actuators for fume exhaust systems be located in the air stream or require entering the air stream to service an actuator.

SMOKE DETECTORS

Smoke detectors are furnished and installed by the Electrical Contractor.

ACCESS DOORS

Access door to be designed and constructed for the pressure class of the duct in which the door is to be installed. Doors in exposed areas shall be hinged type with cam sash lock. Hinges shall be steel full length continuous piano type. Doors in concealed spaces may be secured in place with cam sash latches. For both hinged and non hinged doors provide sufficient number of camp sash latches to provide air tight seal when door is closed. Do not use hinged doors in concealed spaces if this will restrict access. Use minimum 1” deep 24 gauge galvanized steel double wall access doors with minimum 24 gauge galvanized steel frames.

For non-galvanized ductwork, use minimum 1” deep double wall access door with frame that shall use materials of construction identical to adjacent ductwork. Provide double neoprene gasket that shall provide seals from the frame to the door and frame to the duct. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners will not be accepted.

FLEXIBLE DUCT

Manufacturers: Anco Products, Clevaflex, Thermaflex, Flexmaster or approved equal.

Factory fabricated , UL 181 listed as a class 1 duct, and having a flame spread of 25 or less and a smoke developed rating of 50 or under in accordance with NFPA 90A.

Suitable for pressures and temperatures involved but not less than a 180°F service temperature and ±2 inch pressure class, depending on the application.

Duct to be composed of polyester film, aluminum laminate or woven and coated fiberglass fabric bonded permanently to corrosion resistant coated steel wire helix. Two-ply, laminated, and corrugated aluminum construction may also be used.

Where duct is specified to be insulated, provide a minimum 1 inch fiberglass insulation blanket with maximum thermal conductance of 0.23 K (75 degrees F.) and vapor barrier jacket of polyethylene or metalized reinforced film laminate. Maximum perm rating of vapor barrier jacket to be 0.1 perm.

DUCT LINING

Manufacturer: Manville, Owens-Corning, Knauf, or approved equal.

1 inch thick, flexible, mat faced insulation made from inorganic glass fibers bonded with a thermosetting resin with thermal conductivity of .25 Btu inch / hour sq.ft. deg F.

Meet erosion testing per UL 181 or ASTM C 1071 for 5000 fpm maximum air velocity. ASTM C 411 maximum operating temperature rating of 250 deg F. ASTM E84 flame spread less than 25 and smoke developed less than 50.

Meet requirements of ASTM C 1338 and ASTM G21 for fungi resistance.

Install liner using adhesive conforming to ASTM C 916.

FLASHINGS
Provide flashing to completely weatherproof connection of ductwork to louvers. Flashing to be constructed of material similar to louver material.

Flashing and curbs for duct and pipe penetrations of roof assemblies to be in accordance with details.

DUCT FLEXIBLE CONNECTIONS
Material to be fire retardant, be UL 214 listed, and meet the requirements of NFPA 90A.

Connections to be a minimum of 3 inches wide, crimped into metal edging strip, and air tight. Connections to have adequate flexibility and width to allow for thermal expansion/contraction, vibration of connected equipment, and other movement.

Use coated glass fiber fabric for all applications. Material for inside applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with neoprene, air and water tight, suitable for temperatures between -10°F and 200°F, and have a nominal weight of 30 ounces per square yard. Material used for outdoor applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with Hypalon¿,air and water tight, suitable for temperatures between -10°F and 250°F, and have a nominal wight of 26 ounces per square yard.

LOUVERS
Manufacturers: Airolite K6776, Industrial Louvers 658, American Warming and Ventilating LE-31, Construction Specialties 6177, Ruskin ELF6375DX or approved equal.

Similar to Airolite Type K6776, extruded aluminum alloy not less than 12 gauge (.081" thick), 6063 series frame and blades, all-welded assembly, 35 degree or 45 degree blades with water baffle, 6 inches thick.
Provide with bird screen of ½" x ½" mesh aluminum in 12 gauge aluminum frame and an aluminum sill. Locate the bird screen inside of the louver unless noted otherwise.

Louver to bear the AMCA certified ratings seal for both air performance and water penetration, having a free area not less than 50% based on a 48" x 48" section, a water penetration less than 0.1 oz/square foot under AMCA test at 1000 feet per minute, and an intake pressure drop less than 0.20 inches of water at 1000 feet per minute.

Finish to be anodized or Kynar 500 in a custom color to be selected by the Architect. Furnish sufficient paint in the same color as the louver to paint the outer surface of panels over unused portions of louvers and to paint the interior portion of ductwork visible through the louvers.

P A R T 3 - E X E C U T I O N

MANUAL VOLUME DAMPERS
Install manual volume dampers in each branch duct and for each grille, register, or diffuser as far away from the outlet as possible while still maintaining accessibility to the damper. Install so there is no flutter or vibration of the damper blade(s).

TURNING VANES
Install turning vanes in all rectangular, mitered elbows in accordance with SMACNA standards and/or manufacturer's recommendations.

Install double wall, airfoil, 2 inch radius vanes in ducts with vane runner length 18" or greater and air velocity less than 2000 fpm.
Install double wall, airfoil, 4-1/2 inch radius vanes in ducts with vane runner length 18" or greater and air velocity 2000 fpm or greater.

If duct size changes in a mitered elbow, use single wall type vanes with a trailing edge extension. If duct size changes in a radius elbow or if short radius elbows must be used, install sheetmetal turning vanes in accordance with SMACNA Figure 2-5 and Figure 2-6.

CONTROL DAMPERS
Install dampers in locations indicated on the drawings, as detailed, and according to the manufacturer's instructions. Install blank-off plates or transitions where required for proper mixing of airstreams in mixing plenums. Provide adequate operating clearance and access to the operator. Install an access door adjacent to each control damper for inspection and maintenance.

SMOKE DETECTORS
Installation and wiring of detectors will be by the Electrical Contractor. Install an access door at each detector location.

ACCESS DOORS
Install access doors where specified, indicated on the drawings, and in locations where maintenance, service, cleaning or inspection is required. Examples include, but are not limited to motorized dampers, fire and smoke dampers, smoke detectors, fan bearings, heating and cooling coils, filters, valves, and control devices needing periodic maintenance.

Size and numbers of duct access doors to be sufficient to perform the intended service. Minimum access door size shall be 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, or other size as indicated. Install access doors on both inlet and outlet sides of reheat coils as well as other duct mounted coils.

FLEXIBLE DUCT
Flexible duct may only be used for final connections of air inlets and outlets at diffuser, register, and grille locations. Where flexible duct is used, it shall be the minimum length required to make the final connections, but no greater than 5 feet in length, and have no more than one (1) 90 degree bend.
Secure inner jacket of flexible duct in place with stainless steel metal band clamp. Secure insulation vapor barrier jacket in place with steel or nylon draw band. Sheetmetal screws and/or duct tape will not be accepted.

Flexible duct used to compensate for misalignment of main duct or branch duct will not be accepted.

Individual sections of flexible ductwork shall be of one piece construction. Splicing of short sections will not be accepted.

Flexible ductwork used as transfer duct shall be sized for a maximum velocity of 300 fpm.
Penetration of any partition, wall, or floor with flexible duct will not be accepted.

DUCT LINING
Apply lining to the following ductwork or as noted on the plans.

- Transfer air ductwork.
- Return air ductwork where noted on plans.

Do not apply lining to the following ductwork:

- Outside air ductwork.
- Supply, return and exhaust ductwork associated with all air handling units.

Install liner in compliance with the latest edition of NAIMA's Fibrous Glass Duct Liner Standard.

Locate longitudinal joints at the corners of duct only. Cut and fit to assure lapped, compressed joints. Coat all transverse and longitudinal joints and edges with adhesive. Provide metal nosing on leading edge where lined duct is preceded by unlined duct. Adhere liner to duct with full coverage area of adhesive. Additionally secure liner to duct using mechanical fasteners spaced as recommended by the liner manufacturer without compressing liner more than 1/8" with the fasteners.

FLASHINGS
Flashing for roof curbs, equipment supports or rails located on roof, will be installed by others.

DUCT FLEXIBLE CONNECTIONS
Install at all duct connections to rotating or vibrating equipment, including air handling units (unless unit is internally isolated), fans, or other motorized equipment in accordance with SMACNA Figure 2-19. Install thrust restraints to prevent excess strain on duct flexible connections at fan inlets and outlets; see Related Work.

For applications in corrosive environments or fume exhaust systems, use a double layer of the Teflon¿ coated fabric when making the connector.

LOUVERS
Louvers are furnished and installed by others.

Furnish louvers to the General Contractor for mounting in exterior walls. Connect outside air intake duct to the louver, sealing all connections air and water tight.

Provide bird screen on inside of active louver area where none is provided with louvers. Where louvers are equipped with inside birdscreen, remove screen at all locations where duct connections are not made.

Install insulated metal panel on unused portion of louver. Panels must be sealed weathertight to louver assembly with flashing as required for proper drainage to outside of building. Paint outside surface of panel to match louver prior to installation. Where ductwork is visible through louver when viewed from outside the building, paint inside of duct to match louver color.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

END OF SECTION

SECTION 23 34 00
HVAC FANS

PART 1 - GENERAL

SCOPE

This Section includes specifications for fans that are not an integral part of a manufactured device. Included are the following requirements:

PART 1 - GENERAL
- Scope
- Related Work
- Reference Standards
- Quality Assurance
- Shop Drawings
- Design Criteria

PART 2 - PRODUCTS
- General
- Inline Centrifugal Fans

PART 3 - EXECUTION
- Installation – General
- Construction Verification Items
- Functional Performance Testing

RELATED WORK

Provisions of Division 01 govern work under this Section.

Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment
Section 23 05 13 – Common Motor Requirements for HVAC Equipment
Section 23 05 48.10 – Vibration and Seismic Controls for HVAC Piping and Equipment
Section 23 33 00 – Air Duct Accessories

REFERENCE STANDARDS

AMCA 203	AMCA Fan Application Manual - Troubleshooting
AMCA 204	Balance Quality and Vibration Levels for Fans
AMCA 210	Laboratory Method of Testing Fans for Rating
AMCA 300	Reverberant Room Method for Sound Testing of Fans
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems
UL	Underwriters Laboratory for fan electrical components and wiring.
UL 705	Underwriters Laboratory for emergency smoke control systems

QUALITY ASSURANCE

Substitution of Materials: Refer to Division 01 and General Conditions of the Contract, Article 3.

SHOP DRAWINGS

Include dimensions, capacities, fan curves, materials of construction, ratings, weights, motors and drives, motor efficiencies, sound power levels, appropriate identification and vibration isolation for equipment. Sound power levels to be based on tests performed in accordance with AMCA Standard 300.

Submit color selection charts for equipment where applicable.

Fan curves shall indicate relationship of CFM to static or total pressure for various fan speeds. Brake horsepower, recommended selection range, and limits of operation are to be indicated on curves. Indicate operating point on fan curves at design air quantity and indicate manufacturer's recommended drive loss factor for specific application. Tabular fan performance data is not acceptable.

For variable air volume applications, include data which indicates effect of capacity control devices on performance.

For units specified with motorized backdraft dampers, submit damper air leakage data with unit Shop Drawings.

Include vibration isolation equipment Shop Drawing information as part of fan submittal. Reference Section 23 05 48 for additional requirements.

DESIGN CRITERIA

Tested and certify fans are in accordance with applicable AMCA test code.

Each fan and motor combination shall be capable of delivering 110 percent of air quantity scheduled at scheduled static pressure. Motor furnished with fan shall not operate into motor service factor when operating under these conditions.

Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA Publication 203, Appendix L.

Where inlet and outlet ductwork is field modified at fan location from that shown on Drawings, all required motor, drive and wiring changes required due to increased static pressure or baffling necessary to prevent uneven airflow or improve mixing.

Internal insulation and other components exposed to air stream to meet flame spread and smoke ratings contained in NFPA 90A.

Roof mounted equipment shall be provided with curbs or equipment stands in accordance with specification in Section 23 05 29.

PART 2 - PRODUCTS

GENERAL

Use fan size, class, type, arrangement, and capacity as scheduled on the drawings.

Furnish complete with motors, wheels, drive assemblies, bearings, vibration isolation devices, and accessories required for specified performance and proper operation.

Single-phase motors shall have inherent thermal overload protection.

Provide adjustable pitch sheaves for fans with V-belt drives. V-belt drives shall be sized for 150 percent of motor rating. Provide fixed sheaves for fans using variable frequency drives.

Use OSHA approved belt guards that totally enclose entire drive. Construct guards of expanded metal to allow for ventilation; provide tachometer openings at shaft locations.

Statically and dynamically balance fans so they operate without objectionable noise or vibration.

IN-LINE CENTRIFUGAL FANS

Manufacturers: Carnes, Cook, or Greenheck.

Specification is applicable to fans similar in style to Greenheck SQ or a Cook SQ.

Construct housing of steel with reinforcing to prevent distortion. Fan housings shall include bolted and gasketed access panel for inspection of fan drive and fan wheel. Use non-overloading, aluminum, backward inclined type fan wheels. For belt drive units, isolate belt drives from air stream with belt tube and bearing cover.
For direct drive units, provide internal motor/bearing cover. Externally mount motors on an adjustable base. Bearings to be grease lubricated, self-aligning ball bearing type with grease seal and external grease fitting. Fan housing shall include square duct mounting collars.

Fan shall be configured for either horizontal or vertical airflow configuration and include integral support points for suspended or base mounting as specified on Drawings.

Design vertically mounted fans to withstand vertical thrust loads.

Unit shall include factory mounted and prewired NEMA 1 fan motor disconnect switch.

Fan motor shall be NEMA approved, open ball bearing type with resilient mounting. Motors shall be totally enclosed, explosion proof or 2 speed type.

Provide 1/2 inch square galvanized wire mesh inlet screens for fans without inlet ductwork.

For direct drive units, furnish solid state, variable speed controller for each fan. Speed controller to be used for final air balancing of fan.

Provide each fan with neoprene or spring isolation hangers as specified in Section 23 05 48.10.

PART 3 - EXECUTION

INSTALLATION - GENERAL

Install units as shown on Drawings, as detailed, and according to manufacturer's installation instructions. On units provided with drain connection, install drain valve and cap discharge of drain.

Install thrust restraints in accordance with requirements of Section 23 05 48.10.

Fan drive sheaves on belt driven units shall be adjusted or replaced by Contractor to provide design air volumes.

Furnish wall and roof opening locations and dimensions to other sections of work requiring opening information.

For direct drive fans furnished with variable fan speed controllers, Electrical Contractor will wire and install fan speed controllers on fans.

Suspend inline fans from structure with vibration isolation devices as specified herein.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

FUNCTIONAL PERFORMANCE TESTING

Contractor is responsible for utilizing the functional performance test forms supplied by the third party commissioning agent in accordance with the procedures defined for functional performance testing in Section 01 91 00.

END OF SECTION

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SECTION 23 36 00
AIR TERMINAL UNITS

PART 1 - GENERAL

SCOPE
This section includes specifications for air terminal equipment. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- Supply Air Terminal Boxes
- Access Doors

PART 3 - EXECUTION
- Installation
- Access Doors
- Adjusting
- Construction Verification Items
- Functional Performance Testing

RELATED WORK
Section 23 09 14 - Electric Instrumentation and Control Devices for HVAC
Section 23 09 93 – Sequence of Operations for HVAC Controls
Section 23 31 00 - HVAC Ducts and Casings
Section 23 33 00 - Air Duct Accessories

REFERENCE
Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS
NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
UL 181 - Factory-Made Air Ducts and Connectors.
ARI-ADC Standard 880
ASTM E84 – Surface Burning Characteristics of Building Materials
UL 723 – Surface Burning Characteristics of Building Materials

QUALITY ASSURANCE
Refer to Division 1, General Conditions, Equals and Substitutions.

SHOP DRAWINGS
Refer to Division 1, General Conditions, Submittals.

Contractor shall submit air terminal unit data including materials of construction, dimensions, scheduled flow rates, pressure drops, radiated and discharge sound power levels, reset volume controller data, actuator spring range and torque data.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA
Select sizes, capacities, configuration, and operating characteristics as shown on the plans and/or as scheduled.

PART 2 - PRODUCTS

SUPPLY AIR TERMINAL BOXES
Units shall be single duct and pressure independent.

MANUFACTURER:
Titus

CONSTRUCTION:
As scheduled, unit casing shall be minimum 22 gauge steel and internally insulated with 1" thick matte faced insulation with solid 22 gauge metal liner cover over all insulation including cut edges. Provide low leakage casing. Construction to meet UL 181 and NFPA 90A.

Casing outlet shall have slip and drive joint for connection to discharge ductwork.

Metal damper blade shall be mounted to shaft having self-lubricated bearings. Shaft end shall be marked to indicate damper position and shall have a built-in stop to prevent overstroking. Damper blade shall close off against gasket to limit leakage to 10 cfm at 6.0 inches of differential static pressure. Damper linkage shall be sized to accept at least 40 inch-pounds of torque to the damper shaft. Damper shaft shall be provided with a marking indicating damper position.

Round inlet collar shall be equipped with a multi-point flow sensor that shall amplify the measured velocity pressure. Pneumatic tubing from flow sensor to differential pressure transducer shall be UL listed, fire retardant (FR) type.

HOT WATER REHEAT COIL**:**
Reference section 23 82 00 for hot water reheat coil specifications.

TERMINAL AIR BOX CONTROLS

ACCESS DOORS
STANDARD ACCESS DOORS
Access door to be designed and constructed for the pressure class of the duct in which the door is to be installed. Doors in exposed areas shall be hinged type with cam sash lock.

Hinges shall be steel full length continuous piano type. Doors in concealed spaces may be secured in place with cam sash latches. For both hinged and non hinged doors provide sufficient number of camp sash latches to provide air tight seal when door is closed. Do not use hinged doors in concealed spaces if this will restrict access. Use minimum 1" deep 24 gauge galvanized steel double wall access doors with minimum 24 gauge galvanized steel frames.

For non-galvanized ductwork, use minimum 1" deep double wall access door with frame that shall use materials of construction identical to adjacent ductwork. Provide double neoprene gasket that shall provide seals from the frame to the door and frame to the duct. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners will not be accepted.

ROUND DUCT ACCESS DOORS:
For duct pressure class positive or negative up to 6 in. wg. Access doors shall be constructed from 16 gauge stainless steel for fume exhaust ducts and 16 gauge galvanized steel for general exhaust or return ducts. Hinges shall be continuous piano style constructed from the same material as the access door.

Access doors shall be sealed with ¼" closed cell butyl gasketing permanently bonded on all four sides and no fewer than two draw latches with strike plates. The strike plates shall match the duct/access door material.

INSULATION
Refer to Section 23 07 00 for insulation requirements for ductwork and reheat coils.

PART 3 - EXECUTION

INSTALLATION
Install air terminal units as indicated on project drawings and in accordance with the manufacturer's installation instructions.

Mount air terminal boxes with a minimum 3 feet of straight ductwork upstream of inlet flow sensor for sizes 12" diameter and below. Provide a minimum of 3X the inlet diameter of straight duct upstream of the inlet flow sensor for inlet sizes above 12" diameter.

Field mount coil separate from box with a 12-18" section of duct between the air terminal box and reheat coil. The reheat coil and 12-18" section of duct shall be wrapped with external insulation as indicated in specification section 23 07 00 – HVAC Insulation.

Provide at least 24" of clearance on controller side of the air terminal unit. The clearance area shall extend the full length of the supply air terminal unit and the full length (including the access door) of the exhaust/return air terminal unit

Support air terminal units from building structure using sheet metal straps or trapeze hanger with rods. Do not mount air terminal units off of adjacent ductwork or piping.

ACCESS DOORS

DUCT ACCESS DOORS – SQUARE DUCT:
Provide duct access doors in duct or extended supply air terminal unit upstream and downstream of the reheat coil. Duct access doors shall be as large as duct allows with a maximum size of 18"x18". Install heating coils in accordance with Section 23 73 12 - Air Handling Unit Coils.

DUCT ACCESS DOORS – ROUND DUCT:
Install round duct access doors on the side of the duct upstream of the return/exhaust terminal unit. At no time shall the access door be installed in the bottom of the duct. Piano hinged style access doors shall be installed with the piano hinges located ½ above the bottom of the duct to allow the access door to swing down toward the floor.

ADJUSTING

Coordinate adjustment of air terminal units with section 23 05 93 - Testing, Adjusting and Balancing.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

FUNCTIONAL PERFORMANCE TESTING

Contractor is responsible for utilizing the functional performance test forms supplied by the third party commissioning agent in accordance with the procedures defined for functional performance testing in Section 01 91 00.

END OF SECTION

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SECTION 23 37 13
DIFFUSERS, REGISTERS & GRILLES

PART 1 - GENERAL

SCOPE

This section includes specifications for air terminal equipment. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Submittals
- Design Criteria

PART 2 - PRODUCTS
- Manufacturers
- Round Ceiling Diffusers – Plaque
- Side-Wall Registers and Grilles
- Spiral Duct Grilles
- High-Capacity Drum Louver Diffusers
- Heavy Duty Return Grilles

PART 3 - EXECUTION
- Installation
- Construction Verification Items

RELATED WORK

Section 23 05 93 - Testing, Adjusting and Balancing for HVAC
Section 23 31 00 - HVAC Ducts and Casings
Section 23 33 00 - Air Duct Accessories

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
UL 181 - Factory-Made Air Ducts and Connectors.
ARI-ADC Standard 880

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions.

SUBMITTALS

Refer to division 1, General Conditions, Submittals.

Furnish submittal information including, but not limited to, the following:

- Manufacturer's name and model number
- Identification as referenced in the documents
- Capacities/ratings
- Materials of construction
- Sound ratings
- Dimensions
- Finish
- Color selection charts where applicable
- Manufacturer's installation instructions
- All other appropriate data

DESIGN CRITERIA

All performance data shall be based on tests conducted in accordance with Air Diffusion Council (ADC) Test Code 1062 GRD 84.

PART 2 - PRODUCTS

MANUFACTURERS
Manufacturers: Carnes, Krueger, Titus, Metal-Aire, and E.H. Price, and Nailor.

Acceptable manufacturers for specific products are listed under each item.

ROUNE CEILING DIFFUSERS – Three Cone
Carnes SSRA, Krueger RM2PLQ, Metalaire R5750, Titus Omni R, or Price RPD

Devices shall be specifically designed for variable-air-volume flows.

Material: Steel unless otherwise indicated on Drawings.

Finish: Baked enamel, white unless otherwise indicated on Drawings.

Face Style: One cone.

Mounting, pattern, and damper requirements shall be indicated on Drawings.

SIDE-WALL REGISTERS AND GRILLES
Price model 520 (Supply) or 630 (return/exhaust) or equal.

Aluminum (Steel) unless otherwise indicated, with frame type appropriate to installation.

Single deflection type blade supply registers and supply grilles allow deflection adjustment in all direction.

Opposed blade volume control damper supply registers, operable from face.

Fixed blade (45 degree) core return and exhaust registers and grilles.

Register and grille sizes as shown on drawings and/or as scheduled.

White, baked enamel finish or powder coat finish, unless otherwise indicated.

SPIRAL DUCT GRILLES
Price model SDGE or equal.

Aluminum unless otherwise indicated, with frame type appropriate to installation.

Double deflection type blade supply registers and supply grilles allow deflection adjustment in all direction.

Grille shall be provided with countersunk holes and closed cell foam insulation gasket around grille neck.

Opposed blade volume control damper supply registers, operable from face.

Register and grille sizes as shown on drawings and/or as scheduled.

Coordinate with architect for final finish of grille. Grilles shall have either baked on powder coat finish or clear anodized finish.

HIGH-CAPACITY DRUM LOUVERS
Carnes R series, Krueger DPL, Metalaire RL, Titus DL, or Price HCD.
Airflow Principle: Extended distance for high airflow rates.

Material: Aluminum, heavy gage extruded.

Finish: White baked acrylic.

Border: 1-1/4-inch width with countersunk screw holes.

Gasket between drum and border.

Body: Drum shaped; adjustable vertically.

Blades: Individually adjustable horizontally, minimum 60 degrees.

Mounting: Surface to duct or wall

Accessories: Opposed-blade steel damper, duct-mounting collars with countersunk screw holes.

HEAVY DUTY RETURN GRILLES
Price 90 Series or equal.

Steel, 14 gauge extruded, with frame type appropriate to installation.

Fixed blade (45 degree) core return and exhaust registers and grilles.

Register and grille sizes as shown on drawings and/or as scheduled.

White, baked enamel finish or powder coat finish, unless otherwise indicated.

Border to be 1-1/4-inch width with countersunk screw holes.

PART 3 - EXECUTION

INSTALLATION
Install grilles, registers and diffusers as shown on drawings and according to manufacturer's instructions.

Furnish diffusers with equalizing grids where it is not possible to maintain minimum 2 duct diameter straight duct into diffuser. Equalizing grids shall consist of individually adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.

Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar size.

Seal connections between ductwork drops and diffusers/grilles airtight.

Blank off unused portion of linear slot diffusers and linear bar diffusers and grilles.

Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.

CONSTRUCTION VERIFICATION ITEMS
Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

END OF SECTION

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SECTION 23 41 00
PARTICULATE AIR FILTRATION

PART 1 - GENERAL

SCOPE

This section includes specifications for air system filters. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- Manufacturers
- Panel Filters
- MERV 8 Filters
- MERV 13 Filters
- Housings for Panel Filters
- Housings for MERV 8 Filters
- Side Access Filter Housings

PART 3 - EXECUTION
- Installation
- Construction Verification Items

RELATED WORK

Section 23 07 00 – HVAC Insulation
Section 23 73 13 – Modular Indoor Central-Station Air-Handling Units
Section 23 73 23 – Factory Fabricated Custom AHU
Section 23 82 00 – Heating and Cooling Air Terminal Units

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

ASHRAE Standard 52
UL 181 – Standard for Factory-Made Air Ducts and Air Connectors
UL 586 – Standard for High Efficiency Particulate Air Filter Units
UL 900 – Standard for Air Filter Units

QUALITY ASSURANCE

Refer to Division 1, General Conditions, Equals and Substitutions.

SHOP DRAWINGS

Refer to Division 1, General Conditions, Submittals.
Include data concerning dimensions, materials, efficiencies, installation instructions and appropriate identification.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA

Use UL Class 1 or Class 2 filters unless noted otherwise.(Reference applicable UL standard referenced)

Efficiencies indicated in this section are based on ASHRAE Standard 52.

Fan motors have been selected to operate against the resistance of dirty filters as specified in this section.

PART 2 - PRODUCTS

MANUFACTURERS
American Air Filter, Barnebey-Cheney, Cambridge, Continental, Flanders, Camil-Farr, Mine Safety Appliances, Research Products, BLC Industries or approved equal.

PANEL FILTERS
Use 1" (or as scheduled) thick fiberglass blanket enclosed in a cardboard frame and reinforced with a perforated metal retainer on the air leaving side, Coat media with flameproof, non- volatile adhesive.

Media nominal rating to be 500 FPM face velocity, 0.15 inch WG initial resistance, 0.50 inches WG recommended final resistance. Average arrestance of filter media shall be 80%.

Provide filter holding frame.

MERV 8 FILTERS
Use 2" thick, pleated panels, 100% synthetic, self supported media fully bonded and sealed in cardboard frame.

Media nominal rating to be 500 FPM face velocity, 0.20 inch WG initial resistance, 1.0 inches WG recommended final resistance., Average arrestance of filter media shall be 90-92%
Furnish a side access housing or holding frame as scheduled.

Filter tracks shall be constructed to provide a minimum clearance of 2 inches between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

MERV 13 FILTERS
Use 4" thick, pleated panels, 100% synthetic, self supported media fully bonded and sealed in cardboard frame.

Media nominal rating to be 500 FPM face velocity, 0.30 inch WG initial resistance, 1.0 inches WG recommended final resistance., Average arrestance of filter media shall be 90-92%

Furnish a side access housing or holding frame as scheduled.

Filter tracks shall be constructed to provide a minimum clearance of 2 inches between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

HOUSINGS FOR PANEL FILTERS
Manufactured by air handling unit manufacturer, filter media manufacturer, or contractor fabricated. Casing and tracks constructed of galvanized or enameled steel or aluminum. Provide access to the media tracks from outside the casing so media and be readily changed.

HOUSINGS FOR MERV 8 FILTERS
Housing or holding frame to be of the same manufacturer as filter media or provided by the air handling unit manufacturer. Contractor fabricated housings or filter racks will not be accepted. Casing and tracks constructed of galvanized or enameled steel or aluminum. Provide access to the media tracks from outside the casing so media and be readily changed. Filter tracks shall be constructed to provide a minimum clearance of 2 inches between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

SIDE ACCESS FILTER HOUSINGS
Galvanized steel housing with aluminum or galvanized steel filter mounting tracks. Mounting tracks and access doors to have gaskets to minimize air bypass around the filters. Housing assembly to be suitable for use in modular air handling system.

Standard filter sections provided by air handling unit manufacturers may be used for MERV 11 and MERV 14 filters but will not be accepted for HEPA filters or activated carbon filters.

Insulate housings where adjacent duct or air handling apparatus is insulated. Insulation to be contained within a 2” thick, double wall steel panel and meet the requirements specified for adjacent duct or apparatus.

Furnish a door on each end of the housing to facilitate filter changing. Doors to be hinged and provided with lever handle latches to secure the door. Doors shall not be secured with nuts, bolts, wing nuts, or sheet metal screws.

Furnish housings for MERV 13 filters with a lever action sealing mechanism to secure media in tracks.

Include an integral prefilter track for installation of MERV 7 prefilters. Filter tracks shall be constructed to provide a minimum clearance of 2 inches between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

PART 3 - EXECUTION

INSTALLATION

Where air handling equipment is to be used for temporary heating or ventilation of a facility, do not operate the equipment until specified filter media has been installed. Contractor shall be responsible for maintaining the cleanliness of air handling apparatus and air distribution systems during construction through regular inspection and changing of filter media throughout the construction period.

Where air handling apparatus is used during the construction period, install new filter media prior to start of air balancing. Additionally, deliver one new set of media to the owner prior to substantial completion.

Install units as shown on drawings and details according to manufacturer's instructions.

Reinforce filter holding frames per manufacturer's instructions.

Maintain necessary clearance for changing filters.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

END OF SECTION

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SECTION 23 57 00
HEAT EXCHANGERS FOR HVAC

P A R T 1 - G E N E R A L

SCOPE

This section includes specifications for shell and tube heat exchangers and plate heat exchangers. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Submittals
- Operation and Maintenance Data

PART 2 - PRODUCTS
- Brazed Plate Heat Exchangers

PART 3 - EXECUTION
- Installation
- Brazed Plate Heat Exchangers
- Construction Verification Items
- Functional Performance Testing
- Agency Training

RELATED WORK

Section 23 21 13 - Hydronic Piping

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

ASME Boiler and Pressure Vessel Code VIII - Rules for Construction of Pressure Vessels-Latest Edition.

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions

SUBMITTALS

Refer to division 1, General Conditions, Submittals.

Include data concerning dimensions, capacities, and material of construction.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

P A R T 2 - P R O D U C T S

BRAZED PLATE HEAT EXCHANGERS

Manufactures: Alfa Laval, Bell & Gossett, DHT, ITT, Grundfos, AIC, Standard or approved equal.

Brazed plate type with 316 stainless steel corrugated channel plates, 316 stainless steel cover plates and threaded 316 stainless steel pipe connections. Copper or nickel brazing material shall be used. Design pressure of 435 psig at 437 degrees F.

Provide heat exchangers with capacities and operating characteristics indicated on drawings.

P A R T 3 - E X E C U T I O N

INSTALLATION
Install units as shown on plans, as detailed, and according to manufacturer's installation instructions. Provide clearance around units as shown on the drawings and as recommended by the manufacturer for service access. Provide elbows, flanges and unions on piping to allow for servicing heat exchangers.

BRAZED PLATE HEAT EXCHANGERS
Mount as shown on the drawings. Maintain clearance around unit so it can be easily removed and replaced.

CONSTRUCTION VERIFICATION ITEMS
Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

FUNCTIONAL PERFORMANCE TESTING
Contractor is responsible for utilizing the functional performance test forms supplied by the third party commissioning agent in accordance with the procedures defined for functional performance testing in Section 01 91 00.

AGENCY TRAINING
All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 00.

END OF SECTION

SECTION 23 64 23
MODULAR HEAT RECOVERY CHILLERS

PART 1 - GENERAL

SCOPE

This section includes specifications for modular heat recovery scroll water chillers. Included are the following topics:

PART ONE - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Performance Requirements
- Operating Sound Pressure Level
- Submittals
- Operation and Maintenance Data
- Delivery, Storage and Handling
- Warranty

PART TWO - PRODUCTS
- Manufacturers
- General
- Manufactured Units
- Compressors and Refrigeration
- Evaporator and Condenser Heat Exchanger
- Virtual Moveable Endcap II (VME II)
- Insulation
- Controls
- Electrical
- Vibration Isolation

PART THREE - EXECUTION
- Installation
- Startup
- Training
- Construction Verification Items
- Functional Performance Testing

RELATED WORK

Section 23 05 00 - Common Work Results for HVAC
Section 23 05 13 – Common Motor Requirements for HVAC Equipment
Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
Section 23 21 13 – Hydronic Piping
Section 23 09 23 – Direct Digital Control for HVAC
Section 23 09 93 - Sequence of Operations for HVAC Controls

REFERENCE

Applicable provisions of Division 1 shall govern work under this section.

REFERENCE STANDARDS

ARI 550/590-2003	Centrifugal or Rotary Screw Water-Chilling Packages
ARI 575	Method of Measuring Machinery Sound Within an Equipment Space
ASHRAE 15	Safety Code for Mechanical Refrigeration
ASHRAE 90.1	Energy Standard for Building except Low Rise Residential Buildings
ASME SEC 8	Boiler and Pressure Vessel Code
NEMA MG1	Motors and Generators
UL 1995	Central Cooling Air Conditioners
UL 984	Safety Standards for Hermetic Compressors
COMM 45	Wisconsin Department of Commerce Mechanical Refrigeration Code

QUALITY ASSURANCE
Refer to Division 1, General Conditions, Equals and Substitutions.

Construct, test and rate chiller performance in accordance with ARI 550 with exceptions as noted in this specification.

Construct, install and operate chillers in accordance with ANSI/ASHRAE 15- Safety Code for Mechanical Refrigeration and COMM 45 Wisconsin Mechanical Refrigeration Code.

Construct and test chillers in accordance with ASME SEC 8.

Construct and label chillers in accordance with UL 1995.

PERFORMANCE REQUIREMENTS
Include the following performance documentation submitted along with the submittals.

OPERATING SOUND PRESSURE LEVEL
The unit shall operate at full load and all part load conditions without exceeding 85-dBA sound pressure level in the equipment room. If units do not meet the 85-dBA requirements, as measured in accordance with latest version ARI Standard 575, furnish all attenuation devices necessary to meet this requirement. The sound pressure levels in all octave bands must be met as scheduled for full load and part load conditions.

SUBMITTALS
Refer to Division 1, General Conditions, Submittals

Submit chiller shop drawings including the following information: specific manufacturer and model numbers, dimensional and weight data, required clearances, materials of construction, capacities and ratings, minimum load achievable without hot gas bypass, pressure ratings, refrigerant charge, pumpout refrigerant storage capacity, component information, assembly information, size and location of piping connections, electrical connections, wiring diagrams, motor information (ref. 23 05 13), surfaces requiring insulation, SqFt of surface insulation, sound pressure levels in all octave bands at 25%/50%/75%/100% load, information for all specialties and accessories.

Include an ARI approved chiller selection method for the specified refrigerants. Verification of date and version of computer program selection or catalog is available through the Vice-President, Engineering, ARI (703) 524-8800.

Indicate ASME construction and stamping of pressure vessels or unit physical characteristics and ASME code section and paragraph references that allow non-compliance with this construction and stamping requirement.

Submit manufacturer's installation and start-up instructions, maintenance data, troubleshooting guide, parts lists, controls and accessories.

At substantial completion, submit warranty certificate and copy of start-up report.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DELIVERY, STORAGE AND HANDLING
Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

Protect units from physical damage. Leave factory-shipping covers in place until installation.

WARRANTY
Provide a one year all-inclusive warranty to begin upon acceptance of project by owner.

Provide an additional four (4) year material and labor warranty extension for compressor motor, compressor assembly and unit controls.

PART 2 - PRODUCTS

MANUFACTURERS
Multistack.

GENERAL

The chiller shall be a Multistack VME II patent pending geothermal heat recovery, heat recovery chiller. It shall be equipped with integral valving that allows the assembly to serve the following functions:

- Simultaneous Heating and Cooling Mode – Chiller/Heater assembly must be capable of varying the flow rate on the evaporator and condenser sides of the modules to maintain heating and cooling water set points simultaneously. Simultaneous loads must be satisfied with a single compression cycle and cannot use the source/sink solution as the means of energy transfer. Systems that require double compression to satisfy simultaneous loads are not acceptable.

- Cooling Dominant Mode – Chiller/Heater must be able to reject cooling dominant load to the source/sink. Cooling dominant modules must be capable of running at a lower head pressure than simultaneous modules to minimize power consumption.

- Heating Dominant Mode – Chiller/Heater must be able to satisfy heating dominant load by extracting heat from the source/sink solution. Heating dominant modules must be capable of running at optimal suction pressure to minimize power consumption.

- Packaged System Shall Be Reversing Valve Free Design – Chiller/Heater must be reversing valve free and optimize heat transfer in all control modes.

- Source/Sink Water Connections – Chiller/Heater must allow geothermal loop water to enter both the evaporator and condenser side of the machine.

System shall be configured to allow modules to run in simultaneous DHRC™ mode, dominant cooling mode, and dominant heating mode. The Chiller/Heater must be capable of allowing modules to run in multiple modes at the same time to optimize efficiency.

MANUFACTURED UNITS

Provide factory assembled and tested, packaged, heat recovery liquid chiller consisting of modular dual scroll compressor(s), compressor motor, condenser, evaporator, refrigeration accessories, instrument and control panel, gages and indicating lights, auxiliary components and accessories, solid state motor starter.

Acceptable refrigerant is R-410A.

Firmly attach metal nameplates to major components indicating the name of the manufacturer, unit model number, compressor/condenser/cooler type, refrigerant used, pounds of refrigerant needed for normal operation, operating pressures, and unit serial number.

Modules shall be provided with acoustical panels.

COMPRESSORS AND REFRIGERATION

Compressor assemblies shall be run tested at the factory. Vibration shall not exceed 1.0 mil peak to peak. Over-speed test compressor impeller(s) to not less than 20% above operating conditions.

Chiller must be supplied with dual refrigeration circuits and each circuit complete with externally equalized thermal expansion valve, liquid line solenoid to prevent liquid migration during the off cycle, liquid line filter dryer, sight glass moisture indicator and two (2) hermetic scroll compressors.

Each module have (2) stages of capacity at a minimum.

Scroll compressors must each be supplied with crankcase heaters, internal thermal protection, rubber isolation pads between compressor and frame, have two steps of capacity control by cycling of compressors, 100%, 50% and off.

EVAPORATOR AND CONDENSER HEAT EXCHANGERS

Evaporator and condenser shall be dual circuit brazed plate heat exchanger designed and constructed to ASME and UL standards.

Heat exchangers shall be constructed of copper brazed 316 stainless steel plates. Heat exchangers shall be mounted below the compressor, to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.

Condenser and Evaporator heat exchangers shall be equipped with motorized modulating butterfly type valves driven independently by signals from the module controller and powered from the main power feed (ball valves are not acceptable).

The motorized actuators shall be NEMA 4X rated with easily visible position indicator and internal thermal motor overload protection. Valves shall be fast acting type with a maximum stroke time (full closed to full open) of 15 seconds. Load side valves shall modulate to maintain modular leaving load temperatures.

When heat exchangers are using sink/source due to unequal heating/cooling duty, master controller shall modulate valve to provide minimum required head pressure control in order to maximize efficiency of those Chiller/Heater modules and to provide equipment protection.

All valves must be installed such that proper piping practices are observed, including proper distances before and after elbows. Contractor shall provide required butterfly valves and actuators.

Each inlet water header shall incorporate a built-in 30 mesh inline strainer system to prevent heat exchanger fouling and accommodate 100% flow filtration with a minimum surface area of 475 square inches per module. This filtration is in addition to a field mounted Y-strainer in the chilled water loop piping.

Each module shall include supply and return mains for both load and source-sink water. Grooved end connections are provided for interconnection with Victaulic type couplings. Water Mains shall be installed such that they are beneath any power or control wiring so as to insure for safe operation in the event of any condensation or piping leaks.

Provide thermometer and pressure wells for temperature controller and low temperature cutout.

VIRTUAL MOVEABLE ENDCAP II (VME II)

The heat recovery chiller shall be designed for simultaneous variable heating and cooling capacity. The VME II valve module shall contain fast-acting motorized butterfly valves that open/close on a command from the central control system (ball valves are not acceptable). The motorized actuators shall be NEMA 4X rated with easily visible position indicators and internal thermal motor overload protection. Valves shall be fast acting type with a maximum stroke time (full closed to full open) of 30 seconds. Valve modules shall be built into pre-engineered headers and powered by the heat recovery chiller bussbar. VME II valves shall be Victaulic grooved connections.

INSULATION

3/4" thick, flexible closed cell elastomeric foam insulation; minimum nominal density of 5.5 lbs. per cu. ft., thermal conductivity of not more than 0.27 at 75 ^{o}F, minimum compressive strength of 4.5 psi at 25% deformation, maximum water vapor transmission of 0.17 perm inch, maximum water absorption of 6% by weight, rated for service range of -20 ^{o}F to 180 ^{o}F.

Factory insulate the following:

- Evaporator and condenser heat exchangers
- Motor housing (hermetic compressors)
- Motor cooling lines (hermetic compressors)
- All lines and surfaces 65^{o}F or colder

CONTROLS

Provide fully automatic microprocessor controller in a lockable steel control panel containing solid state chiller operating and safety controls for each chiller. Factory mount, wire and test controls on chiller. Operating setpoints and diagnostic procedures to be programmed through a color-coded, tactile-feel keypad. Provide an alphanumeric display showing all system parameters, safety and cycle shutdowns in the English language with numeric data in English units. Safety and cycle shutdown display to consist of date, time, cause of shutdown, and type of restart required.

Provide master chiller controller, of same manufacturer of chillers, for sequencing, controlling and managing multiple modular chillers in a single plant.

The master controller shall sequence the operation of the of the various compressors, VME Isolating Valves, and Heat Exchanger Variable Flow Valves to maximize efficiency and minimize system energy usage.

Provide the following safety controls arranged so that activation of any one will shut down the respective chiller or plant and require a manual reset:

Low refrigerant pressure
Loss of flow through the source/sink heat exchanger
Loss of flow through the load (cooling and/or heating) heat exchanger
High refrigerant pressure
High compressor motor temperature
Low suction gas temperature
Low leaving water temperature

The Master Controller to be powered from the main Chiller/Heater power. Master controller will monitor and report the following on each refrigeration system:

- Discharge Pressure Fault
- Suction Pressure Fault
- Suction Temperature
- Load Leaving Water Temperature
- Source-Sink Leaving Water Temperature

The Master Controller shall monitor and report the following system parameters:

- Cooling Load Water Entering and Leaving Temperature
- Heating Load Water Entering and Leaving Temperature
- Source-Sink Water Entering and Leaving Temperature
- Load Water (both heating and cooling) and Source-Sink Water Flow

Individual monitoring of leaving water temperatures from each refrigeration system shall be programmed to protect against heat exchanger freeze-up.

The control system shall evaluate the water temperatures of the heating and cooling systems to assess the required capacity of each and cycle compressors of the Chiller/Heater Modules, open/close VME Isolation Valves, & modulate Heat Exchanger Variable Flow Valves to meet load requirements, optimize efficiency, minimize system energy usage and equalize compressor run times.

Chiller/Heater shall have a single point power connection and external inputs and outputs to be compatible with the building management system. Hardwire Inputs/Outputs include:

- Remote Start/Stop
- General Alarm
- Cooling Load Limit
- Heating Load Limit
- Cooling Load Reset
- Heating Load Reset

Failure of DHRC Chiller/Heater/Heater to start or Chiller/Heater shutdown due to any of the above safety cutouts shall be enunciated by display of the appropriate diagnostic description at the unit control panel. This annunciation will be in plain English. Alphanumeric codes shall be unacceptable.

The DHRC Chiller/Heater/Heater shall be furnished with a Master Controller as an integral portion of the Chiller/Heater control circuitry to provide the following functions:

Provide automatic Chiller/Heater shutdown during periods when the load level decreases below the normal operating requirements of the Chiller/Heater. Upon an increase in load, the Chiller/Heater shall automatically restart.

Provisions for connection to automatically enable the Chiller/Heater from a remote energy management system.

The control panel shall provide alphanumeric display showing all system parameters in plain English language with numeric data in English units.

Normal Chiller/Heater Operation

When DHRC Chiller/Heater/Heater is enabled, the factory supplied Master Controller modulates the Chiller/Heater heating and cooling capacity from minimum to maximum as required by building load.

The DHRC Chiller/Heater/Heater control system shall respond to Entering Water Temperature and will have an integral reset based on entering water temperature to provide for efficient operation at part-load conditions.

Power Phase Monitor

Provide a Power Phase Monitor on the incoming power supply to the Chiller/Heater. This device shall prevent the Chiller/Heater from operating during periods when the incoming power is unsuitable for proper operation.

The Power Phase Monitor shall provide protection against the following conditions:

- Low Voltage (Brown-Out)

Phase Rotation
Loss of Phase
Phase Imbalance

The Chiller/Heater shall be capable of communicating the above points with the Building Automation System via an Interoperability Web Portal. BacNet, Lonmark, or Modbus available.

Additional points shall include:

Chiller/Heater leaving chilled water temperature
Chiller/Heater leaving hot water temperature
Chiller/Heater percent cooling capacity
Chiller/Heater percent heating capacity
Module level leaving condenser temperature
Module level leaving evaporator temperature
Individual Compressor Status On/Off
Condenser VME valves Open/Close status
Evaporator VME valve Open/Close status

The master chiller controller shall convert information into the BACnet/IP protocol, or format compatible with the building direct digital control system (DDC) as specified in Section 23 09 23. This output shall be through the appropriate interface port capable of two-way communication with the building DDC system. Coordinate with the DDC contractor so that the data port connection provided at the chiller shall not require any additional intermediate gateway or media conversion devices to provide throughput of data. No additional labor by the DDC contractor to integrate the chiller data points to the DDC system shall be required other than to make the communication trunk connection and program the points at the DDC workstation.

The chiller master controller shall allow the modules to have IP addresses assigned utilizing DHCP. Manufacturer supplied static IP addresses will not be allowed for web interface.

ELECTRICAL
Modular chiller section groups shall have a single point electrical connection. Entire VME II package shall be equipped with a bussbar electrical distribution system to allow for single point power.

Refer to Drawing schedules for chiller section groups.

The pre-engineered system shall also incorporate individual module isolation circuit breakers for full redundancy and ability of a module to be taken off-line for repair while the rest of the modules continue to operate.

Future chiller modules and VME II shall be provided with their own electrical power connection.

VIBRATION ISOLATION
The chiller supplier shall furnish refrigeration machine vibration isolation in accordance with 23 05 48 for the installation by the mechanical contractor.

PART 3 - EXECUTION

INSTALLATION
Install chillers in accordance with manufacturer's installation instructions.

Chillers shall be factory assembled, tested, and shipped to the job site. The chiller manufacturer is responsible for unloading at the job site and the Mechanical Contractor is responsible for final setting and installation.

STARTUP
Include the service of a factory-trained technician/mechanic employed by the chiller manufacturer for the initial startup, 6 month maintenance review, and 1 year maintenance review. Accomplish initial startup before State acceptance of the installation.

Furnish a startup log to the Owner's operating personnel with a copy to the state construction representative for this project. Document each subsequent startup or shutdown procedure and send report to Owner's operating personnel. Demonstrate the following items have been accomplished:

1. Inspect/clean evaporator and condenser heat exchangers.

a. 6 Month & 1 Year Review: Visually inspect for corrosion, pitting, erosion and general appearance. Chemical cleaning will not be allowed.

2. Perform leak test on fabricated compressor, vessel and piping joints after the system has been serviced and closed.

a. Initial startup: Follow manufacturer's instructions with respect to evacuation, charging, positive pressure and/or vacuum testing. Pressure/vacuum testing to be in accordance with manufacturer's instructions. Perform any repairs necessary to obtain a successful pressure test.
Do not operate chiller until it is successfully pressure tested. Use nitrogen and suitable refrigerant for pressure test unless manufacturer's instructions require otherwise.

b. 6 Month & 1 Year Review: Electronically leak test all fabricated compressor and vessel joints in accordance with manufacturer's instructions and perform any repairs necessary to obtain a successful test.

3. Lubrication system

a. Initial startup: Charge unit with oil in accordance with manufacturer's instructions. Energize oil sump heater and verify thermostat setting per manufacturer's specification.

b. 6 Month & 1 Year Review: Remove lubrication charge from modules. Visually inspect for color, dirt, sludge, and burnt or acidic condition. Test oil in the chiller manufacturer's laboratory or a laboratory approved by the manufacturer to determine condition of oil and notify owner of the results. Clean lubrication system if visual and/or laboratory results indicate necessary. Recharge with new oil per manufacturer's specifications and replace oil filter elements.

4. Filters and strainers.

a. 6 Month & 1 Year Review: Remove and replace all oil and refrigerant filters, strainers and filter-drier cores. Use acid/moisture type replacement filter-drier cores.

5. Energize oil sump heater and verify thermostat setting is per manufacturer's instructions at each inspection.

6. Electrical

Tighten all starter electrical power connections and all control terminations at each inspection.

Check all contactors at each inspection for proper mechanical linkage, freedom of operation and contact surfaces for pitting, corrosion and spring tension. Clean all contact surfaces as required; notify owner if replacement is recommended.

Megger test and record all compressor and oil pump motor insulation readings at initial startup and each succeeding inspection. Compare findings to previous readings and make recommendations on any preventative maintenance required.

Visually inspect and clean all components including resistor banks, disconnects, fuse holders, arc chutes, ammeters, voltmeters, watt-hour meters, dash-pots, etc.

8. At initial startup and whenever refrigerant is transferred from a storage device to the chiller, record date and pounds of refrigerant in machine.

9. Clean and touchup paint unit as required for protection.

10. Repair or replace damaged insulation caused by service/repair/maintenance work.

11. Give any used compressor oil to owner; owner will make arrangements for proper disposal.

12. At the initial startup and each maintenance review, check all safety and operating controls, log all pertinent parameters of the unit, including but not limited to the following:
a. Refrigerant pressure in cooler
b. Saturated refrigerant temperature in cooler
c. Water inlet and outlet temperatures in cooler and condenser
d. Water side pressure drop in cooler and condenser
e. Flow rate in gallons per minute in cooler and condenser
f. Bearing temperatures

g. Oil sump temperature
h. Oil pressure
i. Motor voltage and amperage in each phase
j. Purge count and purge unit operating hours, if applicable
k. Purge condensing pressure, if applicable
l. Starter transition time, actual as measured

TRAINING

Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 8 hours.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

FUNCTIONAL PERFORMANCE TESTING

Contractor is responsible for utilizing the functional performance test forms supplied by the third party commissioning agent in accordance with the procedures defined for functional performance testing in Section 01 91 00.

END OF SECTION

SECTION 23 73 12
AIR HANDLING UNIT COILS

PART1 - GENERAL

SCOPE
This section contains specifications for coils used in all indoor central station air handling units. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Submittals
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- Manufacturers
- Hot Water Coils
- Chilled Water Coils

PART 3 - EXECUTION
- Hot Water Coils
- Chilled Water Coils
- Construction Verification Items

RELATED WORK
Section 23 73 13 - Modular Indoor Central-Station Air-Handling Units

REFERENCE
Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS
ARI 410 Forced Circulation Air-Cooling and Air-Heating Coils

QUALITY ASSURANCE
Refer to division 1, General Requirements, Equals and Substitutions

SUBMITTALS
Refer to division 1, General Requirements, Submittals.

Including data concerning dimensions, capacities, flow rate, pressure drop, materials of construction, ratings, weights, and appropriate identification at the same time that the air handling equipment in which the coils will be located are submitted.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA
Select coil sizes, capacities, configuration, and operating characteristics as shown on the plans and/or as scheduled. Coil capacity ratings shall be ARI 410 certified.

PART 2 - PRODUCTS

MANUFACTURERS
Aerofin or pre-approved equal

HOT WATER COILS

Use galvanized steel casing, end supports, top channel, and bottom channel to produce a rigid frame with allowance for expansion and contraction of the finned tube section.

Construct coils of 0.025 inch tube wall seamless copper tubes of 5/8 inch maximum outside diameter with 0.008" thick aluminum fins and suitable for working pressures to 125 psig and temperatures to 250°F. Coil fins may be the continuous serpentine or plate fin type.

Coil headers may be constructed of cast iron, steel, or seamless copper. Where cast iron headers are used, expand tubes into the headers. Where steel or copper headers are used braze tubes to header.

Provide coils with bronze spring turbulators where required to provide the capacities indicated.

CHILLED WATER COILS

Use galvanized steel casing, end supports, top channel, and bottom channel to produce a rigid frame with allowance for expansion and contraction of the finned tube section.

Construct coils of 0.025 inch tube wall seamless copper tubes of 5/8 inch maximum outside diameter with 0.008" thick aluminum fins suitable for working pressures to 200 psig. Coil fins may be the continuous serpentine or plate fin type.

Coil headers may be constructed of cast iron, steel, or seamless copper. Where cast iron headers are used, expand tubes into the headers. Where steel or copper headers are used braze tubes to header.

Coils shall be drainable type with drain and vent plugs for each header.

PART 3 - EXECUTION

HOT WATER COILS

Install in central station air handling unit casings or on structural support frames for field erected units, making allowance for pitching as recommended by the manufacturer. Mount coils in field erected units to allow for individual removal.

Comb bent or crushed fins after installation. Clean dust and debris from each coil to ensure its cleanliness.

Install a separate air vent and drain valve for each coil header in such a manner that the vent and drain valves are located outside of air handling unit casing. Provide offsets in piping to facilitate coil removal.

Unless otherwise specified, pipe coils for counter flow arrangement.

CHILLED WATER COILS

Install in central station air handling unit casings or on structural support frames for field erected units, making allowance for pitching as recommended by the manufacturer.

Mount coils in field erected units to allow individual removal.

Comb bent or crushed fins after installation. Clean dust and debris from each coil to ensure its cleanliness.

Install a separate air vent and drain valve for each coil header in such a manner that the vent and drain valves are located outside of air handling unit casing. Provide offsets in piping to facilitate coil removal. Unless otherwise specified, pipe coils for counter flow arrangement.

Where coils are installed in ductwork or field erected air handling units, provide a 1-1/2" deep 18 gauge welded stainless steel drain pan as an integral part of the duct or at coil support.

Install condensate drain trap with proper depth from each cooling coil condensate drain to the nearest drain location.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

END OF SECTION

SECTION 23 73 13
MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

SCOPE

This section includes specifications for indoor central station package air handling units. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Submittals
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- Manufacturers
- Casing
- Access Doors
- Fan Sections
- Fan Inlet Air Flow Stations
- Coil Sections
- Filter Sections
- Access Sections

PART 3 - EXECUTION
- Installation
- Construction Verification Items
- Functional Performance Testing

RELATED WORK

Section 23 05 13 - Common Motor Requirements for HVAC Equipment
Section 23 05 20 - Variable Frequency Drives
Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
Section 23 31 00 - HVAC Ducts and Casings
Section 23 41 00 - Particulate Air Filtration
Section 23 33 00 - Air Duct Accessories
Section 23 73 12 - Air Handling Unit Coils

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

ARI 430 (latest edition)	Standard for Central Station Air Handling Units
NFPA 90A	Standard for Installation of Air Conditioning and Ventilation Systems

QUALITY ASSURANCE

Refer to Division 1, General Conditions, Equals and Substitutions.

SUBMITTALS

Refer to Division 1, General Conditions, Submittals
Submit shop drawings including the following information: specific manufacturer and model numbers, submittal equipment identification corresponding to project drawings and schedules, unit dimensional and weight data, materials of construction, capacities and ratings, fan curves, fan type, drive and motor information, vibration isolation, coil performance data, sound power levels, filter information, information for all accessories.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA

Furnish factory fabricated modular indoor central-station air handling units complete meeting the configuration shown on drawings and/or as scheduled.

Units to be tested, rated and certified in accordance with ARI Standard 430 and bear ARI certification label.

All material shall meet NFPA 90A flame spread and smoke develop rating requirements.

Any revisions made by the Contractor to the inlet and outlet ductwork conditions from that shown on the drawings shall not increase system effect and/or static pressure and shall not decrease mixing efficiencies.

PART 2 - PRODUCTS

MANUFACTURERS

Daikin, Carrier, or Trane.

Manufacturers must fit within the mechanical rooms while providing the required unit sections and unit maintenance clearances. Units with dimensions that do not fit within the mechanical rooms, and do not maintain required maintenance accesses will not be accepted.

CASING

WALL/ROOF CONSTRUCTION

Construct walls and roof from 2”thick double wall panel assemblies. Panels shall be injected with polyurethane foam insulation and shall have a minimum thermal conductivity (R) of at least 12.5. The outer shell shall be constructed of solid G90 galvanized steel with baked enamel or mill galvanized finish or G40 galvanized steel with gardobond finish. The inner liner shall be constructed of solid G90 galvanized steel or G40 galvanized steel with gardobond finish. Panels shall be gasketed with permanently applied bulb-type gaskets and able to be removed without affecting the integrity of casing structure.

Under 55°F supply air temperature and design conditions on the exterior of the unit of 91°F dry bulb and 74°F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying or replacing units should external condensate form on them.

Wall/Roof panel deflection shall not exceed L/240 ratio at a maximum +/- 5 inches of static pressure. Deflection shall be measured at the midpoint of the panel.

FLOOR CONSTRUCTION

Construct floors from 2”thick double wall panel assemblies. Panels shall be injected with polyurethane foam insulation and shall have a minimum thermal conductivity (R) of at least 12.5. The outer shell shall be constructed of solid G90 galvanized steel with baked enamel or mill galvanized finish or G40 galvanized steel with gardobond finish. The inner liner shall be constructed of solid G90 galvanized steel or G40 galvanized steel with gardobond finish. Panels shall be gasketed with permanently applied bulb-type gaskets.

Under 55°F supply air temperature and design conditions on the exterior of the unit of 91°F dry bulb and 74°F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying or replacing units should external condensate form on them.

Floor panel deflection shall not exceed L/240 ratio based upon a 300 lb concentrated load at the mid-span of the panel.

A full perimeter base rail shall be installed at each air handling unit. The base rail shall be constructed from a minimum of 16 gauge G90 galvanized steel and have a height required for proper condensate trapping (air handlers will also be placed on a 4” concrete equipment pad). Panels shall be able to be removed without affecting the integrity of casing structure.

LEAKAGE RATE

Leakage rate shall not exceed 1% of the total system air quantity when subjected to +/- 5” static pressure.

CASING PENETRATIONS
Install sealing collars to the interior and exterior of each penetration to prevent air leakage where coil piping, humidifier piping, air vents, drain piping, and electrical conduits penetrate air handling unit casing. Silicone sealants and duct sealants are not acceptable to seal pipe penetrations of the air handling unit casing.

Duct sealant and/or gaskets as indicated in specification section 23 31 00 may be utilized to seal duct connections to the air handling unit casing. Silicone sealants are not acceptable.

ACCESS DOORS
Access doors shall be double wall, of same construction and thickness as casing, hinged, continuously gasketed with bulb type gaskets and reinforced nylon handles with cam type latches. Provide access doors on both sides of casing for fan sections, access sections, air to air energy recovery sections, filter sections, damper sections, air blender sections and upstream and downstream of every coil and humidifier.

FAN SECTIONS
Double width, double inlet, housed centrifugal type or single width single inlet plenum type, statically and dynamically balanced fans. For variable speed applications, fan shall be dynamically balanced through entire range of operation. Fan wheels shall be backward inclined, forward curved or airfoil type as specified or required by performance characteristics.

Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. The motor furnished with the fan shall not operate into the motor service factor when operating under these conditions.

Fans to be fastened to hollow or solid steel shafts and designed for continuous operation at maximum rated static pressure.

Fan bearings shall be self-aligning, pillow block, regreasable ball type selected for a minimum average L-50 life of 200,000 hours.

Furnish extended grease lines from bearings to allow servicing without entering the unit. Grease lines can be terminated within the unit as long as they are able to be easily serviced by opening the access door.

Furnish variable pitch sheaves for drives 3 hp and smaller, fixed pitch sheaves for drives 5 hp and larger. Drives shall be designed for 150% of motor rating. Furnish OSHA approved belt guards for all fans.

Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA Publication 203, Appendix L.

Furnish a metal access guard at the access door of all plenum fan sections. A wheel guard may be substituted if a metal access guard is not available from the manufacturer.

Fan, drive and motor assembly shall be mounted inside fan casing section and integrally isolated within unit. Vibration isolation shall be in compliance with section 23 05 48. Provide flexible connection and thrust restraints at fan discharge connection to casing.

Furnish a label inside the fan section that identifies the specifications of the v-belt drive kit. Include motor sheave, drive sheave and belt data.

Fan motors shall be provided in accordance with section 23 05 13.

COIL SECTIONS
Coils shall be provided in accordance with section 23 73 12.

Air handling unit coils mounted in casing shall be accessible for removal from either side of unit casing without disturbing adjacent sections.

Entire coil frame, headers and U-bends shall be enclosed within air handling unit casing. Extend coil piping connections, air vent and drain connections to exterior of casing.

Support coils along entire length within casing and pitch coil for proper drainage.

Blank off space between coil frames and air handling unit casing.

Fabricate cooling coil drain pans from type 304 stainless steel. Install a drain pan under each cooling coil. Extend drain pans the entire width of each coil, including the header, and from the upstream face of each coil to a distance ½ of the vertical coil height of the bottom coil or 6", whichever is greater, downstream from the downstream face. Pitch drain pans in two directions towards the outlet. Pipe drain pans individually down to the drain pan below using a minimum 1" type 304 stainless steel piping. The bottom drain pan shall be piped to the exterior of the unit base using a minimum of 1.25" type 304 stainless steel piping.

FILTER SECTIONS

Filter box section may be furnished by air handling unit manufacturer in accordance with specification requirements of section 23 41 00. Provide static pressure tips that are arranged to prevent damage to the filter elements during replacement. Provide minimum 2" gap between final and prefilters for static pressure probes.

ACCESS SECTIONS

Provide access sections where shown on drawings.

PART 3 – EXECUTION

INSTALLATION

Install all air handling units and accessories as indicated on drawings and/or as scheduled and according to manufacturer's installation instructions.

Mount units at appropriate height above floor to insure proper condensate trap depth and condensate drainage.

Install air-handling unit to provide for adequate service access. Coordinate with other trades to assure air handling unit does not infringe upon access or service clearances of other equipment.

Lubricate fan bearings. Verify fan isolators have proper deflection.

Upon completion of installation of air handling units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning components, then retest to demonstrate compliance.

Furnish one spare set of fan drive belts and three reinforced nylon access door handles.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

FUNCTIONAL PERFORMANCE TESTING

Contractor is responsible for utilizing the functional performance test forms supplied by the third party commissioning agent in accordance with the procedures defined for functional performance testing in Section 01 91 00.

END OF SECTION

SECTION 23 82 00
HEATING AND COOLING TERMINAL UNITS

P A R T 1 - G E N E R A L

SCOPE

This section includes specification for heating and cooling terminal equipment using water and/or steam as the source. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- Cabinet Unit Heaters

PART 3 - EXECUTION
- Installation
- Cabinet Unit Heaters
- Construction Verification Items
- Functional Performance Testing

RELATED WORK

Section 23 05 13 - Common Motor Requirements for HVAC Equipment
Section 23 05 23 - General-Duty Valves for HVAC Piping
Section 23 36 00 - Air Duct Accessories
Section 23 41 00 - Particulate Air Filtration

REFERENCE

Applicable provisions of Division 1 govern work under this Section.

REFERENCE STANDARDS

ARI 210 Standard for Unitary Air-Conditioning Equipment
ARI 410 Standard for Forced-Circulation Air-Cooling and Air-Heating Coils
CS 140

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions

SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Include dimensions, capacities, materials of construction, ratings, weights, wiring diagrams, and appropriate identification for all equipment in this section. Include color selection chart where applicable.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA

Forced Circulation Coils: Ratings certified in accordance with ARI 410.

Electrical Equipment and heaters shall be UL listed for the service specified.

Electrical components and work must be in accordance with National Electrical Code.

PART 2 - PRODUCTS

CABINET UNIT HEATERS

Manufacturers: Modine, McQuay, Trane, Airtherm, Sterling, Vulcan, Zehnder Rittling or approved equal.

Unit types and arrangements as specified on Drawing Schedule.

Vertical unit casings shall have 16 gauge steel front panels and minimum 18 gauge steel end and side panels. Horizontal units located in concealed spaces or mounted in ceiling shall have minimum 18-gauge front, end, and side panels.

Furnish exposed cabinets in baked enamel finish in one of manufacturer's standard colors, selected by Architect.

Furnish ceiling mounted units with hinged front panel to allow access to internal components.

Heating elements constructed of copper tubes with aluminum fins, tested at 200 psig.

Use centrifugal type fans, statically and dynamically balanced to operate without objectionable noise and vibration.

Motors to be 120 volt, single phase, permanently lubricated, with thermal overload protection and disconnect switch at unit.

Furnish each unit with filter rack and 1 inch panel filters as specified in 23 41 00.

PART 3 - EXECUTION

INSTALLATION

Install units in accordance with manufacturer's installation instructions.

Install branch water or steam/condensate piping to each unit with a minimum of three elbows to allow for expansion and contraction of the piping system.

Coordinate location of units with other trades to assure correct recess size for recessed units.

After installation, provide protective covers to prevent accumulation of dirt on units during balance of construction.

CABINET UNIT HEATERS

Mount units in locations indicated on Drawings and as detailed. Install drain valve on coil side of shutoff valves for each hot water cabinet heater.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied by the third party commissioning agent in accordance with the procedures defined for construction verification in Section 01 91 00.

FUNCTIONAL PERFORMANCE TESTING

Contractor is responsible for utilizing the functional performance test forms supplied by the third party commissioning agent in accordance with the procedures defined for functional performance testing in Section 01 91 00.

END OF SECTION

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

The electrical work included in all other divisions is the responsibility of the contractor performing the division 26 work unless noted otherwise.

PROJECT OVERVIEW

The project consists of an addition and minor renovation of the existing Warner Park Community Recreation Center facility on Northport Drive in Madison, Wisconsin. As part of the addition, new electrical distribution will be extended and a new PV array will be provided on the roof of the addition.

SCOPE

The work under this section includes basic electrical requirements, which are applicable to all Division 26 sections. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

PART 1 - GENERAL
- Project Overview
- Scope
- Related Work
- Reference
- Reference Standards
- LEED Certification
- Commissioning
- Regulatory Requirements
- Quality Assurance
- Continuity of Existing Services and Systems
- Protection of Finished Surfaces
- Approved Electrical Testing Laboratories
- Sleeves and Openings
- Sealing and Fire Stopping
- Intent
- Omissions
- Submittals
- Project/Site Conditions
- Work Sequence and Scheduling
- Work by Other Trades
- Salvage Materials
- Certificates and Inspections
- Operating and Maintenance Data
- Record Drawings

PART 2 - PRODUCTS
- Access Panels and Doors
- Identification
- Sealing and Fire Stopping

PART 3 - EXECUTION
- Paintability
- Concrete Work
- Cutting and Patching
- Building Access
- Equipment Access
- Coordination
- Sleeves and Openings

Sealing and Fire Stopping
Housekeeping and Clean Up
Agency Training

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

REFERENCE STANDARDS

Abbreviations of standards organizations referenced in this and other sections are as follows:

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
EPA	Environmental Protection Agency
ETL	Electrical Testing Laboratories, Inc.
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
ISA	Instrument Society of America
NBS	National Bureau of Standards
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
UL	Underwriters Laboratories Inc.
DSPS	Wisconsin Department of Safety and Professional Services

LEED CERTIFICATION

The project will be LEED Certified thru the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) program. Refer to Section 01 81 13 – Sustainable Design Requirements for additional requirements.

In addition to complying with Division 26 drawings and specifications, equipment and material shall also comply with Section 01 81 13 and LEED requirements.

The Division 26 contractor will be expected to provide all required documentation, submittals, etc. in accordance with prerequisites and credits associated with Division 26 work and LEED Certification.

COMMISSIONING

The systems will be commissioned by an independent third party in accordance with USGBC LEED Energy and Atmosphere Credit C3 – Enhanced Commissioning. Refer to Sections 01 91 00 – Commissioning and 01 95 01 – Monitoring-Based Commissioning for additional requirements.

REGULATORY REQUIREMENTS

All work and materials are to conform in every detail to applicable rules and requirements of the Wisconsin State Electrical Code (SPS 316), the National Electrical Code (NFPA 70), other applicable National Fire Protection Association codes, the National Electrical Safety Code, and present manufacturing standards (including NEMA).

All Division 26 work shall be done under the direction of a currently licensed State of Wisconsin Master Electrician.

QUALITY ASSURANCE

Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space, and for obtaining the performance from the system into which these items are placed.

Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.

All materials shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable, and approved by City of Madison, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system shall be so labeled.

CONTINUITY OF EXISTING SERVICES AND SYSTEMS

No outages shall be permitted on existing systems except at the time and during the interval specified by the user agency and by the City of Madison Project Representative. The institution may require written approval. Any outage must be scheduled when the interruption causes the least interference with normal institutional schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours.

This Contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible. Note that institutional operations are on a seven-day week schedule.

PROTECTION OF FINISHED SURFACES

Furnish one can of touch-up paint for each different color factory finish furnished by the Contractor. Deliver touch-up paint with other "loose and detachable parts" as covered in the General Requirements.

APPROVED ELECTRICAL TESTING LABORATORIES

The following laboratories are approved for providing electrical product safety testing and listing services as required in these specifications:

Underwriters Laboratories Inc.
Electrical Testing Laboratories, Inc.

SLEEVES AND OPENINGS

Refer to Division 1, General Requirements, Sleeves and Openings.

SEALING AND FIRE STOPPING

Sealing and fire stopping of sleeves/openings between conduits, cable trays, wireways, troughs, cablebus, busduct, etc. and the sleeve, structural or partition opening shall be the responsibility of the contractor whose work penetrates the opening. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with section 07 84 00 Fire Stopping.

INTENT

The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.

If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship, which is the highest quality, largest, or most closely fits the City's intent (as determined by the City of Madison Project Manager). Refer to the General Conditions of the Contract for further clarification.

It must be understood that the details and drawings are diagrammatic. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.

All sizes as given are minimum except as noted.

Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to the City of Madison's and/or A/E's inspections, tests and approval from the commencement until the acceptance of the completed work.

Whenever a particular manufacturer's product is named, it is intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.

OMISSIONS

No later than ten (10) days before bid opening, the Contractor shall call the attention of the City of Madison to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

SUBMITTALS

Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and resubmission. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.

On request from the City of Madison, the successful bidder shall furnish additional drawings, illustrations, catalog data, performance characteristics, etc.

Submittals shall be grouped to include complete submittals of related systems, products, and accessories in a single submittal. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered equipment.

The submittals must be approved before fabrication is authorized.
Submit sufficient quantities of submittals to allow the following distribution:

Operating and Maintenance Manuals	2 copies
User agency	1 copy
A/E	1 copy

PROJECT/SITE CONDITIONS

Install Work in locations shown on drawings, unless prevented by project conditions.

Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of City of Madison before proceeding.

Tools, materials and equipment shall be confined to areas designated by the City of Madison.

WORK SEQUENCE AND SCHEDULING

Install work in phases to accommodate user agency's occupancy requirements. During the construction period coordinate electrical schedule and operations with City of Madison's Construction Representative.

WORK BY OTHER TRADES

Every attempt has been made to indicate in this trade's specifications and drawings all work required of this Contractor. However, there may be additional specific paragraphs in other trade specifications and addenda, and additional notes on drawings for other trades which pertain to this trade's work, and thus those additional requirements are hereby made a part of these specifications and drawings.

Electrical details on drawings for equipment to be provided by others are based on preliminary design data only. This Contractor shall lay out the electrical work and shall be responsible for its correctness to match equipment actually provided by others.

SALVAGE MATERIALS

No materials removed from this project shall be reused unless specifically noted otherwise. All materials removed shall become the property of and shall be disposed of by the Contractor.

CERTIFICATES AND INSPECTIONS

Obtain and pay for all required installation inspections.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

1. Manufacturer's wiring diagrams for electrically powered equipment.

RECORD DRAWINGS

The Contractor shall maintain at least one copy each of the specifications and drawings on the job site at all times.

The City of Madison will provide the Contractor with a suitable set of contract drawings on which daily records of changes and deviations from contract shall be recorded. Dimensions and elevations on the record drawings shall locate all buried or concealed piping, conduit, or similar items.

The daily record of changes shall be the responsibility of Contractor's field superintendent. No arbitrary mark-ups will be permitted.

At completion of the project, the Contractor shall submit the marked-up record drawings to the Architect/Engineer prior to final payment.

PART 2 - PRODUCTS

ACCESS PANELS AND DOORS

Lay-in Ceilings:
Removable lay-in ceiling tiles in 2 x 2 foot or 2 x 4 foot configuration provided under other divisions are sufficient; no additional access provisions are required unless specifically indicated.

IDENTIFICATION

See Electrical section 26 05 53 – Identification for Electrical Systems.

SEALING AND FIRE STOPPING

FIRE AND/OR SMOKE RATED PENETRATIONS:
Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with section 07 84 00 "Fire Stopping".

NON-RATED PENETRATIONS:
Conduit and Cable Tray Penetrations:
At conduit and cable tray penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between conduit and sleeve, or the core drilled opening.

PART 3 - EXECUTION

PAINTABILITY

Any/all electrical equipment, conduit, wiring, boxes, etc. that is to be exposed shall be painted to match the architectural colors throughout the construction limits. Provide the appropriate finish on all electrical equipment, conduit, wiring, boxes, etc. such that painting is possible. Coordinate all finish requirements with architectural documents.

CONCRETE WORK

The Division 3 Contractor will perform all cast-in-place concrete unless noted otherwise elsewhere. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for the support of electrical equipment.

CUTTING AND PATCHING

Refer to Division 1, General Requirements, Cutting and Patching.

BUILDING ACCESS

Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

EQUIPMENT ACCESS

Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Where access is required in plaster or drywall walls or ceilings, furnish the access doors to the General Contractor and reimburse the General Contractor for installation of those access doors.

COORDINATION

The Contractor shall cooperate with other trades and City of Madison in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost to the City of Madison, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.

The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to light fixtures, panelboards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.

Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

SLEEVES AND OPENINGS

Conduit penetrations in existing concrete floors: Core drill openings.

Where penetrating conduit weight is supported by floor, provide manufactured product or structural bearing collar designed to carry load.

SEALING AND FIRE STOPPING

FIRE AND/OR SMOKE RATED PENETRATIONS:

Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with section 07 84 00 Fire Stopping.

NON-RATED PENETRATIONS:

At all interior walls and exterior walls, conduit penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the sleeve or cored opening and the conduit is completely blocked.

PENETRATIONS SUBJECT TO WATER INTRUSION:

For penetrations (both rated and non-rated) in floors subject to water intrusion or in rooms housing electrical equipment (but not within walls) provide one of the following:

- Conduit penetration where steel pipe sleeve is used extend steel sleeve 2” above the floor.
- Conduit penetration where cast in place fire stopping device/sleeve is used, extend device/sleeve 2” above the floor (provided it meets the device’s UL listing).
- Conduit penetration where there is no steel sleeve or cast in place fire stopping device/sleeve, provide 2”x 2” x 1/8” galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8”on center. Seal corners water tight with urethane caulk.

Floors subject to water intrusion or rooms housing electrical equipment include the following locations:

- Restrooms
- Janitor Rooms w/ Sinks
- Mechanical/Plumbing Equipment Rooms
- Data/Telecommunications Rooms
- Electrical Equipment Rooms

Provide waterproof caulk sealant top coating on fire stopping system (or other approved means to protect the fire stopping system from water) in areas subject to wash down such as Food Service and Dish Washing Areas.

HOUSEKEEPING AND CLEAN UP

The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

AGENCY TRAINING

Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 4 hours.

END OF SECTION

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SECTION 26 05 02
ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

SCOPE

The work under this section includes the demolition associated with the addition and minor renovation of the existing Warner Park Community Recreation Center facility on Northport Drive in Madison, Wisconsin. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work

PART 2 - PRODUCTS
- Materials and Equipment

PART 3 - EXECUTION
- Examination
- Preparation
- Demolition and Extension of the Existing Electrical Work

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

PART 2 - PRODUCTS

MATERIALS AND EQUIPMENT

Materials and equipment for patching and extending work as specified in the individual Sections.

PART 3 - EXECUTION

EXAMINATION

Verify field measurements and circuiting arrangements as shown on Drawings.

Verify that abandoned wiring and equipment serve only abandoned facilities.

Demolition Drawings are based on casual field observation and/or existing record documents. Report discrepancies to the User Agency, Architect/Engineer, and City of Madison Field Representative before disturbing existing installation.

Beginning of demolition means installer accepts existing conditions.

PREPARATION

Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

Coordinate utility service outages with the User Agency, City of Madison Field Representative, and Architect/Engineer. Also, if applicable, coordinate utility service outages with the local Utility Company.

Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations and follow the safe working practice requirements of NFPA 70E.

Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the City of Madison Field Representative at least 48 hours before partially or completely disabling system. Minimize outage duration. If required, make temporary connections to maintain service in areas adjacent to work area.

Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Obtain permission from the City of Madison Field Representative and local Authority Having Jurisdiction at least 48 hours before partially or completely disabling system. Minimize outage duration. If required, make temporary connections to maintain service in areas adjacent to work area.

DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

Remove, relocate, and extend existing installations as necessary, to accommodate new construction and to meet all requirements of these specifications. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

Remove abandoned wiring to source of supply.

Remove exposed abandoned conduit and abandoned conduit above accessible ceiling finishes, unless noted otherwise on drawings. Cut conduit flush with walls and floors, and patch surfaces. If certain conduits and boxes are abandoned but not scheduled for removal, they shall be shown on the "As Built Drawings".

Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit and wiring servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

Provide revised typed circuit directory in panelboards that have circuits removed.

Repair adjacent construction and finishes damaged during demolition and extension work.

Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

Provide supplemental support for conduits that are routed through demolition area and are to remain. Supplemental support shall be added so that the conduit meets the support requirements of electrical specification section 26 05 33.

END OF SECTION

SECTION 26 05 04
CLEANING, INSPECTION, AND TESTING OF ELECTRICAL EQUIPMENT

PART 1 - GENERAL

SCOPE

The work under this section includes the required cleaning, inspection, adjustment, maintenance and testing of electrical equipment, as specified herein. This applies only to new electrical and existing electrical equipment being furnished, modified, worked on or serviced by this contractor for this project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work

PART 2 - PRODUCTS
- Not Used

PART 3 - EXECUTION
- General Inspection and Cleaning of All Electrical Equipment
- Grounding Systems
- Light Fixtures
- Occupancy Sensors

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

GENERAL INSPECTION AND CLEANING OF ALL ELECTRICAL EQUIPMENT

Inspect for physical damage and abnormal mechanical and electrical conditions.

Any item found to be out of tolerance, or in any other way defective as a result of the required inspection or testing, shall be reported to the City of Madison. Procedure for repair and/or replacement will be outlined. After appropriate corrective action is completed the item shall be re-tested.

Compare equipment nameplate information with the latest single line diagram and report any discrepancies.

Verify proper auxiliary device operation and indicators.

Check tightness of accessible bolted electrical joints. Use torque wrench method.

Make a close examination of equipment and remove any shipping brackets, insulation, packing, etc. that may not have been removed during original installation.

Make a close examination of equipment and remove any dirt or other forms of debris that may have collected in existing equipment or in new equipment during installation.

Clean All Equipment:
- Vacuum inside of panelboards, switchboards, switchgear, transformer core and coils, bus ducts, MCC's, fire alarm panels, communication/data panels, security panels, etc.
- Loosen attached particles and vacuum them away.
- Wipe all insulators with a clean, dry, lint free rag.
- Clean insulator grooves.

Inspect equipment anchorage.

Inspect equipment and bus alignment.

Check all heater elements for operation and control.

Lubricate nonelectrical equipment per manufacturer's recommendations.

GROUNDING SYSTEMS

Inspect the ground system for adequate termination at all devices.

LIGHT FIXTURES

Check the bonding and proper lamping. Verify that recessed fixtures are installed with hold down clips. Confirm operation of the fixture with the proper switch or sensor.

OCCUPANCY SENSORS

Confirm operation of the sensor per the manufacturer’s specification.

END OF SECTION

SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

SCOPE

The work under this section includes furnishing and installing required wiring and cabling systems including pulling, terminating and splicing. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Submittals
- Project Conditions

PART 2 - PRODUCTS
- General
- Building Wire
- Wiring Connectors

PART 3 - EXECUTION
- General Wiring Methods
- Wiring Installation in Raceways
- Wiring Connections and Terminations
- Field Quality Control
- Wire Color
- Branch Circuits

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 26 05 33 – Raceway and Boxes for Electrical Systems.
Section 26 05 53 – Identification for Electrical Systems.

REFERENCES

SPS 316- Electrical

SUBMITTALS

Submit product data: Provide for each cable assembly type.

Submit factory test reports: Indicate procedures and values obtained.

Submit shop drawings for modular wiring system including layout of distribution devices, branch circuit conduit and cables, circuiting arrangement, and outlet devices.

Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

PROJECT CONDITIONS

Verify that field measurements are as shown on Drawings.

Conductor sizes are based on copper.

Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required for project conditions.

Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 - PRODUCTS

GENERAL

All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.

All conductors shall be copper. All ground conductors shall be copper.

Insulation shall have a 600 volt rating.

All conductors shall be stranded.

> Stranded conductors may only be terminated with UL OR ETL Listed type terminations or methods: e.g. stranded conductors may not be wrapped around a terminal screw but must be terminated with a crimp type device or must be terminated in an approved back wired method.

BUILDING WIRE

Description: Single conductor insulated wire 90 degree C.

Insulation: Type THHN/THWN-2, XHHW-2 insulation.

WIRING CONNECTORS

Split Bolt Connectors: Not acceptable.

Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment terminals. Not approved for splicing.

Twist Type Wire Connectors: Solderless twist type spring connector (wire-nut) with insulating cover for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller. The manufacturer’s wire fill capacity must be followed. Use Silicone filled twist type spring connectors in all wet location areas.

Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.

Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic copper tubing; internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps. Connector must be installed with a crimper tool listed for use with the manufacturer and type of compression connector.

Insulation Piercing Connectors: Molded insulated body, copper teeth, wrench tightened, UL 486B Listed. May be used only for connection of a tap conductor in run and tap type applications when main conductor is 8 AWG and larger.

PART 3 - EXECUTION

GENERAL WIRING METHODS

All wire and cable shall be installed in conduit.

Do not use wire smaller than 12 AWG for power and lighting circuits.

All phase, neutral and ground conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity. As a minimum use 10 AWG conductors for 20 ampere, 120 volt branch circuit home runs longer than 100 feet (30 m), and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet (61 m).

Ground conductor size shall be increased per NEC 250.122(B) when phase and phase/neutral conductors are increased in size.

Make conductor lengths for parallel conductors equal.

Splice only in junction or outlet boxes.

No conductor less than 10 AWG shall be installed in exterior underground conduit.

Identify ALL low voltage wire, 600V and lower, per section 26 05 53.

Neatly train and lace wiring inside boxes, equipment, and panelboards.

WIRING INSTALLATION IN RACEWAYS

Pull all conductors into a raceway at the same time. Use Listed water or silicone based wire pulling lubricant for pulling 4 AWG and larger wires and for other conditions when necessary. Wax based lubricants are not allowed. Pulling lubricant is not required for low friction type products where the cable manufacturer recommends that cables be pulled without lube.

Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

Completely and thoroughly swab raceway system before installing conductors.

Place all conductors of a given circuit (this includes phase wires, neutral (if any), and ground conductor) in the same raceway. If parallel phase and/or neutral wires are used, then place an equal number of phase and neutral conductors in same raceway or cable.

In high ambient spaces, mechanical rooms, utility rooms and exterior exposed conduit, 90 degree C, XHHW-2 conductors shall be utilized.

WIRING CONNECTIONS AND TERMINATIONS

Splice only in accessible junction boxes.

Wire splices and taps shall be made firm, and adequate to carry the full current rating of the respective wire without soldering and without perceptible temperature rise.

All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.

Use solderless twist type spring connectors (wire nuts) with insulating covers for wire splices and taps, 10 AWG and smaller.

Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the wiring.

Thoroughly clean wires before installing lugs and connectors.

At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

FIELD QUALITY CONTROL

Field inspection and testing will be performed under provisions of Section 26 05 04.

WIRE COLOR

General:

Solid colored insulation is required for all THHN/THWN-2 wire. For other wire types use colored wire or identify wire with colored tape at all terminals, splices and boxes. Wire shall be colored as indicated below.

In existing facilities, use existing color scheme.

Switch legs shall be the same color as their associated circuit, except for the second switch leg used for dual-level switching. The second switch leg shall be the next phase color, e.g. if the first switch leg is brown (277/480V phase A), the second switch leg shall be orange (277/480V phase B).

Traveler conductors run between 3 and 4 way switches shall be colored pink or purple.

Neutral Conductors: White for 120/208V and 120/240V systems, Gray for 277/480V systems. Where there are two or more neutrals in one conduit, each shall be individually identified with a different stripe.

Branch Circuit Conductors: Three or four wire home runs shall have each phase uniquely color coded.

Feeder Circuit Conductors: Each phase shall be uniquely color coded.

Ground Conductors: Green colored insulation for THHN/THWN-2 wire. For other wire types use green colored wire or identify wire with green tape at both ends and at all access points, such as panelboards, motor starters, disconnects and junction boxes. When isolated grounds are required, contractor shall provide green with yellow tracer.

BRANCH CIRCUITS

The use of single-phase, multi-wire branch circuits with a common neutral is not permitted. All single-phase branch circuits shall be furnished and installed with an individual accompanying neutral, sized the same as the phase conductors.

END OF SECTION

SECTION 26 05 23
CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

SCOPE

The work under this section includes furnishing and installing cabling for remote-control, signaling and power-limited circuits. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Submittals
- Project Conditions

PART 2 - PRODUCTS
- General
- Remote-Control and Signaling Cable
- Wiring Connectors

PART 3 - EXECUTION
- General Wiring Methods
- Wiring Installation In Raceways
- Wiring Connections and Terminations
- Field Quality Control

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 26 05 33 – Raceway and Boxes for Electrical Systems.
Section 26 05 53 – Identification for Electrical Systems.

REFERENCES

NFPA 70 - National Electrical Code.

SUBMITTALS

Submit product data: Provide for each cable assembly type.

Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency.

PROJECT CONDITIONS

Verify that field measurements are as shown on Drawings.

Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 - PRODUCTS

GENERAL

All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.

All conductors shall be copper.

Insulation shall have a 600 volt rating.

All conductors shall be suitable for the application intended. Conductors #12 and smaller may be solid or stranded with the following requirements or exceptions:

All conductors terminated with crimp type devices shall be stranded.

Stranded conductors shall be terminated with UL OR ETL Listed type terminations or methods: e.g. stranded conductors shall not be wrapped around a terminal screw but shall be terminated with a crimp type device or in an approved back wired method.

REMOTE-CONTROL AND SIGNALING CABLE

Refer to Section 28 46 21 for requirements for cable to be used on fire alarm systems.

Refer to Sections 27 00 05 and 27 21 33 for requirements for cable to be used on communication systems.

All other systems cabling shall meet the requirements of NEC Article 725 and the following:

Cable for Class 1 Remote-Control, Signaling and Power-Limited Circuits: 600 volt insulation, individual conductors twisted together, shielded, and covered with an overall PVC jacket. Cable shall be Listed, temperature rated, and suitable Type (general purpose, riser or plenum) for the application as required in the National Electrical Code.

Cable for Class 2 or Class 3 Remote-Control, Signaling and Power-Limited Circuits shall be Listed, temperature rated, and suitable Type (general purpose, riser or plenum) for the application as required in the National Electrical Code.

WIRING CONNECTORS

Split Bolt Connectors: Not acceptable.

Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.

All wire connectors used in underground or exterior pull boxes shall be gel filled twist connectors or a connector designed for damp and wet locations.

PART 3 - EXECUTION

GENERAL WIRING METHODS

Control-voltage cables shall be installed in conduit. However, they may be installed free-air (without conduit) above accessible ceilings if the cable meets NEC requirements for the application, unless specified to be in conduit in other sections of the specifications. See requirements for free-air cable installation below.

Do not use wire smaller than 14 AWG for control wiring greater than 60 volts, or 18 AWG for voltages less than 60 volts, all sizes subject to NEC 725 requirements.

Splice only in junction boxes.

Identify wire per section 26 05 53.

Neatly train and lace wiring inside boxes, and equipment.

WIRING INSTALLATION IN RACEWAYS

Pull all conductors into a raceway at the same time. Use Listed wire pulling lubricant for pulling conditions when necessary.

Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

WIRING CONNECTIONS AND TERMINATIONS

Splice only in accessible junction boxes (except splices to low voltage occupancy sensor power packs and terminations to temperature control devices).

All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.

Use solderless spring type pressure connectors with insulating covers for wire splices and taps, 10 AWG and smaller.

Thoroughly clean wires before installing lugs and connectors.

At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

FIELD QUALITY CONTROL

Field inspection and testing will be performed under provisions of Section 26 05 04.

END OF SECTION

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SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

SCOPE

The work under this section includes equipment grounding conductors, and bonding for Electrical and Communications systems. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Regulatory Requirements

PART 2 - PRODUCTS
- Mechanical Connectors
- Compression Connectors
- Conductors
- Bus/Busbar

PART 3 - EXECUTION
- General
- Less Than 600 Volt System Grounding
- Communication System Grounding
- Field Quality Control
- Identification and Labeling
- Construction Verification Items
- Warranty

All hardware, cables and related termination and support hardware shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in this and related sections.

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

REFERENCES

ANSI/IEEE 142 (Latest edition) - Recommended Practice for Grounding of Industrial and Commercial Power Systems
UL 467 Electrical Grounding and Bonding Equipment
IEEE 837 - IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
TIA-607-C - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

REGULATORY REQUIREMENTS

Conform to requirements of NFPA 70.

Furnish products listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

PART 2 - PRODUCTS

MECHANICAL CONNECTORS

The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lock washers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt type.

Split bolt connector types are NOT allowed. Exception: the use of split bolts is acceptable for grounding of wire-basket type cable tray, and for cable shields/straps of medium voltage cable.

The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

COMPRESSION CONNECTORS

The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.

Each connector shall be factory filled with an oxide-inhibiting compound.

The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.

The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.

The installation of the connectors shall be made with a compression tool and die system, as recommended by the manufacturer of the connectors, and shall be irreversible.

Pre-crimping of the ground rod is required for all irreversible compression connections to a ground rod.

Terminal lug for communication system grounding shall be compression type and conform to the following:

Material: Tin Plated Copper (aluminum not permitted).
Wire Size: to match conductor
Number of Stud Holes: 2
Stud Hole Size: 3/8”
Bolt Hole Spacing: per TIA-607-C
Tongue Angle: Straight

CONDUCTORS

Material: Stranded copper (aluminum not permitted).

Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Differentiate between the normal ground and the isolated ground when both are used at the same facility.

Branch Circuit Equipment Ground shall be proportionately increased in size when routed with phase conductors increased in size.

Conductors for Telecommunications shall be as follows:

Telecommunications Bonding Conductor (TMGB to Service Ground): No. 3/0 minimum or as shown on drawings.
Telecommunications Bonding Backbone (TBB; TMGB to TGB): No. 3/0 minimum or as shown on drawings.
Telecommunications Grounding Equalizer (GE): No. 3/0 minimum or as shown on drawings.
Bonding Conductors shall be insulated with a Green Jacket or jacket marked with Green Tape or labeled per NEC Guidelines.

BUS/BUSBAR

Material: Copper (aluminum not permitted).

Size:

All Power systems: 1/4" X 2", length as needed (24” minimum).
Telecommunications Main Ground Busbar (TMGB): 1/4" x 4" x 20" long (minimum).
Telecommunications Grounding Busbar (TGB): 1/4" x 2" x 12" long (minimum).

Busbars:

Be pre-drilled to accommodate two-hole lugs.
3/8” stud hole size; hole spacing per TIA-607-C.
Incorporate insulators and stand-off brackets that electrically isolate busbar from mounting surface.

Provide main ground busbar located adjacent to main electrical service equipment to terminate all ground conductors. Refer to grounding detail on plans.

PART 3 - EXECUTION

GENERAL

Install Products in accordance with manufacturer's instructions.

Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.

Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.

Attach grounds permanently before permanent building service is energized.

Terminate each grounding conductor on its own terminal lug. Sharing a single lug by multiple conductors is not allowed.

All grounding electrode conductors and individual grounding conductors shall be installed in PVC conduit, in exposed locations.

LESS THAN 600 VOLT ELECTRICAL SYSTEM GROUNDING

Equipment Grounding Conductor: Provide separate, insulated equipment grounding conductor within each raceway. Terminate each end on suitable lug, bus, enclosure or bushing. Provide a ground wire from each device to the respective enclosure.

Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

COMMUNICATION SYSTEM GROUNDING

Grounding and Bonding System for Communications shall be an isolated grounding system with a single ground point. That ground point is to be the common grounding electrode system at the building electrical service entrance (main ground bar located in electrical room).

The system shall be compliant with ANSI J-STD-607-B with the exception that the ground cable shall not be bonded to building steel except at the electrical service entrance.

Provide Grounding Busbar for Telecommunications at each Telecommunications Room, the Main Equipment Room and at the electrical service entrance per project drawings. Coordinate Busbar location(s) and conductor routing per drawings with Division 27 contractor.

Provide Telecommunications Bonding Conductor from Telecommunications Main Grounding Busbar (TMGB) at the Communications Entrance Facility to building common grounding electrode system. Attach grounding conductor to building steel as allowed only at the main electrical service entrance. Provide physical protection as required.

Provide Telecommunications Bonding Backbone (TBB) conductor from the TMGB to Telecommunications Grounding Busbar (TGB) at each Telecommunication Room, Telecommunications Equipment Room and Telecommunications Enclosure.

- TBB shall be continuous and not connected through Telecommunications Grounding Busbars (TGBs).
- Bond TGBs to TBB via tap off of TBB. Gauge of conductor to be same at TBB.
- Leave 10 feet slack in conductor from TBB to TGB at TGB location(s).
- Do not bond TBB or TGB to building steel at TGB location(s).

FIELD QUALITY CONTROL

Inspect grounding and bonding system conductors and connections for tightness and proper installation.

Provide resistance test at each electrical and telecommunications Busbar to ground.

IDENTIFICATION AND LABELING

Label Grounds at point of termination.

CONSTRUCTION VERIFICATION

Record locations of all electrical and telecommunications grounding electrodes, busbars and grounding conductors as installed including recorded ground resistance test results.

WARRANTY

See Division 1, General Conditions, and General Requirements.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

SCOPE

The work under this section includes conduit and equipment supports, straps, clamps, steel channel, etc., and fastening hardware for supporting electrical work. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Submittals
- Quality Assurance

PART 2 - PRODUCTS
- Material

PART 3 - EXECUTION
- Installation

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 26 05 53 – Identification for Electrical Systems

SUBMITTALS

Product Data: Provide data for support channel.

QUALITY ASSURANCE

Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 - PRODUCTS

MATERIAL

Support Channel

- Epoxy Painted:
  - Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS Grade 33, then painted with water born epoxy applied by a cathodic electro-deposition process.
  - All fittings and hardware shall be zinc plated in accordance with ASTM B633 (SC3 for fittings, SC1 for threaded hardware).
- Hot-dip Galvanized Steel:
  - Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 and shall be hot-dip galvanized after fabrication in accordance with ASTM A123.
  - Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33, and hot-dip galvanized after fabrication in accordance with ASTM A123.
  - All hardware shall be stainless steel Type 304 or chromium zinc ASTM F1136 Gr. 3.
  - All hot-dip galvanized after fabrication products must be returned to point of manufacture after coating for inspection and removal of all sharp burrs.
- Stainless Steel:

- All strut, fittings and hardware shall be made of AISI Type 304 or Type 316 stainless steel as indicated.

Conduit Supports

- Conduit clamps, straps, supports, etc., shall be steel or malleable iron.

- One-hole straps shall be heavy duty type. All straps shall have steel or malleable backing plates when rigid steel conduit is installed on the interior or exterior surface of any exterior building wall.

- Above suspended ceilings, bar joist conduit hangers: Spring Steel Clips with Snap-Close Clamps (Conduit Supports): Conduit clamps shall pivot a full 360 degrees and shall snap close around the conduit. Push-in type conduit clamps are not allowed. Spring clips shall require a hammer to install onto supporting surface.

- Stud wall applications: Spring Steel Clips with Push-in or Snap-Close Conduit Clamps (Conduit Supports): Conduit clamps shall pivot a full 360 degrees. Spring clips shall require a fastener to install onto stud.

- Box/conduit hanger with rod/wire clip (a.k.a. antlers): One assembly provides support for electrical box and conduit from drop wire or rod. Conduit clamps shall snap close around the conduit.

- Spring Steel Clip products shall be provided with corrosion resistance and be warranted against failure from corrosion for a period of ten (10) years from date of manufacture.

Threaded Rod: Minimum sized threaded rod for supports shall be 3/8" for trapezes and single conduits 1-1/4" and larger, and ¼" for single conduits 1" and smaller.

Hardware: Corrosion resistant, or as noted for each product above.

PART 3 - EXECUTION

INSTALLATION

Fasten hanger rods, conduit clamps, and outlet-, junction-, and pull-boxes to building structure using pre-cast insert system, preset inserts, beam clamps, or expansion anchors.

Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs and wood screws in wood construction. If nail-in anchors are used, they must be removable type anchors.

Powder-actuated fasteners are not permitted.

Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit. Do not fasten to suspended ceiling grid system.

Do not drill structural steel members unless approved by City of Madison.

Furnish and install all supports as required to fasten all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.

Fabricate supports from galvanized structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

Support Channel

Use one of the following types of support channel as appropriate for the installed environment:

- Indoor: Epoxy Painted Steel, Hot-dipped Galvanized Steel, or as noted on the drawings.

- Exterior and wet locations: Hot-dipped Galvanized Steel or Stainless Steel, as appropriate for the environment or as noted on the drawings. Type 316 stainless steel shall be used for Food Service type environments. Epoxy painted support channel shall not be used for exterior installations.

- Field cuts: File and de-bur cut ends of support channel and paint to prevent rusting. For epoxy-painted support channel, paint cut ends to match the original color. For hot-dipped galvanized support channel, spray cut ends with cold galvanized paint.

Support Wires

- Support wires that are installed in addition to the ceiling grid support wires to provide secure support for raceways, cables assemblies, boxes, cabinets, and fittings shall be secured at both ends (e.g. the ceiling structure at the top and the ceiling grid at the bottom) per NEC 300.11(A).

- Compressed-air power-actuated fasteners may ONLY be used for the installation of separate ceiling wires required for support of conduits and aircraft cable hung light fixtures.

- Support wires shall be identified per specification section 26 05 53.

Spring Steel Clip Conduit Supports

- Above suspended ceilings: Spring steel clips with snap-close clamps may be used to support conduit from bar joist (steel truss) systems above suspended ceilings.

- Stud wall applications: Spring steel clips with push-in or snap-close conduit clamps may be used to support conduit in interior metal stud wall applications. Use screw fasteners to install conduit clamp onto stud.

- Box/conduit hanger with rod/wire clip (a.k.a. antlers): These may only be used in limited applications with the pre-approval of the State of Wisconsin Electrical Inspector.

END OF SECTION

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SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

SCOPE

This section describes the products and execution requirements relating to furnishing and installing raceways and boxes and related systems as part of a raceway system for electrical, communications, and other low-voltage systems for the project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Submittals

PART 2 - PRODUCTS
- General
- Rigid Metal Conduit (RMC) and Fittings
- PVC Coated Rigid Metal Conduit
- Intermediate Metal Conduit (IMC) and Fittings
- Electrical Metallic Tubing (EMT) and Fittings
- Liquidtight Flexible Metal Conduit (LFMC) and Fittings
- Conduit Supports
- Pull and Junction Boxes
- Outlet Boxes
- Boxes for Audio-Video Equipment
- Boxes for Fire Alarm Audio-Visual Notification Appliances

PART 3 - EXECUTION
- Conduit Sizing, Arrangement, and Support
- Conduit Installation
- Conduit Installation Schedule
- PVC Coated Rigid Metal Conduit Installation
- Coordination of Box Locations
- Pull and Junction Box Installation
- Outlet Box Installation
- Audio-Video System Box and Conduit Installation

RELATED WORK

Applicable provisions of Division 1 govern work under this section.

Section 26 05 26 – Grounding and Bonding for Electrical Systems
Section 26 05 29 – Hangers and Supports for Electrical Systems
Section 26 27 02 – Equipment Wiring Systems
Section 26 27 26 – Wiring Devices.

REFERENCES

ANSI/TIA-569-C-Telecommunications Pathways and Spaces

SUBMITTALS

Boxes - provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

PART 2 - PRODUCTS

GENERAL

All steel fittings and conduit bodies shall be galvanized.

No cast metal or split-gland type fittings permitted.

Mogul-type condulets larger than 2 inch (50 mm) not permitted except as approved or detailed.

All condulet covers must be fastened to the condulet body with screws and be of the same manufacture.

C-condulets shall not be used in lieu of pull boxes.

All boxes shall be of sufficient size to provide free space for all conductors enclosed in the box and shall comply with NEC requirements.

RIGID METAL CONDUIT (RMC) AND FITTINGS

Conduit: Heavy wall threaded, galvanized steel, schedule 40.

Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

Expansion Fittings/Expansion Joints: Expansion Fittings shall be Internal Grounding type and shall not rely on external bonding jumpers to maintain grounding continuity between raceway components.

PVC COATED RIGID METAL CONDUIT

PVC Externally Coated Conduit: Rigid heavy wall, schedule 40, steel conduit with external 40 mil (0.1 mm) PVC coating. Conduit must be hot dipped galvanized inside and out including threads. The PVC coating bond to the galvanized steel conduit shall be stronger than the tensile strength of the coating itself.

Fittings and Conduit Bodies: Threaded type, material to match conduit. PVC coated fittings and couplings shall have specially formed sleeves to tightly seal to conduit PVC coating. The sleeves shall extend beyond the fitting or coupling a distance equal to the pipe outside steel diameter or two inches (50 mm) whichever is greater.

INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

Conduit: Galvanized steel, threaded.

Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

Expansion Fittings/Expansion Joints: Expansion Fittings shall be Internal Grounding type and shall not rely on external bonding jumpers to maintain grounding continuity between raceway components.

ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

Conduit: Steel, galvanized tubing.

Fittings: All steel, set screw type. No push-on or indenter types permitted.
Conduit Bodies: All steel threaded conduit bodies.

LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC) AND FITTINGS

Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.

Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

RIGID POLYVINYL CHLORIDE CONDUIT (PVC) AND FITTINGS

Conduit: Rigid non-metallic conduit, Schedule 40 PVC minimum, Listed, sunlight resistant, rated for 90^0 C conductors. Schedule 80 for locations exposed to physical damage or as required.

Fittings and Conduit Bodies: NEMA TC 2, Listed.

CONDUIT SUPPORTS
See section 26 05 29.

PULL AND JUNCTION BOXES
Interior Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot welded joints and corners.

Interior Sheet Metal Boxes larger than 12 inches (300 mm) in any dimension shall have a hinged cover or a chain installed between box and cover.

Boxes 9 square feet and larger shall have hinged covers. Single covers shall not exceed 10 square feet.

Interior Sheet Metal Boxes connected to an exterior underground raceway shall have a drain hole located in the bottom of the box.

Exterior Boxes and Wet Location Installations: Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as rain-tight. PVC box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

Box extensions and adjacent boxes within 48 inches of each other are not allowed for the purpose of creating more wire capacity.

Junction boxes 6 inch-by-6 inch or larger size shall be without stamped knock-outs.

Wireways shall not be used in lieu of junction boxes.

OUTLET BOXES
Sheet Metal Outlet Boxes: galvanized steel, with stamped knockouts.

Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.

Concrete Ceiling Boxes: Concrete type.

Cast Boxes: Cast ferroalloy or aluminum, deep type, gasketed cover, threaded hubs.

BOXES FOR AUDIO-VIDEO EQUIPMENT
Provide floor, wall, and/or ceiling boxes for Audio-Video (AV) Equipment as indicated on the Electrical and/or Audio-Video drawings.

FLAT SCREEN MONITOR BOXES
Provide a recessed wall box for mounting behind flat screen monitors, allowing the screens to sit flush against the wall. These boxes shall provide a neat and secure environment for the audio, video, control and power connections.

The recessed wall box shall install easily between any two standard studs in the wall. Connections and cable entry can be on the top or the bottom depending on installation preference.

The recessed wall box shall be provided with one low-voltage conduit entry box and Nationally Recognized Testing Laboratory (NRTL) listed single gang box for AC power.
The recessed wall box cover shall be provided in white or black and shall be suitable for painting. The cover shall have a cable exit slot for the display connections and the excess cable can easily be hidden inside of the box making the entire installation as clean as possible. The cover screws onto the front of the box once all connections are in place.

The recessed wall box shall be designed for new or existing construction. Brackets shall be included for mounting to studs in new construction as well as surface mount clips for mounting to sheet rock or plywood in existing construction.

BOXES FOR FIRE ALARM AUDIO-VISUAL NOTIFICATION APPLIANCES

Recessed boxes for Fire Alarm audio, visual, and audio-visual notification appliances shall be galvanized steel sheet metal with stamped knockouts. Boxes shall be painted red.

For surface mounting, use manufacturer supplied back boxes and trim plates, painted red or off white to match device color, and shall contain no visible conduit knock-outs. Mark each device with its circuit number.

PART 3 - EXECUTION

CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

EMT is permitted to be used in sizes 4 inch (100 mm) and smaller for power and low-voltage systems. See CONDUIT INSTALLATION SCHEDULE below for other limitations for EMT and other types of conduit.

Size power conductor raceways for conductor type installed. Conduit size shall be 1/2 inch (16 mm) minimum except **all homerun conduits shall be 3/4 inch (21 mm),** or as specified elsewhere. **Caution: Per the NEC, the allowable conductor ampacity is reduced when more than three current-carrying conductors are installed in a raceway. Contractor must take the NEC ampacity adjustment factors into account when sizing the raceway and wiring system.**

Size communications and other low-voltage systems raceways as follows:

Communications, including Outlet Box: 1 inch minimum. Conduit used for single device locations (e.g. Wireless Access Point, Video Surveillance Camera, and Wall mounted telephone) may be 3/4 inch minimum.

Control, security, signal, video, and other low-voltage applications: 3/4 inch minimum.

Fire Alarm: 1/2 inch minimum.

Provide one raceway from each communications outlet box to above accessible ceiling.

Arrange conduit to maintain 6’-8” clear headroom and present a neat appearance.

Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

Maintain minimum 6 inch (150 mm) clearance between conduit and piping. Maintain 12 inch (300 mm) clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.

Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay-in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.

Group conduit in parallel runs where practical and use conduit rack (lay-in adjustable hangers) constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.

Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.
Support and fasten metal conduit at a maximum of 8 feet (2.4 m) on center.

Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, other conduits, etc., unless so approved or detailed.

Conceal all conduits except where noted on the drawings or approved by the Architect/Engineer. Contractor shall verify with Architect/Engineer all surface conduit installations except in mechanical rooms.

Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.

For indoor conduits, no continuous conduit run shall exceed 100 feet (30 meters) without a junction box.

All conduits installed in exposed areas shall be installed with a box offset before entering box.

CONDUIT INSTALLATION

Cut conduit square; de-burr cut ends.

Conduit shall not be fastened to the corrugated metal roof deck.

Bring conduit to the shoulder of fittings and couplings and fasten securely.

Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations.

Threads cut in the field, and factory threads of conduit and nipples not coated with corrosion protection, shall be coated with an approved electrically conductive corrosion compound per NEC 300.6.
Corrosion inhibitor, when used in a food service environment, shall be approved for Food Service locations.

Terminate all conduit (except for terminations into conduit bodies) using conduit hubs, or connectors with one locknut, or utilize double locknuts (one each side of box wall).

Provide bushings for the ends of all conduit not terminated in a box. Refer to Section 26 05 26 – Grounding and Bonding for Electrical Systems for grounding bushing requirements.

Provide insulated bushings where raceways contain 4 AWG or larger conductors.

Communication and Low Voltage systems conduits shall terminate in horizontal plane.

Install no more than the equivalent of:

Three 90 degree bends between boxes for electrical systems.

Two 90 degree bends between boxes for communications and other low voltage systems. Note: Offsets shall be considered 90 degrees.

No single bend may exceed 90 degrees.

Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch (50 mm) size unless sweep elbows are required.

Bend conduit according to manufacturer's recommendations. Torches or open flame shall not be used to aid in bending of PVC conduit.

Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.

Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.

Install listed expansion-deflection fitting or other approved means shall be used where a raceway crosses a structural joint for expansion, contraction or deflection, used in buildings, bridges, parking garages or other structurers.

Route conduit through roof openings for piping and ductwork where possible.

Where communication cabling is to be installed in conduit to the wiring hub (e.g. Telecom Room), multiple conduits may be consolidated into fewer, larger conduits. Capacity of shared conduits shall equal the capacity of the individual conduits unless otherwise noted.

Use NRTL listed metallic grounding clamps when terminating conduit to cable tray.

Ground and bond conduit under provisions of Section 26 05 26.

Conduit is not permitted in any slab topping of two inches (50 mm) or less.

PVC conduit in concrete pole bases shall transition to galvanized rigid metal conduit 12 inches before it enters a concrete pole base. Inside the pole base, the elbow shall be galvanized rigid metal conduit. From the elbow, the conduit shall transition back to PVC as it continues up and out the top of the concrete pole base.

PVC conduit shall transition to galvanized rigid metal conduit before it enters a foundation wall or up through a concrete floor.

Identify conduit under provisions of Section 26 05 53.

Clean PVC conduit with solvent, and dry before application of glue. The temperature rating of glue/cement shall match weather conditions. Apply full even coat of cement/glue to entire area that will be inserted into fitting. The entire installation shall meet manufacturer's recommendations.

CONDUIT INSTALLATION SCHEDULE

Conduit other than that specified below for specific applications shall not be used.

- Wet Interior Locations: Exposed: Rigid Metal conduit, Schedule 80 PVC conduit, PVC coated Rigid Metal conduit.
- Concealed Dry Interior Locations: Rigid Metal conduit, Intermediate Metal conduit, Electrical Metallic Tubing.
- Interior Building Grounding Electrode Conductor: Schedule 80 PVC.
- Exposed Dry Interior Locations: Rigid Metal conduit, Intermediate Metal conduit, Electrical Metallic Tubing.
- Motor and equipment connections: Liquidtight flexible metal conduit (LFMC) (all locations). Minimum length shall be one foot (300 mm); maximum length shall be three feet (900 mm). Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
- Light fixtures: Refer to specification section 26 51 13.

PVC COATED RIGID METAL CONDUIT INSTALLATION

Installers of PVC Coated Rigid Metal Conduit shall be factory trained and certified in the proper installation methods for this type of conduit. Proof of such certification shall be kept on the project site at all times and shall be produced upon request.

COORDINATION OF BOX LOCATIONS

Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

No outlet, junction, or pull boxes shall be located where it will be obstructed by other equipment, piping, lockers, benches, counters, etc.

Conduit and boxes shall not be fastened to the metal roof deck. If conduit and boxes are required to be located and installed on roof decks, the conduit and boxes are required to be spaced minimum 1-5/8 inch off the lowest part of the metal roof decking material, per NEC 300.4 (E).

It shall be the Contractor's responsibility to study drawings pertaining to other trades, to discuss location of outlets with workmen installing other piping and equipment and to fit all electrical outlets to job conditions.

In case of any question or argument over the location of an outlet, the Contractor shall refer the matter to the Architect/Engineer and install outlet as instructed by the Architect/Engineer.

The proper location of each outlet is considered a part of this contract and no additional compensation will be paid to the Contractor for moving outlets which were improperly located.

Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 inch (450 mm) by 24 inch (600 mm) access doors. Boxes must be installed within 12" from edge of the access door.

Locate and install to maintain headroom and to present a neat appearance.

Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.

PULL AND JUNCTION BOX INSTALLATION

Boxes shall be minimum 4 inches square (100 mm) by 2 1/8 inches (54 mm) deep for use with 1 inch (25 mm) conduit and smaller. On conduit systems using 1 1/4 inch (31.75 mm) conduit, minimum box size shall be 4 11/16 inches square by 2 1/8 inches deep.

Where used with raceway(s) containing conductors of 4 AWG or larger, box shall be sized as required unless otherwise noted on the drawings.

Where used with raceway(s) containing conductors on systems over 600V, size box per NEC 314 Part IV unless otherwise noted as larger on the drawings.

Size boxes for communications per ANSI/TIA-568-C.

Locate boxes above accessible ceilings, in unfinished areas or furnish and install approved access panels in non-accessible ceilings where boxes are installed. All boxes are to be readily-accessible.

Provide boxes for communications and other low voltage applications (a) in any section of conduit longer than 100 feet, (b) where there are bends totaling more than 180 degrees between pull points or pull boxes and (c) wherever there is a reverse bend in run. Locate boxes on straight section of raceway (e.g. do not use boxes in place of raceway bends).

Support boxes independent of conduit.

OUTLET BOX INSTALLATION

Do not install boxes back-to-back in walls. Provide minimum 6 inch (150 mm) separation, except provide minimum 24 inch (600 mm) separation in acoustic-rated walls.

Power:

Recessed (1/4 inch maximum) outlet boxes in masonry, concrete, tile construction, or drywall shall be minimum 4 inch square, with device rings. Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes. A single gang box can be used in drywall and masonry, for a single device location, when a single conduit enters box.

Shallow 4 inch square by 1 1/2 inch deep boxes can be used as device boxes for power provided the box and plaster ring is sized for installed device and conductors.

Low Voltage:

Recessed (1/4 inch maximum) outlet boxes in masonry, concrete, tile construction or drywall shall be minimum 4 11/16 inch square by 2 1/8 inch deep with single gang device ring (unless noted otherwise on drawings). Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes.

Provide one conduit from each communications outlet box. Conduit runs between outlet boxes for communications are not allowed. Terminate conduit above accessible ceiling in corridor.

Provide knockout closures for unused openings.

Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches (300 mm) of box.

Use multiple-gang boxes where more than one device are mounted together; do not use sectional boxes. Provide non-metallic barriers to separate wiring of different voltage systems.

Install boxes in walls without damaging wall insulation.

Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

Ceiling outlets shall be 4 inch square, minimum 2 1/8 inch (54 mm) deep except that concrete boxes and plates will be approved where applicable. Position outlets to locate luminaires as shown on reflected ceiling plans.

In inaccessible ceiling areas, position outlets and junction boxes within 6 inches (150 mm) of recessed luminaire, to be accessible through luminaire ceiling opening.

Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

Provide cast ferroalloy or aluminum outlet boxes in exterior and wet locations.

Surface wall outlets shall be 4 inch (100 mm) square with raised covers for one and two gang requirements. For three gang or larger requirements, use gang boxes with non-overlapping covers.

AUDIO-VIDEO SYSTEM BOX AND CONDUIT INSTALLATION

Conduit requirements for AV systems cabling may differ from those of other trades. It is important that the electrical contractor become familiar with these specialized requirements. AV systems cabling must be enclosed within continuously grounded ferrous metallic conduit or raceway. PVC conduit is not acceptable. Conduit and raceway is to be furnished and installed by electrical contractor. Conduits containing different wiring classes must maintain minimum separations to minimize interferences from electrical noise. Conduits sizes and quantities shown on bid documents are minimums. Separate conduit runs specified in bid documents may not be combined for any purpose.

Conduit runs entering or exiting the audio equipment racks shall be electrically isolated from the racks. PVC or other non-conductive fittings shall be used to isolate the conduit from the audio equipment racks.

Provide AV boxes as shown on the Electrical and/or Audio-Video drawings. Install boxes at heights and locations as indicated on the drawings. Coordinate all box installations with the AV equipment provider.

Flat screen monitor boxes shall be installed so that all cabling is concealed behind the monitor. Coordinate box location with flat screen mounting brackets so that the box cover and cables are not blocked by the brackets.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

SCOPE

The work under this section includes the products and execution requirements relating to labeling of power, control, signaling and fire alarm wiring. Further, this section includes the installation of labels, nameplates, and directories for electrical boxes, wiring devices, and equipment. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Submittals

PART 2 - PRODUCTS
- Materials

PART 3 - EXECUTION
- General
- Box Identification
- Communication Conduit Labeling
- Power, Control and Signal Wire Identification
- Wiring Device Identification
- Support Wire Identification
- Nameplate Engraving for Electrical Equipment
- Panelboard Directories

RELATED WORK

Applicable provisions of Division 1 shall govern work under this section.

Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
Section 26 05 23 – Control-Voltage Electrical Power Cables

SUBMITTALS

Include schedule for nameplates.

Prior to installation, the Contractor shall provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8 1/2" x 11" sheets annotated, explaining their purposed use.

PART 2 - PRODUCTS

MATERIALS

Labels: All labels shall be permanent, and machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED.

Wire Labels: All wiring labels shall be white/transparent vinyl or vinyl-cloth, self-laminating, wraparound type. Flag type labels are not allowed. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminate over the full extent of the printed area of the label.

Tape (wiring phase identification only): Scotch #35 tape in appropriate colors for system voltage and phase.

Nameplates: Engraved three-layer laminated plastic. Normal system shall use nameplates with black letters on white background, emergency system (NEC 700) shall use white letters on red background.

See Box Identification and Wiring Device Identification sections for allowed usage of permanent marker.

PART 3 - EXECUTION

GENERAL

Where mixed voltages are used in one building (e.g. 4160 volt, 480 volt, 208 volt) each switch, switchboard, junction and pull box, equipment, etc., on each system shall be labeled for voltage in addition to other requirements listed herein.

All branch circuit and power panels shall be identified with the same symbol used in circuit directory in main distribution center.

Clean all surfaces before attaching labels with the label manufacturer's recommended cleaning agent. Install all labels firmly as recommended by the label manufacturer. Labels shall be installed plumb and neatly on all equipment.

Install nameplates parallel to equipment lines. Secure nameplates to equipment fronts using screws, rivets or manufacturer approved adhesive or cement.

Embossed tape shall not be permitted for any application.

Provide all warning labels to electrical equipment as required per NEC 110.16 and 110.21. Provide available fault current labeling to service equipment as required per NEC 110.24.

Fire pump disconnecting means shall be marked as "Fire Pump Disconnecting Means", per NEC 695.4(B)(3)(c).

BOX IDENTIFICATION

The following junction and pull boxes shall be identified utilizing spray painted covers:

System	Color(s)
Secondary Power – 480Y/277V	Brown
Secondary Power – 208Y/120V, 240/120V	White
Fire Alarm (see below)	Red
Temperature Control	Green
Door Access Control	Orange
Communications	Blue

All boxes with power wiring shall be further identified with circuit numbers and source panel designation as follows:

- All outlet and device boxes shall use machine-generated adhesive labels, or neatly hand-written permanent marker.
- All exposed junction and pull boxes larger than 8" square shall utilize engraved nameplates with ½" minimum letter height. All exposed junction and pull boxes 8" square or smaller shall utilize machine-generated adhesive labels.
- All junction and pull boxes located above an accessible ceiling shall utilize machine-generated adhesive labels, or neatly hand-written permanent marker.

All fire alarm boxes (covers and outer sides) shall be painted red and labeled "Fire Alarm" or "FA". When red conduit is used for the alarm system installation, there is no need to paint the box sides, - paint the covers only. Non-factory device boxes shall also be painted red.

Other system boxes shall be further identified as shown on drawing details or approved shop drawings.

COMMUNICATIONS CONDUIT LABELING

Provide label on all conduits installed between Telecommunication Equipment Rooms. Both ends of the conduits shall be labeled. All labels shall be mechanical, no hand-written labels.

The label shall indicate the location of the far end of the conduit run and a unique conduit number. (i.e. TR-1A-01 or Room #216 – 01). Refer to agency standards where applicable.

POWER, CONTROL AND SIGNALING WIRE IDENTIFICATION

Provide wire labels on each conductor in panelboard gutters, all boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control and signaling wires.

All wiring shall be labeled within 2 to 4 inches of terminations. Each end of a wire or cable shall be labeled as soon as it is terminated, including wiring used for temporary purposes.

WIRING DEVICE IDENTIFICATION

Wall switches, receptacles, occupancy sensors, photocells, poke-through fittings, access floor boxes, and time clocks shall be identified with circuit numbers and source (ex. Panel ABC-3). In exposed areas, identifications should be made inside of device covers, unless directed otherwise. Use machine-generated adhesive labels, or neatly hand-written permanent marker.

SUPPORT WIRE IDENTIFICATION

Support wires that are installed in addition to the ceiling grid support wires to provide secure support for raceways, cables assemblies, boxes, cabinets, and fittings shall be distinguishable from the ceiling grid support wires per NEC 300.11(A). This identification shall be either approximately 6 inches of fluorescent orange paint, or orange tape flags 3/4 inches high-by-2 inches wide (minimum) within 12 inches of the bottom of the support wires.

NAMEPLATE ENGRAVING FOR ELECTRICAL EQUIPMENT

Provide nameplates of minimum letter height as scheduled below.

All Panelboards (Distribution, Branch, Sub-feed, and Feed-Through), Switchboards and Motor Control Centers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify voltage rating, source and room location of the source. Panelboards serving NEC 700, 701 or 702 loads shall identify which branch they serve. Both panels in a double tub application shall be labeled.

Circuit Breakers, Switches, and Motor Starters in Distribution Panelboards, Switchboards and Motor Control Centers: 1/2 inch (13 mm); identify circuit number and load served, including location.

Individual Circuit Breakers, Disconnect Switches, Enclosed Switches, and Motor Starters: ½ inch (13 mm); identify source and load served.

PANELBOARD DIRECTORIES

Update existing directories with typed directories.

Typed directories for panelboards shall be covered with clear plastic, and have a metal frame. Room number on directories shall be Owner's numbers, not Plan numbers unless Owner so specifies.

END OF SECTION

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SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

SCOPE
The work under this section includes branch circuit panelboards. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Submittals
- Operation and Maintenance Data
- Spare Parts

PART 2 - PRODUCTS
- Branch Circuit Panelboards
- Coordination of Overcurrent Protective Devices

PART 3 - EXECUTION
- Installation
- Field Quality Control

RELATED WORK
Applicable provisions of Division 1 govern work under this Section.

REFERENCES
NEMA AB 1 - Molded Case Circuit Breakers
NEMA KS 1 - Enclosed Switches

SUBMITTALS
Include outline and support point dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, and interrupting ratings confirming a fully-rated system for all equipment and components.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

SPARE PARTS
Keys: Furnish 2 keys for each panelboard to Owner.

Handle lock-off: Furnish (2) 20/1P circuit breaker handle lock-off devices for each panelboard to Owner.

One set of three spare fuses of each size and type utilized.

PART 2 - PRODUCTS

BRANCH CIRCUIT PANELBOARDS
Lighting and Appliance Branch Circuit Panelboards: Circuit breaker type.

The panelboard and overcurrent devices contained within shall be fully-rated.

Enclosure: Type 1. Minimum cabinet size: 5-3/4 inches (144 mm) deep; 20 inches (508 mm) wide with 5" minimum gutter space top and bottom. Constructed of galvanized code gauge steel. Panel enclosure (back box) shall be of non-stamped type (without KO's) to avoid concentric break out problem.

Provide flush or surface cabinet front with concealed trim clamps, concealed hinge and flush cylinder lock all keyed alike. Front cover shall be hinged to allow access to wiring gutters without removal of panel trim. Hinged trim shall be held in place with screw fasteners. Finish in manufacturer's standard gray enamel.

Provide metal directory holders with clear plastic covers. Holder to be factory mounted.

Provide panelboards with copper bus (phase buses, bus fingers, etc.), ratings as scheduled on Drawings. Provide ground bars in all panelboards. Phase, neutral and ground bar terminations can be dual rated ALCU9. All spaces shall have bus fully extended and drilled for the future installation of breakers.

Incoming conductors shall terminate at lug landing pads rated for the panelboard.

Provide compression type lugs to accommodate the conductor shown on drawings.

Minimum System (i.e. individual component) Short Circuit Rating: As required by short circuit/ coordination study.

Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers. Provide UL Class A ground fault interrupter circuit breakers where shown on Drawings. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

Do not use tandem circuit breakers.

Circuit breakers shall be bolt-on type with common trip handle for all poles. No handle ties of any sort will be approved.

Provide a minimum of 10% spare circuit breakers in branch panelboards.

All of the panelboards provided under this section shall be by the same manufacturer.

All panelboards installed side by side (double tub) shall utilize same enclosure height.

Double tub panelboard installations shall identify type of feed to adjacent panelboard- sub-feed or feed-thru. Identification shall be integral with panel label.

COORDINATION OF OVERCURRENT PROTECTIVE DEVICES

Provide a coordination study of the electrical system and recommend set points for all of the overcurrent and ground fault trip adjustments on the equipment provided. The coordination study and set point recommendations shall be submitted to the consulting engineer for approval as part of the 26 24 16 package. Submittal shall be on or before date of switchboard and panelboard equipment submittal. Failure to include coordination study will result in immediate rejection of the submittal package.

PART 3 - EXECUTION

INSTALLATION

See section 26 05 29 for support requirements.

Install panelboards plumb with wall finishes.

Height: Branch panelboards: 6’-0” to top of panelboard.

Install a crimp type stud termination to stranded conductor when terminating on circuit breakers without a captive assembly rated for terminating stranded conductors.

Provide filler plates for unused spaces in panelboards.

See section 26 05 53 for identification requirements. Provide typed circuit directory for each panelboard per NEC 408.4(A). Revise directory to reflect circuiting changes required to balance phase loads.

Stub three (3) empty ¾” conduits to accessible location above ceiling or below floor out of each recessed panelboard. Cap these conduits to prevent material from entering them.

FIELD QUALITY CONTROL

The Contractor shall circuit the panelboards as shown on the drawings. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 10 percent, rearrange circuits in the panelboard to balance the phase loads within 10 percent.

Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections.

END OF SECTION

SECTION 26 27 02
EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

SCOPE

The work under this section includes electrical connections to equipment specified under other Divisions and/or Sections, or furnished by Owner, including, but not limited to:

-Misc. Equipment
-HVAC and Plumbing motors, VFDs, and panels

Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Submittals
- Coordination

PART 2 - PRODUCTS
- Cords and Caps
- Other Products

PART 3 - EXECUTION
- Inspection
- Preparation
- Installation
- Miscellaneous Connections
- HVAC and Plumbing Connections
- Equipment Connection Schedule

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
Section 26 05 33 – Raceway and Boxes for Electrical Systems

SUBMITTALS

Product Data: Provide data for cord and wiring devices.

COORDINATION

Coordinate all equipment requirements with the various contractors and the Owner. Review the complete set of drawings and specifications to determine the extent of wiring, starters, devices, etc., required.

PART 2 - PRODUCTS

CORDS AND CAPS

Straight-blade Attachment Plug: NEMA WD 1.

Locking-blade Attachment Plug: NEMA WD 5.

Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.

Cord Construction: Oil-resistant thermoset insulated multi-conductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.

Cord Size: Suitable for connected load of equipment and rating of branch circuit overcurrent protection.

OTHER PRODUCTS
Refer to related sections for other product requirements.

PART 3 - EXECUTION

INSPECTION
Verify that equipment is ready for electrical connection, wiring, and energizing.

PREPARATION
Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

INSTALLATION
Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.

Provide a green equipment ground conductor for all installed equipment wiring.

Make conduit connections to equipment using flexible PVC-coated metal conduit.

Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.

Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.

Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.

Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated. Connect with conduit and wiring as indicated.

MISCELLANEOUS CONNECTIONS
Hand Dryers: Provide handle lock on source circuit breaker to serve as required lock open disconnect.

Drinking Fountains and Bottle Fill Fountains: Provide GFCI source circuit breaker to serve receptacle at fountain.

HVAC AND PLUMBING CONNECTIONS
Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source through starters, variable frequency drives (VFDs), and disconnects to motors or to packaged control panels. Packaged control panels may include disconnects and starters and overcurrent protection. Provide all wiring between packaged control panels and motors.

Contractor shall verify with mechanical contractor the electrical requirements including voltages, horsepower, disconnecting means, starters and variable frequency drives for motors and equipment prior to ordering circuit breakers, disconnects and starters.

Provide 120 volts to each temperature control panel. Coordinate quantity and exact locations with HVAC/DDC contractors.

Unless otherwise specified, all electrical control devices such as aqua-stats, float and pressure switches, fan powered VAV boxes, switches, electro-pneumatic switches, solenoid valves and damper motors requiring mechanical connections shall be furnished and installed and wired by the Contractor supplying the devices.

Provide 120V, single phase 15 ampere circuit and switching means to serve factory installed interior lighting within each HVAC unit.

Each motor terminal box shall be connected with a minimum 12", maximum 36" piece of flexible PVC-coated metal conduit to a fixed junction box. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.

Check for proper rotation of each motor.

EQUIPMENT CONNECTION SCHEDULE

As indicated on the drawings.

END OF SECTION

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SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

SCOPE

This section describes the products and execution requirements relating to furnishing and installing wiring devices and related systems for the project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Submittals
- Operation and Maintenance Data

PART 2 - PRODUCTS
- Modularly Connected (Modular) Devices
- Wall Switches
- Receptacles
- Occupancy Sensors
- Wall Dimmers
- Device Plates and Box Covers

PART 3 - EXECUTION
- Installation
- Field Quality Control
- Occupancy Sensors
- Adjusting

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

SUBMITTALS

Provide product data showing model numbers, configurations, finishes, dimensions, and manufacturer's instructions.

For occupancy sensor shop drawings, the manufacturer’s actual layout of occupancy sensors and the wiring diagrams shall be provided.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

MODULARLY CONNECTED (MODULAR) DEVICES:

Modularly connected devices are allowed, but not required.

Modular Pigtailed Connector: Polarized connector with minimum six-inch stranded copper wire leads, polycarbonate right-angle housing, UL498 listed, with finger-safe connector housing which provides insulation from conductive surfaces. Contacts shall be brass. Connector shall be manufactured so that it provides a secure connection such that it will maintain contact with the device until the device is removed for replacement. Modular connectors shall be provided with covers which protect the contacts from paint, drywall mud, and construction dust and debris. Connectors shall be Hubbell SNAPConnect, Leviton Lev-Lok, Pass & Seymour PlugTail, or approved equal.

WALL SWITCHES

General: Heavy duty use toggle switch, rated 20 amperes and 120 volts AC. Switches shall be UL20 Listed and meet Federal Specification WS-896. All switches shall be heavy duty Specification Grade.

Handle: Ivory made of nylon or high impact resistant material.

All switches on emergency circuits shall have a red handle with matching red cover plate.

Wall Switches for Lighting Circuits and Motor Loads Under 1/2 HP: All switches shall be back and side wired, screw clamp type, suitable for solid or stranded wire up to #10 AWG, with separate green ground screw. Switches shall be as follows:

Hubbell 1221*,
Leviton 1221-S*,
Pass & Seymour CSB20AC1-*,
or approved equal. (* indicates color selection).

Modular Wall Switches for Lighting Circuits and Motor Loads Under 1/2 HP: Switches shall be as follows:

Hubbell SNAP1221*NA,
Leviton M1221-*,
Pass & Seymour PT20AC1-*,
or approved equal. (* indicates color selection).

RECEPTACLES

General Requirements: NEMA Type 5-20R, ivory nylon or high impact resistant face. Receptacles shall be UL498 Listed and meet Federal Specification WC-596. All duplex receptacles shall be heavy duty Specification Grade, 20 amp rated.

Generally, all receptacles shall be duplex convenience type unless otherwise noted.

All receptacles on emergency circuits shall have a red face with matching red cover plate.

All receptacles installed in bathrooms, kitchens, and within 6 feet of the outside edge of sinks shall be GFCI type.

All receptacles installed in outdoor locations, garages, rooftops, and in other damp or wet locations shall be GFCI type with a weather-resistant (WR) rating.

Convenience and Straight-blade Receptacles: All receptacles shall be back and side wired, screw clamp type, suitable for solid or stranded wire up to #10 AWG, with a separate green ground screw. Receptacles shall be as follows:

Hubbell 5362*,
Leviton 5362-*,
Pass & Seymour PS5362*,
or approved equal. (* indicates color selection).

GFCI Receptacles: Duplex convenience receptacle with integral ground fault current interrupter meeting the requirements of UL standard 943 Class A, including self-test functionality and reverse line-load misfire function repeatability. GFCI receptacles shall be as follows:

Hubbell GFR5362SG*,
Leviton GFNT2-*,
Pass & Seymour 2097*,
or approved equal. (* indicates color selection).

GFCI Receptacles with a weather-resistant (WR) rating: Weather-Resistant duplex convenience receptacle with integral ground fault current interrupter meeting the requirements of UL standard 943 Class-A, including self-test functionality and reverse line-load misfire function repeatability. WR GFCI receptacles shall be as follows:

Hubbell GFR5362SG*,
Leviton GFWR2-*,
Pass & Seymour 2097TRWR*,
or approved equal. (* indicates color selection).

USB Charger Receptacles: Do not use combination duplex receptacles with USB chargers. Use duplex receptacles as required for the application and as specified herein. Use separate 4-port USB charging devices.

USB Charging Devices: Single-gang 4-port USB charging station. USB ports shall meet UL94 for 5V flammability rating, and shall comply with battery charging specification USB BC1.2. USB ports shall be compatible with USB 1.1/2.0/3.0 devices, including Apple products. USB ports shall be rated 5VDC, 4.2A minimum. Devices shall be as follows:

Hubbell USB4*,
Leviton USB4P-*,
Pass & Seymour TM8USB4*CC6,
or approved equal. (* indicates color selection).

Locking-Blade Receptacles: As indicated on drawings.

Specific-use Receptacle Configuration: As indicated on drawings.

Modular Convenience and Straight-blade Receptacles: Receptacles shall be as follows:

Hubbell SNAP5362*A,
Leviton M5362-*,
Pass & Seymour PT5362*,
or approved equal. (* indicates color selection).

Modular GFCI Receptacles: Duplex convenience receptacle with integral ground fault current interrupter meeting the requirements of UL standard 943 Class A, including self-test functionality and reverse line-load misfire function repeatability. GFCI receptacles shall be as follows:

Hubbell GFRST83SNAP*,
Leviton MGFN2-*,
Pass & Seymour PT2097*,
or approved equal. (* indicates color selection).

Modular GFCI Receptacles with a weather-resistant (WR) rating: Use back and side wired devices in lieu of modular weather-resistant rated GFCI receptacles.

OCCUPANCY SENSORS

General Requirements: All occupancy sensors shall be hardwired type; battery type shall not be permitted.

Sensors shall use either passive infrared, or if dual technology, passive infrared and passive acoustic sensing or passive infrared and ultrasonic sensing for detecting room occupancy.

Sensitivity shall be user adjustable or self-adjusting type.

The delay timer shall be adjusted within a range of 6 to 30 minutes by the contractor in the field. The sensor shall have a test mode for performance testing.

The test LED shall indicate motion.

Line voltage sensors are acceptable, especially in exposed ceiling areas where all wiring shall be installed in conduit, including low voltage cabling if power packs are used. Provide power pack as required for low voltage sensors.

See drawings for actual types of sensors.

Occupancy sensors and power packs shall have five year warranties.

Wall Mounted (Wall Switch Type): The unit shall fit in/on a standard single gang switch box.

Rated capacity: 600 watts minimum at 120 volts, 60 Hz.
The sensor shall have two switches where dual-level lighting is required. The switch shall have manual override for positive OFF and automatic ON.

The area of coverage shall be approximately 180 degrees by 35-40 feet.

Ceiling Mounted: The unit shall fit in/on a standard octagon box. All ceiling mounted sensors shall be installed to a box with ring and box support.

The coverage area shall be 360 degrees by approximately 15 feet radius when mounted at 9 foot height. The sensor shall have provisions, such as masking, to block out problem areas.

Ceiling/Corner Mounted: The unit shall fit in/on a standard octagon box. All ceiling mounted sensors shall be installed to a box with ring and box support.

The coverage area shall be 90 degrees or greater by approximately 40 feet radius when mounted at 9 foot height. The sensor shall have provisions, such as masking, to block out problem areas.

Power Packs: Provide power packs as required for low voltage sensors. Rated capacity shall be 20 amps at 120 volts.

The unit shall fit on a standard octagon box. All power packs shall be installed onto a supported box.

Low voltage cabling shall be plenum rated or installed in conduit in plenum-rated areas.

Auxiliary Contacts for HVAC Interlock: Provide auxiliary dry contacts for HVAC BAS interlock when required. Refer to the "Occ Sensor Interlock" column in the Air Terminal Schedule(s) on the HVAC drawings. When required, provide auxiliary contacts regardless if the occupancy sensors are line or low voltage.

The occupancy sensors and auxiliary contacts shall be wired such that the sensor still detects occupancy and controls the auxiliary contacts regardless if the light switch(es) are in the OFF position (e.g. the occupant has turned the lights OFF because there is enough daylight, but the occupant is still occupying the space, and the occupancy sensor senses the occupant and closes the auxiliary contacts for BAS input).

The BAS wiring to the auxiliary contacts shall be by the Division 23 contractor.

WALL DIMMERS

General:

1. Compatible with the voltage of the circuit being controlled: 120V;
2. Compatible with the load being dimmed;
3. Linear full-range slide control;
4. Separate ON/OFF switch: single-pole, 3-way, or multiple-location operation as indicated on the drawings;
5. No derating required in multi-gang applications;
6. Polycarbonate construction;
7. Color to match receptacles and/or standard toggle switches.

Line-voltage LED Dimmer:

1. Forward or reverse phase dimming control as required for the application;

0-10 V Dimmers:

1. Ratings: 30 mA sink current;
2. Adjustable dial allows users to trim the low-end dimming range;

DEVICE PLATES AND BOX COVERS

Decorative Cover Plate: Stainless steel.

Weatherproof Cover: All receptacles installed in wet locations shall have an enclosure that is weatherproof whether or not the attachment plug is inserted. Covers shall be gasketed metal with hinged "in-use" device covers, powder coat painted. Non-metallic covers are not allowed. Covers shall be latching type and shall be lockable. Covers shall be identified as "extra-duty" type per NEC 406.9(B)(1).

Damp Location Cover: All receptacles installed outdoors in a location protected from the weather or in other damp locations shall have an enclosure that is weatherproof when the receptacle is covered (attachment plug not inserted

and receptacle covers closed). Covers shall be gasketed metal with hinged device covers, powder coat painted. Non-metallic covers are not allowed.

Surface Cover Plate: Raised galvanized steel.

PART 3 - EXECUTION

INSTALLATION

See plans for device mounting heights.

Install wall switches with OFF position down.

Wall dimmers: de-rate ganged dimmers as instructed by manufacturer; do not use common neutral.

Install convenience receptacles with grounding pole on bottom.

Install box for information outlet at the same height as adjacent convenience receptacles. Locate boxes for information outlet as close as practical to duplex power outlet, approximately 2-inches apart.

Install box for telephone jack for wall telephone at 46-inches to center above finished floor.

Install specific-use receptacles at heights shown on Contract Drawings.
Install decorative plates on switch, receptacle, and blank outlets in finished areas.

Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

Install devices and wall plates flush and level.

Receptacles shall have a bonding conductor from grounding terminal to the metal conduit system. Self-grounding receptacles using mounting screws as bonding means are not approved.

FIELD QUALITY CONTROL

Inspect each wiring device for defects.

Operate each wall switch and sensor with circuit energized, and verify proper operation.

Verify that each receptacle device is energized.

Test each receptacle device for proper polarity.

Test each GFCI receptacle device for proper operation.

The City of Madison personnel reserve the right to be present at all tests.

OCCUPANCY SENSORS

Power packs used in return air plenum ceiling areas shall be installed in an approved enclosure or UL listed for return air plenum.

Provide a minimum of 4’ of coiled cable for ceiling-mounted sensors.

Occupancy sensors shall be installed at locations indicated on the manufacturer’s submittal layout drawings. Sensors shall be located to prevent false “ON” tripping of the lights.

Sensitivity Test: After the sensor has been energized for at least 15 minutes, walk to the middle of the room (if conference room) or sit at the normal desk position (if an office). Make no motion for 20 seconds. Move one arm up and down slowly. The test LED should blink.

Time Delay Test: Set the time delay for 10 minutes. Walk into the room to activate the sensor then leave room. Sensor must turn lights off at approximately 10 minutes. Walk into the room again to reactivate the lights. Lights should activate within 1 second.

Provide controls suitable for receptacle/plugload control as required.

ADJUSTING

Adjust devices and wall plates to be flush and level.

Mark all conductors with the panel and circuit number serving the device with a machine generated label, at the device, and on the back of the device cover.

END OF SECTION

SECTION 26 27 28
DISCONNECT SWITCHES

PART 1 - GENERAL

SCOPE

The work under this section includes disconnect switches, fuses, and enclosures. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Submittals
- Operation and Maintenance Data
- General

PART 2 - PRODUCTS
- Disconnect Switches
- Fuses

PART 3 - EXECUTION
- Installation

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 26 27 02 - Equipment Wiring Systems

REFERENCES

NECA (National Electrical Contractors Association) "Standard of Installation"
NEMA ICS 2 – Industrial Control Devices, Controllers, and Assemblies
NEMA KS 1 – Enclosed Switches
UL 50 – Enclosures for Electrical Equipment
UL 98 – Enclosed and Dead-front Switches

SUBMITTALS

Include outline drawings with dimensions, and equipment ratings for voltage, ampacity, horsepower, and short circuit.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

GENERAL

Provide disconnect switches for loads required by code. Review HVAC and Plumbing specifications to determine what equipment is furnished with disconnect switches. Install disconnect switches whether furnished under this contract or not. It is the Electrical Contractors responsibility to determine the need for a disconnect switch for each load. The contractors shall include in their bid the code required disconnect switches whether indicated on the drawings or not.

PART 2 - PRODUCTS

DISCONNECT SWITCHES

Fusible Switch Assemblies (use only when overcurrent protection is required): NEMA Type Heavy Duty; quick-make, quick-break, load interrupter, enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: designed to accommodate Class R, Class J or Class CC (motors) cartridge type fuses.

Nonfusible Switch Assemblies: NEMA Type Heavy Duty; quick-make, quick-break, load interrupter, enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

Enclosure:

Indoor: NEMA 1 code gauge steel with rust inhibiting primer and baked enamel finish.

Outdoors: NEMA 3R code gauge zinc coated steel with baked enamel finish or NEMA 4 when indicated on drawings.

Provide manufacturer's equipment ground kit in all disconnect switches.

In applications where the switch serves as the service entrance disconnect, provide service ground kit, label as service disconnect and provide UL listing for service disconnect.

FUSES

Fuses 600 Amperes and Less: Dual element, time delay, 600 volt, UL Class RK 5. Interrupting Rating: 200,000 rms amperes.

Fuses 30 Amperes and less: Time-Delay, 600 volt, UL Class CC. Interrupting rating: 200,000 rms amperes.

Provide three (3) spares of each size and type fuse.

PART 3 - EXECUTION

INSTALLATION

Install disconnect switches where indicated on Drawings or required by NEC.

Provide identification as specified in Section 26 05 53.

Provide label on inside of disconnect cover identifying the type and size of fuse to be utilized.

END OF SECTION

SECTION 26 31 00
PHOTOVOLTAIC SYSTEM PERFORMANCE REQUIREMENTS

PART 1 - GENERAL 1
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3.4 IDENTIFICATION 5
3.5 FIELD QUALITY CONTROL 5

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes general performance requirements that apply to installing a solar electric (PV) system for this project

B. Contractor is the Designer of Record for this system. Contractor is required to provide a Structural PE (Professional Engineer) Stamp for the structural design and an Electrical PE Stamp for the overall system design.

C. Both the structural and electrical stamps are to be provided from experienced PV designers with at least 5 similar completed projects.

D. Contractor is required to have experience with at least 5 similar completed PV projects.

E. Product specifications included in this section are the Basis for Design. Design substitutions shall meet the minimum performance requirements defined in this section. Contractor shall select number of inverters and perform string sizing.

F. Related Work and Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

G. Incentive Paperwork:

1. Contractor to provide support with Owner's application for Focus on Energy incentives.

1.2 DEFINITIONS

A. MPPT: Maximum power point tracking.

B. STC: Standard test conditions, 1000 W/m2, 1.5 air mass, and 25°C cell temperature.

C. NABCEP: North American Board of Certified Energy Practitioners

D. PTC: PV USA Test Conditions, 1000 W/m2, 1.5 air mass, 20°C air temperature, and 1 meter/sec. wind speed.

E. Voc: Open circuit voltage

F. Isc: Short circuit current.

1.3 SUBMITTALS

A. Experience: Submit resumes for individuals involved with the design and construction of the PV System. Submit references and summaries of five similar projects that these individuals have completed.

B. Product Data: For each type of component indicated below. Include rated capacities, operating characteristics, and furnished specialties and accessories. All product data submittals shall be submitted for review by Owner prior to purchasing any materials or equipment.

1. Solar modules
2. Grid tied inverters, including efficiency data.
3. Racking system, including rail, clamps, brackets, and/or roof attachments.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. All shop drawings shall be submitted for review by Owner prior to purchasing any materials or equipment.
   1. Dimensioned AutoCAD plan drawings of equipment including solar module array, inverters, disconnects, metering, and electrical conduit routing.
   2. Provide AutoCAD drafted one-line wiring diagram of solar PV system indicating ratings of all modules and inverters, wire and conduit types and sizes, and disconnects.

D. Design Calculations
   1. The following design calculations shall be performed by Contractor and submitted for review by Owner prior to purchasing any materials or equipment.
      a. Electrical calculations, including string sizing, inverter selection, and voltage losses.
      b. Structural calculations, including rail spans, wind and snow loading, required ballast weights, and roof strength calculations.

E. Permitting and Agreements
   1. The following permits and agreements shall be prepared by Contractor on behalf of the Owner. All approved permits and agreements shall be submitted for review by Owner prior to purchasing any materials or equipment.
      a. Utility interconnection agreement
      b. Building permit
      c. Electrical permit

F. As built drawings:
   1. Dimensioned AutoCAD plan drawings of equipment including solar module array, inverters, disconnects, metering, and electrical routing.
   2. Provide AutoCAD drafted one-line diagram of solar PV system indicating ratings of all modules and inverters, wire and conduit types and sizes, and disconnects.

G. Field quality-control test reports.
   1. Include voltages and power output for each string. Measure and record solar intensity during testing. Include time, date, and weather conditions of test.

H. Warranty: Copies of all manufacturer's and installer's warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
   2. Installer must have PV Installer certification through NABCEP or applying for certification.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70 and all applicable state and local codes

1.5 COORDINATION

A. Coordinate metering and interconnection agreement with electric utility. Contractor shall pay all interconnection fees including the application review fee, engineering review fee, and distribution system study fee. Contractor shall submit all required forms to utility.

B. Coordinate all work affecting building's roof with roofing manufacturer to ensure the roof's warranty is maintained.

1.6 WARRANTY

A. Installer must provide a two year installation warranty covering any defects of the installation.

B. Module Warranty Period:
   1. 5 years workmanship warranty.
   2. Module warranty provided by manufacturer, not through a third party
   3. 1 year 97% power output warranty, then:
      a. 10 year 90% linear power output warranty.
      b. 25 year 80% linear power output warranty.

C. Inverter Warranty Period: 15 year warranty.

D. Racking Warranty Period: 10 year warranty.

PART 2 - PRODUCTS

2.1 SOLAR MODULES

A. Preapproved Manufacturers: Subject to compliance with performance requirements, manufacturers offering products that may be incorporated into the Work include:
   1. Canadian Solar

2. Hanwha Q-cells
3. Heliene
4. REC Group
5. Trina Solar.
6. First Solar
7. Mission Solar
8. SilFab
9. CrossRoads Solar

B. If an alternate product is proposed, bid is to document how the proposed solution is more cost effective to the owner. Follow substitution request procedure per 01 25 13.

C. Capacities and Characteristics:
1. All modules shall be from a single manufacturer.
2. Power Output Ratings: STC rated power of at least 300 watts if 60 or 120 cell and at least 360 watts if 72 or 144 cell.
3. DC Array size of at least 80 KW.
4. Power tolerance: -0%/+5%
5. Nameplates: To identify electrical characteristics, manufacturer's name and address, and model and serial number of component.
6. Module efficiency: minimum 19.50% at STC
7. 60, 72 (or 120, 144 half cells)

D. Materials and construction
1. Monocrystalline or Polycrystalline
2. Monofacial
2. Junction box with bypass diodes.
3. Staubli MC4 connectors.
4. Anodized aluminum frame with drainage holes and grounding holes.
5. Operating temperature range of -40°C to +85°C.
6. Withstand 1" diameter hail at 50 mph without damage.
7. Load rated at 5400 Pa (113 psf) when used with two rail system.

2.2 INVERTERS

A. Preapproved Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include:
1. Fronius
2. SMA
3. Solar Edge
4. Enphase
5. Chilicon

B. If an alternate product is proposed, bid is to document how the proposed solution is more cost effective to the owner. Follow substitution request procedure per 01 25 13.

C. Standards
1. IEEE 1547
2. UL 1741 – anti-islanding.

D. Electrical characteristics
1. AC kW rating: Minimum DC-to-AC ratio of 1.2
2. Output voltage: 208 VAC 3 phase
3. Frequency: 60 Hz sine wave
4. Input voltage: Coordinated with solar array.
5. Max Voc: Coordinated with solar array.
6. Max DC current: Coordinated with solar array.
7. Startup voltage: Coordinated with solar array.
8. Output power factor: Unity
9. DC to AC conversion efficiency:
   a. 97.5% CEC rated efficiency
10. AC and DC rapid shutdown compliant with NEC 2017

E. Features
1. Transformerless design.
2. Forward facing DC disconnect
3. DC side ground fault protection.

4. Inverter must limit power output to nameplate value. If connected to an array capable of producing more than the inverter's capacity, the inverter must limit the power without damage.
5. Maximum power point tracking over the range of voltages of the array, at the ambient temperatures of the site.
6. User navigable display.
7. LED status lights on enclosure.
8. Communication port for diagnostics and communication port for communication with multiple inverters and internet interface device.
9. NEMA 3R enclosure

2.3 PV WIRING

A. Type PV-WIRE, #10AWG, from array to combiner box, and where used as a jumper for connection between modules.

B. UV-Stabilized Cable Ties:
1. Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
2. Minimum Width: 3/16 inch (5 mm).
3. Tensile Strength at 73 °F (23 °C), According to ASTM D 638: 12,000 psi (82.7 MPa).
4. Temperature Range: -40 to +185 °F (-40 to +85 °C).
5. Color: Black.

C. Ampacity of PV source circuits shall be a minimum of 156% of the sum of parallel strings short circuit currents.
1. Shall be sized to limit voltage drop to 1.5% from array to inverter during full production at MPPT voltage at maximum ambient temperature.
2. Shall be in metallic conduit from combiner box, if installed, to inverter.

2.4 RACKING & ROOF ATTACHMENT & ROOF PENETRATIONS

A Preapproved Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include:
1. Products for attached systems on flat roofs:
   a. Roof attachment
      i. Anchor Products U-Anchor
      ii. Iron Ridge Flat Roof Attachment
      iii. OMG Roofing Products Power Grip Plus
   b. Racking
      i. Iron Ridge XR
      ii. Unirac SM
2. Products for ballasted systems on flat roofs:
   a. Unirac RM10
   b. Ecolibrium Solar Ecofoot
3. Products for pitched roofs:
   a. Roof attachment
      i. Anchor Products U-Anchor
      ii. Iron Ridge Flat Roof Attachment
      iii. OMG Roofing Products Power Grip Plus
      iv. S-5 Clamps (for standing seam installations)
         A.) Use S-5-U, S-5-S, or the required clamp for the specific roofing product.
         B.) S-5 mini clamps are not acceptable.
      v. EcoFasten GreenFasten or QuickFoot (for composite shingle installations)
   b. Racking
      i. Iron Ridge XR
      ii. Unirac SM
4. Products for pole mount arrays
      i. MTSolar Top of Pole Mounts
      ii. Preformed Line Products Top of Pole Mounts
5. Products for ground mount arrays
      i. MTSolar Ground Mounts
      ii. Preformed Line Products Power Peak
      iii. Iron Ridge XR Ground Mount
      iV. Unirac GFT or ULA

2.5 INTERNET BASED MONITORING

A. Provide standard package from inverter manufacturer and connect to the City Network. Coordinate with Owner. Contractor is required to test monitoring to confirm it is functioning.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of electrical connections. Verify actual locations of connections before module installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ARRAY REQUIREMENTS

A. Install modules on racking designed for solar (PV) modules.

B. Structural Performance: Installation shall withstand all local wind and snow loads, and all local building department requirements.

C. If applicable, slip sheet is to be used between ballasted racking and roof membrane

D. All fastening hardware must be stainless steel.

E. All materials must be metallurgically compatible where different materials are in contact with each other.

F. Roof penetrations shall be made watertight using methods that are standard to the roofing industry, are approved by the roofing manufacturer, and that protect the warranty of the roof.

G. The modules shall be connected in arrays with the following characteristics:

1. The modules shall be installed only in the area outlined in Exhibit A.
2. Proposed alternate layout shall be submitted to CPM and approved prior to installation begins.
3. If needed, each array shall be provided with a combiner box.
4. PV module cables may be installed exposed where routed directly behind modules, but all cables shall be installed in a section of conduit where crossing part of the roof not under a module. Conduit running across roof shall be supported on roof using Cooper B-Line Dura-Blok or equivalent.
5. All PV module cables shall be installed in a neat and workmanship like manner. Excess wire shall be coiled and bundled neatly and supported securely in an area where they are not subject to environmental degradation, such as from wind, sun, and animals. Attach PV module cables to racking with zip-ties listed for use in direct sunlight.
6. Modules shall be connected in series and parallel to match voltage and current ratings of inverter, across all ambient temperatures common to site (-25°C to 40°C).
   a. Open circuit voltage of array on coldest day of year in full sunlight shall not exceed maximum operating voltage rating of inverter, modules, or any other equipment.
   b. Open circuit voltage on warmest day of year in morning sunlight conditions (200W/m2 irradiance) shall exceed inverter startup voltage. Voltage under operating MPPT conditions, minus any voltage drop over conductors, shall exceed minimum inverter input voltage.
   c. Available short circuit current multiplied by 1.25 shall not exceed ratings for the inverter or any modules.
   d. All series strings of modules shall have same performance characteristics.

3.3 ELECTRICAL INSTALLATION

A. Ground equipment according to Division 26

1. Size grounding conductors per NEC articles 250 and 690.
2. All conductive equipment enclosures must be grounded.
3. All module frames must be grounded.
   a. The removal of any module shall not interrupt a grounded conductor to another photovoltaic source circuit.

B. Install wiring, combiner boxes, conduit, disconnects, inverter, web based monitoring hardware, sensors and other equipment according to Division 26.

1. Exception – If Division 26 specifies otherwise, All Solar Electric Conduit material is to be metallic.

C. Connect wiring according to Division 26.

3.4 IDENTIFICATION

A. Identify and label system components according to Division 26.

1. Provide a unique label for each inverter, PV output circuit, combiner box, PV Source circuit, and module. Labeling shall match labeling shown on as-built diagram and plan provided by contractor.

B. Provide all labeling required by NEC article 690, including, but not limited to:

1. Label disconnects capable of being energized from both directions as such.
2. Provide plaque at utility service disconnect per article 690.56B. Field verify exact location.
3. Label each photovoltaic disconnecting means per NEC article 690.53.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections as indicated below and prepare test reports. Correct any deficiencies.

1. Visually inspect all connections.
2. Visually inspect all supports.
3. Measure Voc of each individual string of modules under full sunlight.
   a. Verify Voc of all strings are balanced.
   b. Verify measured Voc against calculated Voc for the ambient temperature. Extrapolate Voc to temperatures expected at site, and verify they are within inverters ratings.
4. Measure Isc of each string of modules.
5. Verify correct operation of inverter.
6. Verify correct operation of complete system.
7. Replace any defective modules. Modules shall be replaced at contractor's expense.

3.6 DEMONSTRATION

A. Simulate power outage by interrupting normal source, and demonstrate that system disconnects from utility.

B. Provide owner's maintenance personnel with minimum two hour training session and in compliance with Div 1 Training Requirements.
   1. Provide training on function of each piece of equipment.
   2. Provide training on maintaining the system.
   3. Explain means of disconnecting the system, and principals of operation and safety.

END OF SECTION

SECTION 26 51 13
INTERIOR LIGHTING FIXTURES

PART 1 - GENERAL

SCOPE

The work under this section includes interior luminaires and accessories, exit signs, and building-mounted exterior lighting. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference Standards
- Submittals
- Operation and Maintenance Data
- Extra Materials
- Definitions

PART 2 - PRODUCTS
- Interior Luminaires and Accessories
- LED Luminaires
- LED Drivers

PART 3 - EXECUTION
- Installation
- Adjusting and Cleaning
- Interface with Other Products
- Zero-to-10V Dimming Control Wiring Installation
- Field Quality Control
- Luminaire Connections

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 26 27 26 – Wiring Devices

REFERENCE STANDARDS

RoHS – Restriction of Hazardous Substances. Council of the European Union (EC) Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
LM-79-08 (or latest) – IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products.
LM-80-08 (or latest) – IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
TM-21-11 (or latest) – IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.
NEMA SSL 1-2010 (or latest) – Electronic Drivers for LED Devices, Arrays, or Systems.

SUBMITTALS

Include outline drawings, lamp and ballast data, support points, weights, accessory information and performance data for each luminaire type.

For each luminaire type, submit luminaire information including catalog cuts with highlighted catalog numbers and required accessories:

- Luminaire:
  - Manufacturer and catalog number,
  - Type (identification) as indicated on the plans and schedule,
  - Delivered lumens,
  - Input watts,
  - Efficacy,

- Color rendering index.
- Driver:
  - Manufacturer and catalog number,
  - Type (Non-Dimming, Step-dimming, Continuous dimming, etc.),
  - Power Factor, Crest Factor, THD, etc.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

EXTRA MATERIALS

Provide three (3) percent of each lamp type, but not less than one (1) of each type.

Provide one (1) of each type of LED module, light bar, or array (if applicable). If the LED's are integrated into the luminaire and are not separate components, provide one (1) of each of these types of luminaires.

Provide one (1) LED driver or ballast of each type.

DEFINITIONS

Driver: The power supply used to power LED luminaires, modules, or arrays.

L70, $L_{70,}$ or $L_{70\%}$: The reported life of an LED component or system to reach 70% lumen maintenance, or 70% of the LED's original light output. This test is being developed by the IES and is currently described by TM-21-11.

LED's: Broadly defined as complete luminaire with light emitting diode (LED) packages, modules, light bars or arrays, complete with driver.

LED luminaire failure: Negligible light output from more than 10 percent of the LED's constitutes luminaire failure.

PART 2 - PRODUCTS

INTERIOR LUMINAIRES AND ACCESSORIES

See the Luminaire Schedule on the drawings for type of luminaires and catalog numbers. Luminaires manufactured by others are equally acceptable provided they meet or exceed the performance of the indicated luminaires, meet the intent of the design, and are approved by the A/E prior to bid.

Luminaire shall be certified by a Nationally Recognized Testing Laboratory (UL, ETL, or IEC).

Provide luminaires with quick-connect disconnecting means, similar to Thomas & Betts Sta-Kon.

LED LUMINAIRES

- LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The technical requirements that the luminaire shall meet for each Application Category are:
  - Minimum Light Output.
  - Zonal Lumen Requirements.
  - Minimum Luminaire Efficacy.
  - Minimum CRI.
  - L70 Lumen Maintenance.
  - Minimum Luminaire Warranty of 5 years (not pro-rated) to include LED driver and all LED components.

Additional requirements:

- Color Temperature of 3000K-4100K for interior luminaires as listed in the Luminaire Schedule on the plans. The color temperature of exterior LED luminaires should not exceed 4100K (nominal).

- Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent luminaire-to-luminaire color for interior luminaires. Exterior luminaires shall use a maximum 5-step MacAdam Ellipse binning process.
- Glare Control: Exterior luminaires shall meet DesignLights Consortium's® criteria for Zonal Lumen Distribution requirements or Backlight-Uplight-Glare (BUG) standards for exterior luminaires.
- Luminaire shall be mercury-free, lead-free, and RoHS compliant.
- Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
- Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.
- Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.
- Lumen output shall not depreciate more than 20% after 10,000 hours of use.
- Luminaire and driver shall be furnished from a single manufacturer to ensure compatibility.
- Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior luminaires, and a minimum of 70 for exterior luminaires.
- LED luminaire shall be thermally designed as to not exceed the maximum junction temperature of the LED for the ambient temperature of the location the luminaire is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found for the intended installation. Exterior luminaires to operate in ambient temperatures of -20°F to 122°F (-29°C to 50°C).
- Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.
- Luminaire shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
- All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
- All luminaires shall be provided with knockouts for conduit connections.
- The LED luminaire shall carry a limited 5-year warranty minimum for LED light engine(s)/board array, and driver(s).
- Provide all of the following data on submittals:
    - Delivered lumens
    - Input watts
    - Efficacy
    - Color rendering index.

LED Luminaires used for Emergency Egress Lighting:

- The failure of one LED shall not affect the operation of the remaining LEDs.

Emergency LED Luminaire Compatibility with Inverters:

- Emergency Inverters shall be sine-wave type, or have written confirmation from the luminaire manufacturer that the luminaire will function with a square-wave inverter.

LED DRIVERS

General:

- Provide driver type (non-dimmed, step-dimmed, continuous-dimming, etc.) as indicated on the luminaire schedule on the drawings.
- Minimum Warranty of 5 years (not pro-rated) to include LED driver and all LED components.
- Driver shall have a rated life of 50,000 hours, minimum.
- Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.
- Driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.
- Driver shall operate normally for input voltage fluctuations of plus or minus 10 percent.
- Driver shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
- Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.
- Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.
- Provide all of the following data on submittals:
    - Input watts
    - Power Factor (pf)

- Crest Factor (cf) at full input power
- Total Harmonic Distortion (THD).

Dimming Drivers:

- LED driver shall be compatible with dimming controls where dimming is indicated on the plans. Dimmable drivers shall use Dimming Constant Current (DCC) or Pulse Width Modulation (PWM) operation.

- Continuous Dimming Drivers: LED luminaires shall dim to (20%, 15%, 10%, 5%, or 0.1%) as specified in the Luminaire Schedule on the plans without visible flicker or "popcorn effect". "Popcorn effect" is defined as the luminaire being on a pre-set dimmed level (less than 100%), and going to 100% prior to returning to the pre-set level when power is returned to the luminaire. Continuous Dimming Drivers shall use 0-10V control.

PART 3 - EXECUTION

INSTALLATION

Verify ceiling types with Architectural plans or with existing ceilings. Verify specified luminaires are compatible with specified ceiling type(s) prior to ordering luminaires.

Install in accordance with manufacturer's instructions.

Install suspended luminaires using aircraft cable, or pendants supported from swivel hangers. Heavy duty chain supports may be used where indicated on the luminaire schedule. Provide aircraft cable, pendants, or chain lengths required to suspend luminaire at indicated height. All aircraft cables or pendant supported luminaires shall have an independent support to structure at all cable or pendant support locations. When chain is used, tie-wrap the luminaire whip to the chain.

Support luminaires larger than 2 x 4 foot (600 x 1200 mm) size independent of ceiling framing.

Provide independent support for all luminaires over 50 lbs.

Locate ceiling luminaires as indicated on reflected ceiling plan.

Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.

The Contractor shall install luminaire supports as required. Luminaire installations with luminaires supported only by insecure boxes will be rejected. It shall be the Contractor's responsibility to support all luminaires adequately, providing extra steel work for the support of luminaires if required. Any components necessary for mounting luminaires shall be provided by the Contractor. No plastic, composition or wood type anchors shall be used.

Install recessed luminaires to permit removal from below.

Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

Install code required hardware to secure recessed grid-supported luminaires in place.

Install wall mounted luminaires and exit signs at height as scheduled. Use pendants supported from swivel hangers in exposed ceiling/structure locations where necessary to mount exit signs at the specified height.

Install accessories furnished with each luminaire.

Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

Bond luminaires and metal accessories to branch circuit equipment grounding conductor.

Install specified lamps in each luminaire and exit sign.

Dimmed luminaire circuits shall have separate neutrals.

Dimmed LED luminaires shall have a positive OFF, which requires turning off the circuit to the luminaire so that the luminaires don't "glow" at the lowest dimmed setting. This shall be accomplished using a switch, relay, or some other means acceptable to A/E.

All lamps shall be delivered to the job in sealed cartons and protected from dirt and dust during storage on the project. Lamps shall be taken directly from the cartons and installed in the luminaire with special care so that they do not become dusty and are not soiled in the operation.

All new lamps shall be operational at the Substantial Completion of the project.

ADJUSTING AND CLEANING

Align luminaires and clean lenses and diffusers at completion of Work. Clean paint splatters, dirt, and debris from installed luminaires.

Aim and adjust luminaires as indicated on Drawings or as directed by the A/E.

Touch up luminaire finish at completion of work.

INTERFACE WITH OTHER PRODUCTS

Interface with air handling accessories furnished and installed under Division 23.

Provide controls as indicated on the plans. Refer to section 26 27 26 - Wiring Devices. Controls shall be compatible with the luminaires/ballasts/drivers being installed.

ZERO-TO-10V DIMMING CONTROL WIRING INSTALLATION

Zero-to-10V dimming control conductors are classified by the NEC as Class 2 conductors and shall be kept separate from line-voltage conductors per NEC 725.136(A). Matching the insulation rating of Conductors of Different Systems does not apply to Class 2 conductors per NEC 300.3(C)(1), Informational Note No.1.

Wall box dimmers will typically have two conduits: One conduit for line-voltage power, and one conduit or conduit stub for the 0-10V control wiring.

The 0-10V wiring may be routed in free air if:

- The room is approximately 900 sq.ft. or less,
- The 0-10V wiring stays within the room,
- The ceiling space is a non-plenum space, and
- All splices of 0-10V wiring are spliced in a box.
- The 0-10V wiring may be tie-wrapped to the outside of the luminaire fixture whip per NEC 300.11(B)(2). Tie-wraps shall be UL listed for UV resistance.

At each luminaire, separate openings (either manufactured knock-outs or punched openings) shall be used for the line-voltage power and the 0-10V wiring. The EC shall use an NM cable connector at the opening for the 0-10V wiring. Zero-to-10V conductors entering and within a luminaire enclosure shall maintain a minimum separation of 6 mm (0.25 in.) per NEC 725.136(D).

METAL-CLAD (MC) CABLE

Metal-Clad (MC) type cable that combines power and Class 2 circuits into a single cable may be used for the luminaire wiring within a single room. Examples of such products are Encore Wire® MC-LED™ or Southwire® MC-PCS Duo™. Manufacturer's names and catalog numbers are used for quality and performance only. MC Cables manufactured by others shall be equally acceptable provided they meet or exceed in performance and quality as specified.

FIELD QUALITY CONTROL

Operate each luminaire after installation and connection. Inspect for proper connection and operation.

LUMINAIRE CONNECTIONS

Recessed, including Master-Satellite connections:

- Use a luminaire fixture whip from a J-box for recessed lay-in luminaires. Luminaire fixture whips shall be aluminum or steel AC Cable (Armored Cable) or Flexible Metal Conduit (FMC).
- Cable/Conduit whips shall be 3/8" (10 mm) minimum diameter, six feet (1.8 m) maximum length.
- Flexible whips or pre-wired systems between master and satellite luminaires may be supported by the ceiling grid wires.
- The flexible connectors shall be steel, galvanized, clamp type with locknut, snap-in type with locknut, or snap-in connector type, including those used on the master-satellite units.

Chain or Cable Hung (unfinished spaces):

- Use manufacturer's SO cord or a luminaire fixture whip from a J-box. Luminaire fixture whips shall be aluminum or steel AC Cable (Armored Cable) or Flexible Metal Conduit (FMC).
- Conduit whips shall be 3/8" (10 mm) minimum diameter. Conduit whip or SO cord shall be cut to length (six feet (1.8 m) maximum) and shall allow movement of the chain/cable/luminaire, but shall not be long enough to "loop" and shall present a neat and workmanlike appearance.
- Luminaire field wired flexible cord installations shall be connected per NEC 410.62.
- The flexible connectors shall be steel, galvanized, clamp type with locknut, snap-in type with locknut, or snap-in connector type, including those used on the master-satellite units.
- Conduit whip slack shall be tie-wrapped to the chain supports. Tie-wraps shall be UL listed for UV resistance.

Cable Hung (finished spaces):

- Use manufacturer's SO cord from luminaire to a J-box.
- SO cord shall be cut to length (six feet (1.8 m) maximum) and shall allow movement of the cable/luminaire, but shall not be long enough to "loop" and shall present a neat and workmanlike appearance.
- SO cord slack may be tie-wrapped to the cable supports. Tie-wraps shall be UL listed for UV resistance.
- Luminaire field wired flexible cord installations shall be connected per NEC 410.62.

Surface Mounted (unfinished spaces):

- Provide direct conduit and box connection.

Surface Mounted (finished spaces):

- Provide direct conduit and box connection. Use surface metal raceway where indicated on drawings. Conceal box and conduit where appropriate. Flexible metal conduit shall not be used where it is exposed.

END OF SECTION

SECTION 27 00 05
STRUCTURED COMMUNICATIONS CABLING

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PART 1 – GENERAL

1.1. SCOPE OF WORK

A. This Document specifies the City of Madison for product design, performance, and quality assurance, and contractor responsibilities for execution of work to install a complete Category 6 structured cabling system. Execution of work includes delivery and storage of materials, preparation, installation, field-testing, and project completion tasks. System certification and warranty submittal requirements for completed work and future moves, additions and changes (MAC's) are also specified in this document. Compliance to applicable codes, standards and regulations is required for all construction work performed.

1.2. SUMMARY

A. Section includes products and execution requirements pertaining to Division 27 systems. Copper and fiber backbone and horizontal cabling along with support systems are covered under this document.

B. Product specifications, general design considerations, and installation guidelines are provided in this document. Quantities for all cabling products shall be provided as required to complete cabling to all work areas as shown on floor plans.

C. The Approved Contractor shall furnish, supply and install a complete Category 6 cabling infrastructure specified in the contract documents.

D. The Approved Contractor shall furnish, supply and install a complete Category 6 cabling infrastructure specified in the contract documents.

E. Work shall include all detailed execution requirements, such as preparation, installation, system certification, and project closeout activities according to the contract.

F. Substitutions: No substituted products shall be installed except with written approval by Owner.

1.3. DATA AND VOICE COMMUNICATIONS CONTRACT WORK

A. General
1. Furnish all labor, materials, tools, equipment and services for the installation in accordance with general provisions of specifications and the Contract Drawings.
2. Report percentage of work completed on a monthly basis.
3. Completely coordinate with work of all other trades.
4. Provide all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation, whether or not specifically indicated in the Contract Documents.
5. Provide labor for testing horizontal and backbone cabling.
6. Provide Firestopping.
7. Provide Telecommunications grounding and bonding.

B. Provide complete installation for Structured Telecommunications Cabling System including but not limited to:
1. Category 6 and 6A UTP horizontal cables.
2. Singlemode optical fiber backbone cables.
3. Work area telecommunication outlets.
4. Wall mounted voice outlets.
5. Equipment mounting racks and rack enclosures.
6. Category 6 and 6A modular patch panels.
7. Optical fiber patch panels.
8. Optical fiber LC connectors.
9. Wire management panels.
10. Field testing.
11. Firestopping.

1.3. SUBMITTALS

A. Submittals shall be complete and at one time. Partial submittals will not be considered.

B. Material lists, schedule of values, lists of subcontractors, and proof of Contractor qualifications shall be provided to Engineer upon request and shall follow the guidelines as stated in the General Requirements (Division 1 of the specification).

C. Shop drawings shall be submitted. All communication system shop drawings shall include:
1. Manufacturer's data (specifications, "cut sheets").
2. Wiring diagrams for all installed cabling.
3. Equipment rack/cabinet layouts.
4. Proposed labeling schemes and labeling method.
5. List of cabling distances (typical and maximum) for all structured cabling
6. Submit copies of certifications for all technicians and the project manager who will support this project. The certifications shall include:
   a. Structured Cabling and termination equipment installation certifications for copper and optical fiber connectivity and cabling.
   b. Approved manufacturer classes satisfactorily completed.
7. Contractor shall submit a test plan that defines the tests required to ensure that the system meets technical, operational, and performance specifications 45 days prior to proposed test date.
8. Work shall not proceed without the Owner's approval of the submitted items.

D. Drawings & Inspection of Site:
1. Communications floor plan drawings are to scale and typically are not dimensioned. The Contractor shall not scale drawings for equipment placement and clearances. Dimensions given on drawings shall always take precedence over scaled drawings.
2. Any existing wires, utilities, or equipment shown on the drawings are shown for general information and to the best knowledge of the Engineer. The Contractor shall field verify all existing wires, utilities, or equipment.
3. The Contractor shall field verify distances and equipment placements coordinating locations with other trades, construction managers, and general Contractor prior to installation.
4. The Contractor shall review all site conditions prior to submitting a bid on this project. Any obvious discrepancies between the site conditions and bidding documents shall be brought to the attention of the Engineer at the time of bidding so clarification can be made by addendum.

5. Change order requests for additional costs related to the contractors misunderstanding related to the amount of work involved and lack of knowledge related to the site conditions will not be allowed.

E. Test Reports: Submit copies of complete reports of all testing performed to the General Contractor, with copies to the Architect's Electrical Engineer upon completion of job.

1.5. APPROVED CONTRACTOR QUALIFICATIONS

A. The Contractor shall have experience in the installation and testing of similar systems as specified herein and shall have completed at least two projects of similar size and scope within the last 24 months. The Contractor shall provide references upon request (including the project name, address, date of implementation, client name, title, telephone number, and project description."

B. All members of the installation team must be certified by the manufacturer as having completed the necessary training to complete their part of the installation. All personnel shall be adequately trained in the used of such tools and equipment as required.

C. The Contractor bidding on communication systems specified herein shall be certified by the connectivity Manufacturer to install, service, and warranty the specified product prior to the time of bid and throughout the duration of the installation. Manufacturer certifications shall not be project specific and should be valid for any and all projects completed by Contractor.

D. The Contractor shall own and maintain tools, installation equipment, and test equipment necessary for successful installation and testing of optical and Category 6 & 6A premise distribution systems.

E. The Owner reserves the right to require the Contractor to remove from the project any such employee the Owner deems to be incompetent, careless or insubordinate.

F. The Contractor must maintain a state Contractor's license as required by the state.

1.6. APPROVED PRODUCT MANUFACTURERS

A. The manufacturer of the Connectivity products specified in this document, as required for construction of the cabling Infrastructure per contract documents shall be:
1. Hubbell Premise Wiring

B. The manufacturer of the Cabling products specified in this document, as required for construction of the copper cable Infrastructure per contract documents shall be:
1. Mohawk cable

C. The manufacturer of the fiber optic cabling products specified in this document, as required for construction of the Fiber Optic cable per contract documents shall be:
1. Mohawk Cable or Equal

D. Product substitutions are permitted under the conditions stated below. (1.7 A).

1.7. PRODUCT SUBSTITUTIONS

A. Product substitutions from other manufacturers shall require the approval of the owner or owner's representative.

1.8. QUALITY ASSURANCE

A. Installed category 6 balanced UTP and fiber cabling systems, pathways and distribution facilities shall adhere to manufacturer's instructions, contract drawings and specifications, and applicable codes, standards and regulations.

B. Installed category 6 balanced UTP cabling systems and field test results shall strictly adhere to requirements of ANSI/TIA/EIA-568-C.0 and ANSI/TIA/EIA-568-C.2.

C. Installed optical fiber cabling systems and field test results shall strictly adhere to requirements of ANSI/TIA/EIA-568-C.0 and ANSI/TIA/EIA-568C.3.

D. Where applicable, all equipment, components, accessories and hardware shall be UL listed for the intended purpose of the installation.

E. Installed products shall be manufactured by an ISO 9001 certified facility.

F. Installed products shall be free from defects in material or workmanship from the manufacturer and shall be of the quality indicated.

G. All methods of construction that are not specified in the contract documents shall be subject to control and approval by the Owner or Owner's Representative.

H. Installed products shall be lot-traceable by date code.

I. All critical internal manufacturing operations for installed products shall have documented in-process inspection and testing according to ISO9001.

1.9. DRAWINGS

A. Approved or preliminary contract drawings furnished at the time of bid solicitation shall serve as the basis for product selection, creation of bills of material, and determination of labor content.

B. Changes, additions, or deletions to contract drawings prior to awarding of the contract, shall require an amendment to the original bid.

C. Prior to submitting the bid, in reviewing the contract drawings, the Approved Contractor shall:

1. Request the attention of the Engineer, Owner, or Design Agency to clarify any materials, apparatus or work believed to be incorrect, inadequate, omitted, or in violation of applicable codes, standards or regulations.
2. Note any contingencies related to unknown aspects of any drawings or specifications.

D. Contract drawings, prior to execution of the project shall be formally approved and released by the Engineer or Design Agency and shall be approved by the Owner or Owner's Representative.

E. Execution of work shall be according to approved drawings, in addition to applicable specifications and contractual obligations.

1.10. APPLICABLE STANDARDS, CODES, AND REGULATIONS

A. Installation Standards: Cable installation shall comply with the following:

1. American National Standards Institute, (ANSI)
2. ANSI/TIA-568-C.0, "Generic Telecommunications Cabling for Customer Premises", published 2009
3. ANSI/TIA-568-C.1, "Commercial Building Telecommunications Cabling Standard", published 2009
4. ANSI/TIA-568-C.2, "Balanced Twisted-Pair Telecommunication Cabling and Components Standard", published 2009
5. ANSI/TIA-568-C.3, "Optical Fiber Cabling Components Standard", published 2008, errata issued in October, 2008
6. ANSI/TIA-568-C.4, "Coaxial Cabling Component Standard" Published 2010
7. ANSITIA/EIA-569-B, Commercial Building Standards for Telecommunications Pathways and Spaces, 2003.
8. ANSI/TIA-607-B, Commercial Building Grounding and Bonding Requirements for Telecommunications, 2010.
9. ANSI/TIA/EIA-942, Telecommunications Infrastructure for Data Centers, 2004.
10. ANSI/ICEA S-83-596, Fiber Optic Premises Distribution Cable, 2001.
11. ANSI/TIA/EIA-598, Color Coding of Optical Fiber Cables, 2001
12. ANSI/ICEA S-87-640, Fiber Optic Outside Plant Distribution Cable, 1999.
13. ANSI/TIA/EIA-492AAAC, Detail Specification for 850nm Laser-Optimized 50um Core Diameter/125 um Cladding Diameter Class 1A Graded Index Multimode Optical Fibers, 2003.
14. ANSI/TIA/EIA-492CAAA, Detail Specification for Class Iva Dispersion-Unshifted Singlemode Optical fibers, 2002.
15. ANSI/TIA/EIA-758: Customer-Owned Outside Plant Telecommunications Cabling Standard, 2004.
16. ANSI/TIA/EIA-526-7, Optical Power Loss Measurements of Installed Singlemode Fiber Plant: OFSTP-7, 2002.
17. ANSI/TIA/EIA-526-14-A, Optical Power Loss Measurements of Installed Multimode Fiber Plant: OFSTP-14A, 2003.
18. ANSI/TIA/EIA-TSB-125, Guidelines for Maintaining Optical Fiber Polarity Through Reverse-Pair Positioning, 2001.
19. ANSI/TIA/EIA-TSB-140, Additional Guidelines for Field Testing Length, Loss, and Polarity of Optical Fiber Cabling Systems, 2004.
20. ANSI/TIA/EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure, 2002.
21. ANSI/EIA-310-D, Cabinets, Racks, Panels, and Associated Equipment, 1992.
22. ANSI/TIA/EIA-604 (Series), FOCIS Fiber Optic Connector Intermateability Standard, 2000-2003.
23. National Fire Protection Association, Inc., NFPA 70
24. National Electric Code (NEC), 2005.
25. NEC Article 250: Grounding
26. NEC Article 386: Surface Metal Raceways
27. NEC Article 388: Surface Non-Metallic Raceways
28. NEC Article 800: Communications Circuits
29. NEC Article 770: Optical Fiber Cables and Raceway
30. Underwriter's Laboratory, Inc. (UL)
31. UL-5A: Standard for Non-Metallic Raceways and Fittings
32. UL-5: Standard for Surface Metal Raceways and Fittings

33. UL-5C: Standard for Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits
34. UL-50: Standard for Enclosures for Electrical Equipment
35. UL-94-V0: Tests for Flammability of Plastic Materials
36. UL-498: Attachment Plugs and Receptacles
37. UL-1479: Fire Tests of Through-penetration Firestops (in Accordance with ASTM E814).
38. UL-1863: Standard for Safety of Communications Circuit Accessories
39. National Electrical Manufacturer's Association (NEMA)
40. ANSI/NEMA WD-6-2002: Wiring Devices – Dimensional Requirements
41. NEMA 250-2003: Enclosures for Electrical Equipment
42. ISO/IEC 11801, Ed. 2:2002, Information Technology – Generic Cabling for Customer Premises, 2002.
43. ISO/IEC 18010, Information Technology – Pathways and Spaces for Customer Premises Cabling, 2005.
44. ISO/IEC 14763-1, Information Technology – Implementation and Operation of Customer Premises Cabling – Part 1: Administration, 2004.
45. CSA C22.1-06, Canadian Electric Code (CEC), 2006
46. Federal Communications Commission (FCC) Title 47, Code of Federal Regulations, Part 68: Connection of Terminal Equipment to the Telephone Network, 1998.
47. U.S. Public Law 336. 101st Congress, ADA: Americans with Disabilities Act of 1992.
48. IEEE 802.3af, Data Terminal Equipment (DTE) Power Over Media Dependent Interface (MDI), 2003.
49. IEEE 802.3at (current draft), Data Terminal Equipment (DTE) Enhanced Power Over Media Dependent Interface (MDI).
50. IEEE 802.3ae, Specification for 10 Gbit/s Ethernet Operation over Optical Fiber.
51. Telecommunications Distribution Methods Manual, 11th Ed., Building Industry Consulting Services International (BICSI), 2006.
52. Information Transport Systems Installation Manual, 4th Ed., Building Industry Consulting Services International (BICSI), 2004.

B. This document is not a substitute for any code, standard or regulation. The Approved Contractor must be aware of local codes that may impact the bid submittal or execution of the project. The current revision of any applicable code, standard, or regulation shall take precedence at the point of project execution, unless otherwise recognized by local authorities. Applicable standards or codes that affect construction, which are listed as normative references within any governing document, are also the responsibility of the Approved Contractor for compliance.

C. Materials
1. All materials shall be UL or ETL listed and verified and shall be marked as such.
2. Products shall be regularly catalogued items of the manufacturer and shall be supplied as a complete unit in accordance with the manufacturer's standard specifications with any optional items required for proper installation unless otherwise noted.
3. Material shall be delivered to the site in the original packing.

1.11. MAINTENANCE

A. All materials used on this project shall be new. Used and refurbished equipment is not permitted unless approved by CITY OF MADISON. Provide equipment to site in original packaging whenever practical.

B. The Contractor is responsible for scheduling all deliveries and providing proper receipt, handling, and storage of all materials. Protect all equipment from physical damages (dents, scratches, dust, water, paint, chemicals, and temperature extremes) and vandalism, or theft. The Contractor shall replace any damaged or stolen equipment. The Contractor is responsible for all equipment until final project acceptance by Owner.

C. Maintenance of the cabling infrastructure is to be done by authorized personnel only or void of manufacturer's warranty may result. It is the responsibility of the owner or end user to utilize a certified installer to maintain warranty coverage on existing or new cabling infrastructure.

D. The telecommunications contractor shall furnish a quotation for time and material to perform maintenance and repairs. The owner has the first right of refusal of selecting suitable contractor or qualified internal personnel to perform maintenance and repairs on structured cabling.

E. Additions of new cabling, either horizontal or backbone, shall be completed, tested, and documented into permanent building records. New cabling installations intended to be covered by the manufacturer's warranty shall adhere to the documentation submittal and system certification provisions stated above.

F. The Contractor is responsible for cleaning the worksite every business day and remove debris from the facility.

1.12. DOCUMENTATION

A. TEST RESULTS

1. All test results are to be saved electronically on CD. Test documentation submitted on disk shall be clearly marked on the cover with the words "Project Test Documentation", the project name, and the date of completion (month and year). For multiple buildings, the building name, including floor or wing I.D. should also be included on the test results disk.
2. File names of the test results recorded for each link shall match the official identification. Test results shall include a complete record for each link, including type of test, cable type, cable/port I.D., measurement direction, reference setup, date, and technician's name(s).
3. The test equipment name, manufacturer, model number, serial number, software version and last calibration date shall also be provided in the test results documentation.
4. When repairs and re-tests are performed, the problem cause and corrective action taken shall be noted, and both the failed and passed test data shall be documented.
5. The owner, engineer, lead project manager, or owner's representative reserve the right to request verification of test results with a re-test of installed cables, on a sampling basis. Re-testing shall be at the expense of the installer unless otherwise noted in the contract documents.

B. AS BUILT DRAWINGS
1. Deviations from the approved drawings, whether or not a change order is submitted, shall be clearly denoted as built on the working hard copy drawing by the telecommunications contractor. As-built drawings shall be returned promptly to the owner or design agent for completion of drafting revisions to the original design. See "Documentation – Change Orders" below. Manufacturer's warranty registrations may also require as-built drawings.
2. Floor plan drawings shall at minimum include detailed cable and pathway layouts, exact locations of workstation outlets, and cable distribution hardware locations. Workstation outlets shall have alphanumeric identifiers on the drawings as specified by the end user or owner.

C. CHANGE ORDERS
1. Any deviation from the approved contract drawings or specifications shall be submitted as a written change order.
2. Execution of work, to perform changes, shall not proceed without prior written approval. Any changes done without written approval will be at no cost to CITY OF MADISON. If the work is shown to be incorrect the contractor will have to correct the problem at no cost to CITY OF MADISON.
3. Significant changes may require a written quotation of additional labor and materials from the telecommunications contractor.
4. It is the responsibility of the owner or owner's representative to bear the added cost of any substantial cabling system design changes. The contractor will not proceed with any change orders without written approval by the owner's representative. Any changes not approved by the owner's representative will be responsibility of the contractor and at no cost to CITY OF MADISON.
5. Field changes that are completed without issuance of revised drawings shall be clearly denoted on the working as-built drawing. Refer to "As-Built Drawings" above.

D. PUNCH LISTS AND CORRECTIVE ACTION
1. As required in the contract documents, the telecommunications contractor shall correct punch-lists items determined to be in violation of drawings, specifications, codes, standards or regulations.
2. The contractor shall be responsible for timely re-work of faulty cabling or hardware installations.
3. The owner reserves the right to withhold final payment until punch list items are resolved satisfactorily.

1.13. WARRANTY

A. THE CITY OF MADISON requires a Permanent Link warranty for the project. Manufacturer requires Permanent Link Test.
B. The length of the extended warranty shall be a minimum of twenty-five (25) years.
C. Warranty covering all components, equipment and workmanship shall be submitted in writing with system documentation.
D. The warranty period shall begin on the system's first use by the owner.
E. Should the cabling system fail to perform its expected operation within this warranty period due to inferior or faulty material and/or workmanship, the contractor shall promptly make all required corrections without cost to the Owner.
F. Upon Completion of the project the Telecommunication Contractor shall forward the signed Warranty Registration Form and warranty certificate to the Owner.
G. The manufacturer warrants category 6 cabling, category 6A cabling, optical fiber cabling and connecting components free of defects in material or workmanship.

H. Category 6, category 6A and optical fiber cabling and components are warranted to perform the intended application upon completion of proper installation and testing.
I. Warranty coverage includes application assurance and compliance to applicable performance specifications.
J. Installed category 6 and 6A cabling systems may be granted a full Channel warranty under the conditions stated below.
1. A certified installer registered who has completed a Manufacturer's training program performs the construction.
2. Contractors performing the certified installation are properly registered in the Manufacturer's warranty program.
3. The channel components are supplied entirely by one Manufacturer, including patch cords.
4. Cable used in the installation is qualified and recognized by Connectivity Manufacturer.
5. Installed link systems are properly documented and tested with a "PASS" result. The county requires a link test and the use of manufacturer patch cords to receive a channel warranty.
6. Field test equipment used for category 6 cabling is minimum level III classification and complies with TIA/EIA-568-B.2 requirements.
7. Required test results, stored on a CD, and project documentation including as-built drawings, are to be submitted to the Manufacturer by the registered contractor.

1.14. MOVES, ADDS AND CHANGES

A. Moves, additions and changes initiated by the owner, end user, project manager, or design agent, which are beyond the scope of work in the original contract, shall require a revised quotation by the telecommunications contractor.
B. It is the responsibility of the owner or owner's representative to bear the added cost of any substantial cabling system design changes.
C. Moves, additions and changes shall either be issued in revised drawings, or otherwise shall be clearly denoted on as-built drawings.
D. Moves, additions and changes that affect installations covered in a manufacturer's warranty shall be performed by a certified contractor that is properly registered in the manufacturer's warranty program.

1.15. CLEANUP

A. The communications Contractor shall clean up all debris related to this work on a regular basis leaving the job site in a clean, safe condition.
B. Protect all equipment from damage during construction. Equipment not protected shall be replaced at the Contractor's expense.

PART 2 - PRODUCTS

2.1. WORK AREA CONNECTORS

A. Category 6 Jacks
1. Jacks shall be standard 8-position, RJ-45 style, un-keyed, FCC compliant.
2. Jacks shall be designed for 4-pair, 100 ohm balanced unshielded twisted pair (UTP) cable.
3. Jacks shall terminate 26-22 AWG solid or stranded conductors.
4. Jacks shall include a dust cap for wire retention.
5. Jacks shall accept FCC compliant 6 position plugs.
6. Jacks shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.
7. Category 6 jacks shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.
8. Jacks shall be manufactured in the USA.
9. Category 6 jacks shall meet or exceed Category 6 transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-C.2, Transmission Performance Specifications for 4-Pair 100 ohm.
10. Jacks shall be UL LISTED and CSA certified.
11. Colors to specified by end user
12. Category 6 modular jacks, as specified in the Contract Documents, shall be:
a. Hubbell
b. HXJ6EI (Category 6 – Ivory)

2.2. FACE PLATES

A. Rear loading w/designation window

1. Faceplates shall be constructed of high impact, UL94 V-0 rated thermoplastic.
2. Faceplates shall be compatible with standard NEMA openings and boxes.
3. Faceplates shall be 2.75" W x 4.5" H (69.8 mm x 114.3 mm) for single gang and 4.5” X 4.5” (114.3 X 114.3 mm) for double gang.
4. Port size in each faceplate shall fit the Category 6 Modular Jack or Snap-Fit fiber optic, audio, and video modules for multimedia applications.
5. Faceplates shall be provided with clear plastic and color-matched label field covers. Faceplates shall provide for ANSI/TIA/EIA-606-A compliant workstation outlet labeling.
6. #6-32 pan head Phillips/slotted mounting screws shall be included with each faceplate.
7. Faceplates shall be UL LISTED and CSA certified.
8. Work area faceplates, as specified in the Contract Documents, shall be:
   a. Hubbell (IFP Series)
   b. IFP14ei (4-Port Ivory)

2.3. CABLE

A. Category 6 UTP

1. Plenum - Cable construction shall be four twisted pairs of 23 AWG insulated solid conductors, with a ripcord, surrounded by a tight outer jacket.
2. Non-plenum - Cable construction shall be four twisted pairs of 24 AWG insulated solid conductors, with a ripcord, surrounded by a tight outer jacket.
3. NO minimum compliant cable will be accepted. The facility requires additional bandwidth.
4. Ripcord shall be directly underneath the outer jacket.
5. Cable shall be marked with Manufacturer and pertinent information. UL, ETL, or CSA agency certification or verification markings shall be marked on the cable jacket according to the certifying agency’s requirements.
6. Color coding of the pairs shall be as follows:
   a. Pair 1: White/Blue; Blue
   b. Pair 2: White/Orange; Orange
   c. Pair 3: White/Green/Green
   d. Pair 4: White/Brown/Brown
7. Plenum or Riser rated jackets
8. Cable shall be supplied in 1000 ft spools or 1000 ft Reelex boxes.
9. Cable shall exceed Category 6 transmission requirements specified in ANSI/TIA/EIA-568-C.2.
10. Cable shall be UL and C (UL) listed.
11. Cable shall exceed the requirements of TIA/TSB-155: 10 Gb/s Ethernet Operation over 37 Meters Channel Length.
12. Category 6 UTP horizontal distribution cable, as specified in the Contract Documents, shall be:
    a. Mohawk AdvanceNet Cable
    b. Plenum M57193
    C. Riser M57202

B. Backbone distribution cable – Fiber Optic

1. Singlemode fiber backbone distribution cable shall be available in multi-strand constructions for intra-building applications.
2. OFNR or OFNP will be determined at each site. The contractor will be responsible to assure that the proper type of jacketing is being used. Failure to meet the local code will be cause for replacement of cable at no expense to CITY OF MADISON.
3. Singlemode fiber shall be dispersion un-shifted fiber in compliance with ANSI/TIA/EIA-492CAAA.
4. Intra-building fiber distribution cable design shall be according to ANSI/ICEA S-83-596.
5. Singlemode backbone fiber distribution cable, when installed, shall exceed the performance requirements of ANSI/TIA/EIA-568-C.3.
6. Singlemode optical fiber Backbone Fiber distribution cable, as specified in the Contract Documents, shall be:
   a. Mohawk Cable or equal
   b. Singlemode Riser M9W042 (12 Strand) unless otherwise specified by the City of Madison.
   C. Singlemode Plenum M9W048 (12 Strand) unless otherwise specified by the City of Madison.

2.4. CONNECTORS – FIBER OPTIC

A. Pre-polished fiber connector basic design shall be a factory pre-polished lc-style optical fiber connector with a zirconium ceramic ferrule.

B. Index-matching gel is factory-injected into the cleaved fiber stub splice to minimize connector insertion loss.
C. LC Singlemode factory pre-polished connectors shall HAVE pre-installed fibers.
D. Connector materials shall be designed with thermal stability to comply with environmental requirements of ANSI/TIA/EIA-568-B.3 and Telcordia GR-1081-CORE.
E. Pre-polished lc connectors shall require no field polishing AND REQUIRE NO ADHESIVES FOR TERMINATION.
F. Connector design and termination technique shall be independent of cable type or manufacturer, and shall be compatible for either 900 micron buffer or 250 micron buffer distribution cables.
G. Pre-polished LC fiber connectors, when properly installed onto qualified cable, shall meet the 10 Gb/s Ethernet performance requirements of IEEE802.3.
H. LC fiber connectors, properly installed onto qualified cable, shall exceed the mechanical and environmental performance requirements of ANSI/TIA/EIA-568-C.3.
I. Optical fiber horizontal distribution cable, as specified in the Contract Documents, shall be:
    1. Hubbell ProClick
    2. Singlemode LC – FCLC900KSM12
    3. AFL (Fast)
    4. Singlemode LC- fast-LC-SM

2.5. PATCH PANELS – CATEGORY 6

A. Category 6 patch panels shall be standard 8-position, RJ-45 style, un-keyed, FCC-compliant receptacle, in 24- and 48-port configurations.
B. Panel frames shall be black powder coated 14-gage steel with rolled edges top and bottom for proper stiffness.
C. Panels shall accommodate a minimum of 24 ports for each rack mount unit (1 RMU = 1.75 in.). 48 ports are recommended.
D. Panels shall be designed for 4-pair, 100 ohm balanced unshielded twisted pair (UTP) cable.
E. Panels shall terminate 26-22 AWG solid conductors.
F. Panels shall have individual port identification numbers on the front and rear of the panel. Panels shall have the Category 6 designation, visible from the front when installed.
G. Printed circuit boards shall be fully enclosed front and rear for physical protection.
H. Panel contacts shall accept a minimum of 2000 mating cycles without degradation of electrical or mechanical performance.
I. Panel termination method shall follow the industry standard 110 IDC punch-down, using a standard 110 impact termination tool.
J. Category 6 panels shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.
K. Category 6 patch panels, when installed, shall exceed the link or channel performance requirements of ANSI/TIA/EIA-568-C.2.
L. Category 6 patch panels shall be able to accommodate 10G in a 37 meter channel per TSB-155.
M. Category 6 patch panels, as specified in the Contract Documents, shall be:
    1. Hubbell (NEXTSPEED 6 Series)
    2. 24 Port - P6E24U
    3. 48 Port - P6E48U

2.6. CABINET – WALL MOUNT

A. Rack material shall be welded steel construction with a durable black polyurethane powder coat finish.
B. Installed racks shall have a static load capacity of 300 Lbs.
C. Cabinet shall be 48-inch high, 23-inch wide and 30-inch depth.
D. Tapped holes in the vertical rails for mounting of panels shall be #12-24 thread size. Coating shall not interfere with thread fit.
E. Cabinet shall have a capacity of 26 RMU.
F. Cabinet consist of: Cabinet & mounts to secure the cabinet, a vertical Electrical 20 amp Outlet strip (Minimum 6 receptacles) with Mounting Brackets.
G. Wall mount cabinet and accessories, as specified in the Contract Documents, shall be:
    1. Hubbell (XHW series)
    2. Hubbell HSQ4836

2.7. CABLE MANAGEMENT –VERTICAL CABLE MANAGEMENT – NOT USED ON THIS PROJECT

A. Z-channel design offers:
    1. Airflow

2. Minimizes weight
3. Maximum cable capacity with unobstructed access to cable

B. Snap in Spools with ability to put them where they will do the most good.
C. Rear cable management allows cable to be run on both left and right sides, while leaving the area behind the electronics and patch panels open for increased airflow.
D. Construction:
1. Cold Rolled steel z-channels
2. Cold rolled steel covers
E. Mounts to 84" Equipment racks
F. Channel width: 6"W
G. Vertical Cable Management and accessories, as specified in the Contract Documents, shall be:
1. Hubbell (NEXTFRAME series)
2. VS76

2.8. CABLE MANAGEMENT –HORIZONTAL CABLE MANAGEMENT

A. Horizontal management will be constructed of 14 ga cold-rolled steel (CRS)
B. Finish shall be a Durable, black powder coat.
C. Size: 2RU
D. Front Ring Depth: 3.5"
E. All steel construction - rugged, non-flammable, no fasteners to wear or break, no fingers to fuss with.
F. Modular components easily configured in field to adapt to demanding applications.
G. Hinged Front Cover - Locks in place when completely open to prevent cover from being removed or lost.
H. Horizontal Cable Management and accessories, as specified in the Contract Documents, shall be:
1. Hubbell (NEXTFRAME series)
2. HC219CE3N
I. Enclosures – fiber rack mount
1. Rack-mounted, powder coated formed cold rolled steel enclosure.
2. Swing-out or pull-out inner tray shall provide access to inner cables and connections, and maintain proper cable bend radius throughout the range of motion.
3. Fiber rack-mount enclosures shall be a 19-inch formed/welded and powder coated modular design, sized according to the cable installation.
4. Fiber rack-mount enclosures may serve as a main, horizontal, or intermediate cross connect facility.
5. Panel mounting brackets shall be configurable to either 19" or 23" racks per ANSI/EIA-310-D.
6. Enclosure chassis shall have two mounting bracket locations for either flush mount or center mount on the rack.
7. Inner tray shall have a threaded mounting boss to accept a mounting stud for splice trays. Splice tray capacity shall be (2) 10" splice trays, each with 24-splice capacities (48 splices total). Splice tray mounting boss shall also accept a stud for mounting 1-RMU blown fiber adapter brackets.
8. Inner tray mounting posts for modular panels shall also accept 12-fiber MTP-style cassettes for "plug & play" installations.
9. Inner tray shall have rear cable tie-down features to accept various diameter backbone cables entering the enclosure.
10. Enclosures shall be constructed of 16 gage cold rolled steel (CRS)
11. Fiber rack-mount enclosures and accessories, as specified in the Contract Documents, shall be:
a. Clearfield – Fieldsmart fiber crossover distribution system.

J. Adapter panels – optical fiber
1. Optical fiber Adapter panels shall be a modular design powder coated stamped metal construction.
2. ADAPTER PANELS SHALL BE LC.
3. High or low-density versions.
4. Adapter panels shall have quick-release snap fasteners to fit directly into fiber enclosures.
5. Fiber patch panels, as specified in the Contract Documents, shall be:
a. Clearfield – Clearview class patch only cassette.

2.9. INNER-DUCT

A. Fiber Optic Cable shall be installed with Innerduct for protection of fiber cables in a shared pathway.
B. The inner duct will be rated for the environment that it is being installed in. Plenum and riser rated.
C. Three inner Ducts will be run between closets. One for current installation, two spare for future applications.

D. Size: 1" CORRUGATED
E. Flexible & Lightweight for ease of handling
F. Pre-threaded with pull line

PART 3 - EXECUTION

3.1. APPROVED CONTRACTOR RESPONSIBILITIES

A. The Approved Contractor shall assume the following responsibilities:
1. Execute construction in accordance with contract drawings and specifications.
2. Adhere to project schedules and job site rules.
3. Adhere to the quality, regulatory, logistics, and documentation requirements.
4. Adhere to the product requirements outlined in PART 2 above.
5. Adhere to the Execution guidelines outlined below.
6. Furnish the cabling system certification and warranty provisions outlined in this specification section.

3.2. DELIVERY, STORAGE AND HANDLING LOGISTICS

A. Materials delivered to the construction site shall be stored in a dry, secure area, preferably indoors. Storage temperature of materials shall adhere to manufacturer's recommendations. Movement of packaged materials shall be in a manner to avoid damage of contents. On-site storage, either indoors or trailer, shall have permission by the owner, and shall not interfere with other construction activity.
B. Installation of category 6 cable shall be within the recommended temperature range specified by the manufacturer. Cable installation temperature above 50F is recommended.

3.3. PREPARATION

A. Cable pathways and Firestops
1. Cable pathways, including conduit, cable tray, ladder rack, raceway, slots, sleeves, etc. shall be located and mounted according to contract drawings and manufacturer's instructions. Pathways shall not be installed in wet areas.
2. Cable pathway fill ratio, bend radius, run length, number of bends, and proximity to EMI sources shall be in accordance with ANSI/TIA/EIA-569-B. Maximum cable count of the initial installation shall not exceed 40% fill ratio in any pathway.
3. In accordance with NEC 2005, power wiring and communications cabling shall not share the same pathway or outlet unless separated by a physical barrier.
4. Cable pathways shall be secured to a structural member of the building, or permanent wall studs. Wall surfaces for raceway mounting should be finished complete.
5. Metallic pathways shall be electrically continuous, free of sharp edges, and properly bonded to an approved ground. EMI sources such as ballasts, motors, and bus conductors shall be avoided by using proper separation distances.
6. Pathways that penetrate fire-rated barriers shall be fire stopped according to local codes and recognized practices. Fire stop materials or devices shall be qualified to UL-1479, in accordance with ASTM E814. Fire stop method shall have P.E. approval.
7. Core drilling of holes for fire-rated poke-through outlet devices shall have approval by a structural engineer or P.E. on the contract drawings prior to start of work.
8. Pathways for vertical cable runs, such as slots and sleeves, shall be installed in the proper location in accordance with applicable codes and standards.

B. Telecommunications rooms and equipment rooms
1. Telecommunications room (TR) layout, location and design shall be in accordance with the guidelines of ANSI/TIA/EIA-569-B. TR's on each floor of the building should be centrally located and vertically aligned to simplify backbone cable and pathway routing. TR's shall not be installed in wet areas, or near EMI sources or caustic chemicals.
2. Layout of rack, cabinet or enclosure locations shall be according to contract drawings.
3. Racks and cabinets shall be secured to the floor using proper anchors and fasteners.
4. Mount and assemble racks, cabinets, brackets and enclosures per manufacturer's instructions. Mount patch panels and cable management accessories in the specified locations.
5. Adjoining pathways (ladder rack, cable tray, etc.) shall be properly secured and positioned to allow adequate bend radius of cables entering the rack or cabinet.

C. Wall outlets and recessed wall boxes

1. Wall outlet and cable drop pathway location shall be according to contract drawings. Guidelines from ANSI/TIA/EIA-569-B should be followed for location with electrical outlets and outlet height above finished floor.
2. Outlet boxes shall be fastened securely to a wall stud or structural element, in a manner to permit flush mounting of the faceplate with the finished wall.
3. Multi-connect boxes shall be installed in a manner to comply with separation rules for power and communications wiring in close proximity.
4. Refer to specific manufacturer's recommendations for wall outlet selection, cable deployment, and termination of jacks into faceplates.

D. Surface housings and MUTOA outlets

1. Raceway or conduit should be deployed to the surface housing location. For through-wall cable entry, cut the wall opening to match the opening in the housing base.
2. Lay out mounting holes onto the desired wall location. For wallboard, concrete or cinder block walls, drill to the proper depth and install anchors.
3. Always use proper wall anchors. Installing mounting screws directly into wallboard without using anchors can cause screw pullout and detachment of the surface housing. Mounting the base plate to studs is recommended.
4. Mount base plate of surface box or MUTOA to outlet location using proper fasteners. Note: furniture and wall outlet applications require mounting of base plate prior to cable pulling and connector termination.
5. Install cover onto base plate.
6. Refer to detailed manufacturer's guidelines for cable deployment and termination of jacks into surface housings. Due to the larger size of category 6 cables, proper cable bend radius must be maintained. Certain restrictions may apply when dressing category 6 cabling into surface housings.

3.4. INSTALLATION

A. Cable Support

1. This Contractor shall install all supports for cables specified in this section. Traditional Ladder rack will be used in each telecommunications room, basket tray and j-hooks will be used in the horizontal.
2. Cable supports shall be spaced randomly, but no further than 5'-0" apart.
3. Inner-ducts will be run between each closet or telecommunications room. One for current installation with three multi cells for future installations or changes. In each telecommunications room the inner-ducts entering the space will be combined, in a size appropriate metallic box that is mounted on the wall. The combined inner ducts will then be routed to the rack and the fiber bay.
4. Provide all additional cable management products, sleeves or conduit raceways as required to protect exposed cabling and complete the installation of cables in a neat manner.
5. A horizontal conduit system consists of conduits radiating from the telecommunications room to the workstation outlets in the floor, walls, ceilings, and columns of a building. When using a conduit distribution system utilize the most direct route following the building lines.
6. The size and number of conduits or sleeves used for backbone pathways depends on the usable floor space served by the backbone system. at least three 4 trade size sleeves are recommended.
7. Conduit is only required if building codes or environmental conditions necessitate it. Rigid or EMT metal conduits are deemed suitable for building installation. Adequate planning should allow for a minimum of one 1-inch conduits to each workstation location if code requires conduit for voice and data cables.
8. Conduit fill ratios shall not exceed 40%; contact your cable manufacturer to get recommendation on fill rates.
9. No conduit run should be designed with more than two (2), 90 degree bends between pull points or pull boxes. If a run requires more than two 90 degree bends, install a pull box.
    a. Exceptions:
        i. The total run is not longer than 33 feet.
        ii. The conduit size is increased to next trade size.
        iii. One of the bends is located within 12 inches of the cable end.
10. All conduits will be equipped with a contiguous length of plastic or nylon pull string with a minimum rating of 200 lbs. (90 Kg)
11. A conduit run should not be designed with continuous closed sections longer than 100 ft without pull points or pull boxes installed.
12. All conduits should terminate above or in the installed ladder racks and allow for proper cable racking. Cable waterfalls should be considered in areas that have excessive distance between the conduit and ladder rack.

13. Trays and conduits located within the ceiling shall protrude into the room a distance of 1 to 2 in without a bend and above 8 ft high. Clear, unobstructed access to the ladder rack and conduits shall be provided within telecommunications rooms.
14. Conduits entering through the floor shall terminate at least two (2) inches above the finished floor
15. Locate slot/sleeve systems in places where pulling and termination will be easy.
16. If possible, locate sleeves, slots, and/or conduits on the left side of the room; this placement enhances the use of wall space from left to right.
17. When possible, entrance conduit and distribution conduit/cable tray should enter and exit on the same wall; if this is not possible, ladder rack inside the room should be provided for distribution from wall to wall.
18. All floor penetrations shall be core drilled with a maximum 1/4 inch size greater than the exterior dimension of the riser conduit.
19. Conduits entering through a wall shall be reamed and bushed, and terminated as close as practicable to the terminating rack or wall.
20. Terminating above a suspended ceiling must terminate not less 3 inches above finished ceiling and finished with bushing opening.
21. All conduit will be labeled for easy identification.
22. All floor penetrations shall be at columns, exterior walls or in equipment rooms.
23. Cables shall be supported at height of bottom flange of structural beams using a rigid support method (i.e. threaded rod, beam clamps, etc.).
24. Do not support cables from ductwork, sprinkler piping, water piping, waste piping, conduit, ceiling wire, or other system supports.
25. The conduits or sleeve will be installed per TIA/EIA-569-B and seal all penetration with approved fire stop product.
26. Provide independent support system for each low voltage cabling system.

B. Cable

1. Category 6 cable will be run for data. Category 6A will be run to all Wireless access points. Category 6 Gelled filled cable will be run in the backbone for all communications applications. Certain environments may require the use of different cables and/or cable jackets.
2. **All Terminations will utilize T568B wiring in THE CITY OF MADISON facility.** Any Contractor not complying with this wiring requirement will fix the problem at no cost to CITY OF MADISON.
3. Maximum cable lengths to be 295 feet (90 m) including service loop. Provide all necessary installation materials, tools and equipment to perform insulation displacement type terminations at all communications outlets, patch panels.
4. All communications cabling that has become abandoned as part of new renovation projects, previous renovation projects, or temporary communication cables used during the construction process shall be completely removed.
5. Refer to detailed manufacturer's guidelines for deployment of category 6 cable. Certain restrictions apply, and specific techniques are recommended.
6. All cabling shall be installed in accordance with manufacturers' written bend radius and pulling tensions. General industry guidelines recommend the following bend radius and pulling tensions:
   a. Tensile loading on a single 4-pair copper UTP cable shall not exceed 25 lbf.
7. Bend radius of a single 4-pair copper UTP cable shall not exceed 4 times the diameter of the cable.
8. Bend radius of multi-pair copper UTP and optical fiber cable shall not exceed 10 times the diameter of the cable.
9. All conduits and conduit sleeves shall have bushings or grommets shall be installed prior to the installation of communications cables to avoid damage and abrasions to cable sheathing and insulation. If bushings have are installed by the electrical Contractor, the communications cabling contract shall furnish and install bushings prior to pulling communications cabling.
10. Horizontal cable length for 4-pair copper UTP cables shall not exceed 295 feet. Prior to bidding and installation, the contactor shall review the drawings and verify no cable run exceeds 295 feet and notify the communications designer of cable runs that may exceed 295 feet.
11. Splices are not permitted in any voice or data cable unless other specified or shown on drawings.
12. Avoid placing copper cables near sources of extreme heat (i.e. boilers, radiators, heat coils).
13. Maintain cable twists for all UTP cables. For terminations cable sheathing shall be stripping back no more than ½" back from termination point for all Category 6 cables.
14. All cables shall be supported by cable tray, cable runway, or J-hooks. When large quantities of cables leave trays or runways, cables shall be supported by drop-outs or cable support hardware manufactured

specifically for the purpose of supporting cables. J-hooks shall be installed a minimum of every 5 feet and cabling shall maintain minimal deflection and strain (less than 12" deflection). Cables shall not be supported from ceiling grid wires. Cables shall not run above iron joists.

15. All cables shall be separated and bundled into like groups.
16. Service loops shall be provided at both ends of installed horizontal and backbone cabling. A 12" service loop shall be installed in the ceiling space near workstation outlets (excessive cable shall not be coiled in outlet boxes). A 10' service loop shall be provided in communication rooms and shall be installed to allow for future equipment rack/cabinet relocations without the need to re-terminate patch panels; the 10' service loop shall be neatly bundled and secured in ceiling space with large D-rings or place in cable trays. Cable slack and service coils shall be stored properly above the ceiling or under the access floor. A "figure-eight" service loop is recommended for category 6 cabling to reduce EMI coupling. Loose, random bundling is recommended.
17. Any cabling installing in equipment rooms shall be neatly placed in cabling trays, cabling runways, or horizontal and vertical rack/cabinet cable managers.
18. Velcro straps shall be utilized in the TR and inside TC enclosures for all cable bundling. Tie wraps shall be prohibited in the telecommunication rooms.
19. Separation: Maintain the following distances between cables, other system cables and other building systems:
    a. One (1) foot from Fluorescent Light.
    b. One (1) foot from power cable in parallel.
    c. One (1) foot from electrical conduits, other systems cables or other electrical equipment.
    d. Four (4) feet from motors or transformers
    e. Three (3) feet from hot water piping or other mechanical equipment.
    f. Ten (10) Feet from Bus Conductors or high-current branch circuits.
20. All low voltage cables shall be run parallel or at right angles to building structural framework. Do not run cables diagonally across ceiling space without written authorization by the Architect's Electrical Engineer or CITY OF MADISON Representative.
21. Communications cabling that must cross power cables or conduit shall cross at a 90-degree angle, and shall not make physical contact.
22. Fire seal around all cables running through rated floors and walls. Firestop all cables and pathways that penetrate fire-rated barriers using approved methods and according to local codes.
23. Leave spare pull string with every outlet installed.
24. Do not install cable in wet areas, or in proximity to hot water pipes or boilers.
25. Cable ends for termination shall be clean and free from crush marks, cuts, or kinks left from pulling operations. Installed cable jackets shall have no abrasions with exposed conductor insulation or bare copper "shiners". The installer is responsible to replace damaged cables.
26. Backbone cables shall be installed and bundled separately from horizontal distribution cables. Backbone and horizontal cable bundles shall be loose and random.
27. Backbone cables spanning more than three floors shall be supported at the top of the cable run with a wire mesh grip and on alternating floors, unless otherwise specified by local codes or manufacturer's guidelines.
28. Vertical runs of backbone cables entering each TR shall be securely fastened along a properly prepared wall in the TR on each floor. Use of cable ladder is recommended.

C. Communications Infrastructure
1. Maximum cable lengths to be 295 feet (90 m) including service loop. Provide all necessary installation materials, tools and equipment.
2. Support and secure cables at patch panels using rear cable management bracket, spools or management device.
3. Cross-connects shall be completed as per construction schedule.

D. Optical Fiber Cable:
1. Inner-ducts of the proper rating will be run between each closet.
2. Cables for direct burial, aerial, or other outside applications shall be designed specifically for the intended purpose.
3. All optical fiber installations shall be installed using open cabling methods. Limit cable-bending radius to 20 times the cable diameter during installation, and 10 times the diameter after installation. Provide all required tools, materials, consumables, and equipment necessary for field mounting of LC connectors.
4. Do not exceed the maximum pull tension specified by the cable manufacturer. Use appropriate lubricants as required to reduce pulling friction. Avoid kinking and twisting of cables during installation.

5. Label each end of each cable as to source and destination. Terminate optical fibers in consistent, consecutive manner at each end. Place all material in inner-duct between Label Optical Fiber raceway cable with yellow "Caution - Optical Fiber Cable" tags every 10 feet. Leave 10 feet of slack at each fiber termination point. Neatly coil slack optical fiber cable on top of rack above optical fiber patch panel enclosure at each rack location.
6. Optical fiber cable terminations shall utilize enclosures and components in quantities consistent with the required fiber counts at each end of each segment.
7. During optical fiber connector termination, visually inspect all terminations with a 200 or 400-power microscope.
8. Follow all of the connector manufacturer's recommendations.
9. Unacceptable flaws in the terminations will include, but not limited to, scratches, full or partial cracks, bubbles, pits, epoxy residual, dirt, dust, oil, moisture, grinding and sanding debris. The acceptable termination will show a connector tip that is free of all imperfections in 100% of the core and 80% of the cladding. All unacceptable connectors shall be inspected after rework.
10. During installation of optical fiber cable do not allow pulling tension to exceed cable manufacturer's specification for the cable being installed. Only the strength member of the cable shall be subjected to the pulling tension.
11. Clean all optical fiber connector tips prior to inserting them into matting receptacles or bulkheads. Install all dust covers.
12. Using approved methods, pull cable into conduit, or place into raceway or cable tray as specified. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
13. Where cables are installed in air return plenum, riser rated cable shall be installed in metallic conduit.
14. Backbone and horizontal cables shall be installed and bundled separately in any pathway.
15. Cables above ceilings or below access floors shall be installed in cable tray or open-top cable hangers.
16. Cable slack and service coils shall be stored properly above the ceiling or under the access floor. Pathway fill ratio in conduit, tray, raceway, etc. shall not exceed 40% of pathway cross-sectional area.
17. A service coil of at least 1 meter is recommended within workstation outlets, and at least 2 meters is recommended for telecommunications enclosures. Main trunk and OSP cables shall also have a large diameter service coil in the specified location.
18. Recommended maximum spacing of cable supports above the ceiling is 60 in.
19. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.
20. Vertical runs of cable shall be supported to messenger strand, cable ladder, or other approved structure to support the weight of the cable. Do not exceed maximum cable vertical rise limits.
21. Cables that are damaged during installation shall be replaced by the contractor.

E. RACKS AND ENCLOSURES:
1. Freestanding equipment racks and enclosures shall be protected free of all dust, debris and other environmental elements during construction until substantial completion walk-through.
2. Each rack, enclosure shall have a dedicated #6 AWG ground wire to a grounding buss bar or building ground as defined by NEC.
3. Secure racks and enclosures to floor using rack installation kit.

F. CATEGORY 6 JACKS
1. Refer to specific manufacturer's guidelines for termination of jacks and dressing category 6 cables inside wall outlets and surface housings. Due to the larger size of category 6 cable, service coils in outlet boxes and surface housings are not recommended.
2. Terminate jacks according to manufacturer's instructions.
3. All jack will be wired utilizing T568B.
4. To assure 10GBase-T performance, maintain wiring pair twists as close as possible to the point of termination. Also minimize the length of exposed pairs from the jacket to the IDC termination point during installation.
5. The length of wiring pair un-twist in each termination shall be less than 0.5 inches (13 mm).
6. Jacks shall be properly mounted in plates, frames, or housings with dust caps fully installed over IDC contacts.
7. Horizontal cables extending from mounted jacks shall maintain a minimum bend radius of at least 4 times the cable diameter, unless space is restricted. Note: Refer to specific manufacturer's recommendations for restricted cable bend radius.
8. Cable terminations shall minimize tensile or bending strain on IDC contacts after assembly of faceplate or housing to the wall outlet.

G. CATEGORY 6 PATCH PANELS
1. Properly mount patch panels into the designated rack, cabinet, or bracket locations with the #12-24 screws provided.
2. Terminate cables behind the patch panel according to manufacturer's instructions.
3. To assure performance, maintain wiring pair twists as close as possible to the point of termination. Also minimize the length of exposed pairs from the jacket to the ICD termination point during installation.
4. The length of wiring pair un-twist in each termination shall be less than 0.5 inches (13 mm), and shall be kept to a minimum.
5. Each terminated and dressed cable shall be maintained perpendicular to the rear cover using the recommended cable management hardware.
6. Horizontal or backbone cables extending from the rear panel terminations shall maintain a minimum bend radius of at least 4 times the cable diameter.
7. Cable terminations shall have minimal tensile or bending strain on panel IDC contacts in each installed location.
8. Panels shall be properly labeled on the front and back with the cable number and port connections for each port.

H. Harsh Environment Housing and Connectivity
1. Mount connector housing from front of device but Install Gasket or optional Protective Cap before mounting connector housing into device.
2. Secure connector housing to device using supplied plastic nut. Tighten nut with 6-7 inch/pounds of torque.
3. Ensure that mounting surface is clean and free of debris.
4. Installing the jack into the mounted connector housing.
5. Install the terminated jack into the mounted connector housing by tilting the jack and securing the fixed latch in the connector opening. Rotate the jack, securing the spring latch.
6. Clean and remove any obstructions from the surface that the wall plate assembly will be installed against.
7. Place washers provided with HI Impact series plates onto screws. Align rubber gasket on back side of plate prior to installing to box/wall by placing screws through plate and rubber gasket.
8. Secure the wall plate assembly to box/wall by tightening screws with 5 inch/pounds of torque.
9. Attach patch cords and field term plug assemblies (sold separately) to the mounted connector.

I. OPTICAL FIBER CONNECTORS, HORIZONTAL AND BACKBONE
1. Installed fiber connectors shall have proper cable support, routing and strain relief.
2. Installed connectors shall be inspected 100% for polish quality, and contamination.
3. Fusion splices for pigtail connections shall be protected in a suitable enclosure.

J. GROUNDING and BONDING SYSTEMS: Basic Guidelines
1. Telecommunications grounding and bonding system shall be installed in accordance with NEC requirements, and per the guidelines of ANSI J-STD-607-A.
2. The Telecommunications Main Grounding Buss Bar (TMGB) shall be bonded to the building main electrical service ground (Grounding Electrode Conductor or GEC), using approved lugs or exothermic weld methods. Bonding to the GEC or TMGB with sheet metal screws is prohibited.
3. The Telecommunications Bonding Backbone shall be a minimum 6 AWG copper wire conductor. A Telecommunications Grounding Buss Bar (TGB) shall be installed in the TR on each floor, and shall be bonded to the TBB. All metal racks, cabinets, pathway and enclosures shall be bonded to the TGB.
4. Telecommunications equipment shall be grounded according to manufacturer's instructions and in accordance with applicable codes.
5. All metallic pathways, including conduit, raceway ladder or cable trays shall be electrically continuous and shall be bonded to ground on each end.
6. OSP cable entering the building or backbone cables having metal sheaths shall have isolation protection. Isolation protectors shall be bonded to the TMGB.

3.5. LABELING

A. General:
1. **All labels shall be permanent, machine generated labels produced by a labeling machine**. Labels shall be a permanent polyester material clear in color with label lettering black in color. No hand written labels will be accepted.
2. Labeling information will be reviewed at Pre-Install Meeting, and the Owner shall approve the labeling scheme prior to the installation of any cabling.

3. Surfaces shall be cleaned before attaching labels. All labels shall be attached firmly and vertically plumb on equipment, faceplates, patch panels termination blocks, etc.
4. All labeling of cables, equipment, and components shall be included in as-built documentation, floor plan drawings, and schematic deigns.

B. Cabling
1. All structured cables (horizontal and backbone) shall be labeled at both ends within 6" of cable termination point. Where voice backbone cables extend behind termination blocks, cable labels shall be placed at a location on the cable where the labels are visible from the front of the termination blocks.
2. Labels shall have an adhesive backing and shall wrap completely around the circumference of the cable jacket. Label and lettering sizes shall be of appropriate size in regard to cable diameter.

C. Equipment Racks, Termination Hardware, and Faceplates
1. LABELING SCHEME TO BE SPECIFIED BY OWNER.

3.6. TESTING

A. Category 6 and 6A Cable Testing
1. Permanent Link Testing shall be completed on all horizontal (station) cables. The Contractor will be responsible to supply a Channel warranty, but CITY OF MADISON is requiring that the contractor supply all manufacturer patch cords per the contract.
2. Category 6 and 6A cabling systems shall be tested as an installed horizontal permanent link configuration. Jacks and faceplates shall be assembled complete and properly mounted into outlet boxes. Panels shall be terminated complete and fully dressed in proper cable management.
3. All wiring shall be certified to meet or exceed the specifications as set forth in TIA-568C for Category 6 requirements for permanent link. All test will be performed to 250MHz.
4. Field Testing shall include the following parameters for each pair of each cable installed:
   a. Name of the person performing the test.
   b. Test equipment manufacturer and model number.
   c. Cable I.D. The test sheets will be in numerical order by cable ID.
   d. Date of test.
   e. Wire map (pin to pin connectivity and polarity check)
   f. Length (in feet)
   g. Insertion Loss.
   h. Near End Crosstalk (NEXT).
   i. Power Sum Near End Crosstalk (PSNEXT).
   k. Equal-Level Far End Crosstalk (ELFEXT).
   l. Power Sum Equal-Level Far End Crosstalk (PSELFEXT).
   m. Return Loss.
   n. Delay Skew.
   o. Attenuation to Crosstalk ratio (ACR).
5. A "PASS" indication shall be obtained for each link, using at minimum a level III tester that complies with TIA/EIA-568-B.2 field test requirements.
6. Record test results for each cable and turn over to the General Contractor Upon completion of the job. Correct malfunctions when detected, and re-test to demonstrate compliance. Note: Test equipment shall be a Type III cable Tester.

B. Optical Fiber Testing:
1. Test procedures shall be as described by the TIA/EIA-568-B: Commercial Building Telecommunications Cabling Standard, Parts 2 and 3 and TIA/EIA-526-14-A-1998 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant-OFSTP-14A
2. Preinstallation Testing:
   a. Test each conductor of every optical fiber cable on the reel with a light source and a power meter.
   b. Obtain the cable manufacturer power meter test results for each real used on the project. Using the attached Optical Fiber Test Form record the readings and the manufacturer's reel number. Prior to completion of project, turn over the completed optical fiber test form, optical fiber cable reel ID tags and optical fiber cable manufacturer's test results.
3. Acceptance Testing:
   a. Each terminated fiber strand in the horizontal or backbone infrastructure shall be tested individually as a permanent link. A fiber permanent link is defined as a length of individual fiber strand with a connector terminated on each end.

b. Testing for multimode shall be at 850 and 1300 nanometers. Total link insertion loss (dB) shall be within the specified link loss budget.

c. Tier 1 testing for each installed singlemode link shall be performed as an optical power insertion loss measurement, as defined by ANSI/TIA/EIA-526-7. Testing for singlemode shall be at 1310 and 1550 nanometers. Total link insertion loss (dB) shall be within the specified link loss budget.

d. Tier 2 testing, if required for each installed singlemode or multimode link, shall be performed as an OTDR measurement, as defined in TIA-TSB-140. We require Tier 2 testing on all fibers installed in the facility for future troubleshooting.

e. Multimode optical fiber attenuation shall be tested on all individual fibers of each cable segment using an LED light source and power meter to determine the actual loss. These tests shall be performed at the 850nm and 1300nm windows in both directions. Test set up and performance shall be in accordance with ANSI/TIA/EIA-526-14A, Method B.

f. A reference power measurement shall be obtained by connecting one end of test jumper 1 to the light source and the other end to the power meter. After recording the reference power measurement, test jumper 1 shall be disconnected from the power meter without disturbing the light source and attached to the cable plant. The power meter shall be moved to the far end of the cable plant and attached to the cable plant with test 2.

g. Readings must not be higher than the “Optimal Attenuation Loss.” The OAL will be calculated using the manufacturer’s factory certified test results, (db/km) converted to the actual installed lengths plus the manufacturer’s best published attenuation losses for the connector and/or splice installed on this project. (0.30+/-0.30 for Connectors and 0.10 for splices). The construction manager shall use the OAL for comparison with the end to end power loss test results prior to acceptance.

h. Test Results: Must be completed and turned over to the General Contractor prior to active equipment installation. Specific due dates for optical fiber will be established at pre-install meeting.

END OF SECTION

SECTION 27 21 33
WIRELESS ACCESS POINTS (WAP)

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PART 1 – GENERAL

1.1. SCOPE

A. The work under this section is for the installation of OWNER PROVIDED, CONTRACTOR INSTALLED Wireless Access Points (WAP).

B. The WAPs shall be installed by the contractor providing and installing the Communications Cable and Equipment. All contractor qualifications and certifications for that section shall apply to this section.

1.2. RELATED SPECIFICATIONS

A. The Contractor shall be responsible for reviewing all other specifications for requirements associated with the complete installation of WAP's. This includes but is not limited to the following:

1. 01 31 23 Project Management Web Site
2. 27 00 05 Communications Cable and Equipment

1.3. SUBMITTALS

A. Contractor licenses and qualifications are required as part of the complete Division 27 submittal package as indicated under Specification 27 00 05.

B. No submittals are required for the owner provided WAP.

C. Submittals are required for installation/hanger equipment, connectors, and any other required equipment/material required for a complete WAP installation.

PART 2 - PRODUCTS

2.1. WIRELESS ACCESS POINT (WAP) DEVICES

A. The City of Madison Information Technology Department (CoM-IT) will be providing the WAP devices for this project.

B. The WAP device being used will be as manufactured by the Cisco and shall be used for all types of ceiling mounted installations. (suspended, gyp board, open truss, etc.).

PART 3 - EXECUTION

3.1. OWNER RESPONSIBILITIES

A. The CoM-IT shall be responsible for ordering, making payment and configuring all WAP devices.

B. The CoM-IT shall configure and test each WAP to CoM-IT specifications prior to providing the WAP to the contractor for installation.

C. The CoM-IT shall number each WAP and provide the contractor with a location map indicating where each WAP shall be installed.

D. The CoM-IT shall test each WAP after installation to verify configuration and signaling is correct prior to accepting the final installation of the WAP system.

3.2. CONTRACTORS RESPONSIBILITIES

A. The Contractor shall be solely responsible for coordinating with CoM-IT the scheduling and receipt of all WAP devices with the installation schedule.

B. The Contractor shall inspect all WAP devices upon receipt for damage. CoM-IT shall be notified immediately of any damage.
C. The Contractor shall provide all mounting hardware, blocking, and other items required for a complete installation that meets the manufacturer's installation requirements.
D. The Contractor shall install all WAP devices per plans and specifications including cable connections.
E. The Contractor shall be responsible to pick up WAP devices from City IT and delivery to the jobsite.

3.3. FINAL TESTING

A. Contractor shall provide final testing of all WAP devices after installation is complete.
B. In the event any WAP device is not operating properly the contractor shall trouble shoot the Installation and work with the CoM-IT to determine if re-configuration of the device will be required.
C. The CoM-IT shall be responsible for reconfiguring WAP's as needed after installation is complete. The contractor shall be responsible for verifying connections, cabling and connectivity of the installation is correct.

3.4. WARRANTY

A. The CoM-IT will be responsible for registering any warranty information associated with the purchase and ownership of all the WAP devices.
B. The Contractor shall warrant the installation of the WAP device for one (1) year per the terms of this contract.

END OF SECTION

SECTION 28 46 21
ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Addressable fire-alarm system.
2. Fire-alarm control panel (FACP).
3. Manual fire-alarm boxes.
4. System smoke detectors.
5. Duct smoke detectors.
6. Heat detectors.
7. Fire-alarm notification appliances.
8. Fire-alarm remote annunciators.
9. Fire-alarm addressable interface devices.
10. Digital alarm communicator transmitters (DACTs).

B. Related Requirements:
1. Section 08 71 00 "Door Hardware" for magnetic door holders that release in response to fire-alarm outputs.
2. Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" or Section 26 05 23 "Control Voltage Electrical Power Cables" for cables and conductors for fire-alarm systems.

1.2 DEFINITIONS

A. DACT: Digital alarm communicator transmitter.
B. FACP: Fire-alarm control panel.
C. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.3 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. When new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from building.
B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.4 SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.
1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.
1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, and details, including details of attachments to other Work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.
9. Include performance parameters and installation details for each detector.

10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct smoke detectors and access to them.
    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring and equipment required for HVAC unit shutdown on alarm.
    c. Locate detectors in accordance with manufacturer's written instructions.
12. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
13. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. Delegated Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.
1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.
2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
    a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
    b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
    c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
    d. Riser diagram.
    e. Device addresses.
    f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
    g. Record copy of site-specific software.
    h. Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
        1. Equipment tested.
        2. Frequency of testing of installed components.
        3. Frequency of inspection of installed components.
        4. Requirements and recommendations related to results of maintenance.
        5. Manufacturer's user training manuals.
    i. Manufacturer's required maintenance related to system warranty requirements.
    j. Abbreviated operating instructions for mounting at FACP and each annunciator unit.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamper proofed components.

6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in system. Provide in box or cabinet with compartments marked with fuse types and sizes.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ADDRESSABLE FIRE-ALARM SYSTEM

A. Description:
1. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice -and-strobe notification for evacuation.

B. Performance Criteria:
1. Regulatory Requirements:
a. Fire-Alarm Components, Devices, and Accessories: Listed and labeled by a NRTL in accordance with NFPA 70 for use with selected fire-alarm system and marked for intended location and application.
2. General Characteristics:
a. Automatic sensitivity control of certain smoke detectors.
b. Fire-alarm signal initiation must be by one or more of the following devices and systems:
1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Automatic sprinkler system water flow.
6. Fire-extinguishing system operation.
7. Fire standpipe system.
c. Fire-alarm signal must initiate the following actions:
1. Continuously operate alarm notification appliances including voice evacuation notices.
2. Identify alarm and specific initiating device at FACP and remote annunciators.
3. Unlock electric door locks in designated egress paths.
4. Release fire and smoke doors held open by magnetic door holders.
5. Activate voice/alarm communication system.
6. Switch HVAC equipment controls to fire-alarm mode.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Record events in system memory.
d. Supervisory signal initiation must be by one or more of the following devices and actions:
1. Valve supervisory switch.
2. Independent fire-detection and -suppression systems.
3. Zones or individual devices have been disabled.
4. FACP has lost communication with network.
e. System trouble signal initiation must be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at FACP.
5. Ground or single break in internal circuits of FACP.
6. Abnormal ac voltage at FACP.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of switch at FACP or annunciator.
10. Voice signal amplifier failure.
f. System Supervisory Signal Actions:
1. Identify specific device initiating event at FACP and remote annunciators.
2. Transmit system status to building management system.

3. Display system status on graphic annunciator.

g. Device Guards:
1. Description: Welded wire mesh of size and shape for manual station, smoke detector, gong, or other device requiring protection.
a) Factory fabricated and furnished by device manufacturer.
b) Finish: Paint of color to match protected device.

h. Document Storage Box:
1. Description: Enclosure to accommodate standard 8-1/2-by-11 inch manuals and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
2. Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
3. Color: Red powder-coat epoxy finish.
4. Labeling: Permanently screened with 1-inch-high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
5. Security: Locked with 3/4-inch barrel lock. Provide solid 12-inch stainless steel piano hinge.

2.2 FIRE-ALARM CONTROL PANEL (FACP)

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Bosch Security Systems, Inc.
2. Edwards; Carrier Global Corporation.
3. Gamewell-FCI; Honeywell International, Inc.
4. Notifier; Honeywell International, Inc.
5. Potter Electric Signal Company, LLC.
6. Siemens Industry, Inc., Building Technologies Division.
7. Simplex; brand of Johnson Controls International plc, Building Solutions North America.
8. Or approved equal

B. Description: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules.

C. Performance Criteria:
1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
2. General Characteristics:
a. System software and programs must be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining information through failure of primary and secondary power supplies.
b. Include real-time clock for time annotation of events on event recorder and printer.
c. Provide communication between FACP and remote circuit interface panels, annunciators, and displays.
d. FACP must be listed for connection to central-station signaling system service.
e. Provide nonvolatile memory for system database, logic, and operating system and event history. System must require no manual input to initialize in the event of complete power down condition. FACP must provide minimum 500-event history log.
f. Addressable Initiation Device Circuits: FACP must indicate which communication zones have been silenced and must provide selective silencing of alarm notification appliance by building communication zone.
1. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: FACP must be listed for releasing service.
g. Fire-Alarm Annunciator: Arranged for interface between human operator at FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
1. Annunciator and Display: LCD, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
h. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
1. Pathway Class Designations: NFPA 72, Class B .
2. Pathway Survivability: Level 1.
3. Install no more than 50 addressable devices on each signaling-line circuit.
4. Install fault circuit isolators to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions, whichever is more conservative.

i. Serial Interfaces:
   1. One dedicated RS 485 port for central-station operation using point ID DACT.
   2. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
   3. One RS 232 port for voice evacuation interface.

j. Notification-Appliance Circuit:
   1. Audible appliances must sound in three-pulse temporal pattern, as defined in NFPA 72.
   2. Where notification appliances provide signals to sleeping areas, alarm signal must be 520 Hz square wave with intensity 15 dB above average ambient sound level or 5 dB above maximum sound level, or at least 75 dB(A-weighted), whichever is greater, measured at pillow.
   3. Visual alarm appliances must flash in synchronization where multiple appliances are in same field of view, as defined in NFPA 72.

k. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls must be connected to fire-alarm system.

l. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.

m. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as special module that is part of FACP.

n. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of central-control microphone. Amplifiers must comply with UL 1711.
   1. Allow application of, and evacuation signal to, indicated number of zones and simultaneously allow voice paging to other zones selectively or in combination.
   2. Programmable tone and message sequence selection.
   3. Standard digitally recorded messages for "Evacuation" and "All Clear."
   4. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of FACP.

o. Status Annunciator: Indicate status of various voice/alarm speaker zones and status of firefighters' two-way telephone communication zones.

p. Preamplifiers, amplifiers, and tone generators must automatically transfer to backup units, on primary equipment failure.

q. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from other printed indications. Also, print system reset event, including same information for device, location, date, and time. Commands initiate printing of list of existing alarm, supervisory, and trouble conditions in system and historical log of events.

r. Primary Power: 24 V(dc) obtained from 120 V(ac) service and power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and DACT must be powered by 24 V(dc) source.

s. Alarm current draw of entire fire-alarm system must not exceed 80 percent of power-supply module rating.

t. Secondary Power: 24 V(dc) supply system with batteries, automatic battery charger, and automatic transfer switch.

u. Batteries: Sealed lead calcium.

D. Accessories:
   1. Instructions: Computer printout or typewritten instruction card mounted behind plastic or glass cover in stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe functional operation of system under normal, alarm, and trouble conditions.
   2. Preaction System Functionality:
      a. Initiate Presignal Alarm: This function must cause audible and visual alarm and indication to be provided at FACP. Activation of initiation device connected as part of preaction system must be annunciated at FACP only, without activation of general evacuation alarm.

2.3 MANUAL FIRE-ALARM BOXES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bosch Security Systems, Inc.

2. Edwards; Carrier Global Corporation.
3. Gamewell-FCI; Honeywell International, Inc.
4. Notifier; Honeywell International, Inc.
5. Potter Electric Signal Company, LLC.
6. Siemens Industry, Inc., Building Technologies Division.
7. Simplex; brand of Johnson Controls International plc, Building Solutions North America.
8. Or approved equal

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACP.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at top to permit lifting for access to initiate alarm. Lifting cover actuates integral battery-powered audible horn intended to discourage false-alarm operation.
4. Able to perform at up to 90 percent relative humidity at 90 deg F .
5. Able to be used in indoor areas.

2.4 SYSTEM SMOKE DETECTORS

A. Photoelectric Smoke Detectors:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Bosch Security Systems, Inc.
   b. Edwards; Carrier Global Corporation.
   c. Gamewell-FCI; Honeywell International, Inc.
   d. Notifier; Honeywell International, Inc.
   e. Potter Electric Signal Company, LLC.
   f. Siemens Industry, Inc., Building Technologies Division.
   g. Simplex; brand of Johnson Controls International plc, Building Solutions North America.
   h. Or approved equal
2. Performance Criteria:
   a. Regulatory Requirements:
      1. NFPA 72.
      2. UL 268.
   b. General Characteristics:
      1. Detectors must be two-wire type.
      2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
      3. Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
      4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
      5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
      6. Detector address must be accessible from FACP and must be able to identify detector's location within system and its sensitivity setting.
      7. Operator at FACP, having designated access level, must be able to manually access the following for each detector:
         a) Primary status.
         b) Device type.
         c) Present average value.
         d) Present sensitivity selected.
         e) Sensor range (normal, dirty, etc.).
      8. Detector must have functional humidity range within 10 to 90 percent relative humidity.
      9. Sensitivity levels based on time of day.

2.5 DUCT SMOKE DETECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bosch Security Systems, Inc.
   2. Edwards; Carrier Global Corporation.
   3. Gamewell-FCI; Honeywell International, Inc.
   4. Notifier; Honeywell International, Inc.
   5. Potter Electric Signal Company, LLC.
   6. Siemens Industry, Inc., Building Technologies Division.
   7. Simplex; brand of Johnson Controls International plc, Building Solutions North America.
   8. Or approved equal

B. Description: Photoelectric-type, duct-mounted smoke detector.

C. Performance Criteria:
   1. Regulatory Requirements:
      a. NFPA 72.
      b. UL 268A.
   2. General Characteristics:
      a. Detectors must be four -wire type.
      b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
      c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
      d. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
      e. Detector address must be accessible from FACP and must be able to identify detector's location within system and its sensitivity setting.
      f. Operator at FACP, having designated access level, must be able to manually access the following for each detector:
         1. Primary status.
         2. Device type.
         3. Present average value.
         4. Present sensitivity selected.
         5. Sensor range (normal, dirty, etc.).
      g. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with supplied detector for smoke detection in HVAC system ducts.
      h. Each sensor must have multiple levels of detection sensitivity.
      i. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
      j. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

A. Combination-Type Heat Detectors:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Bosch Security Systems, Inc.
      b. Edwards; Carrier Global Corporation.
      c. Gamewell-FCI; Honeywell International, Inc.
      d. Potter Electric Signal Company, LLC.
      e. Siemens Industry, Inc., Building Technologies Division.
      f. Simplex; brand of Johnson Controls International plc, Building Solutions North America.
      g. Or approved equal
   2. Performance Criteria:
      a. Regulatory Requirements:
         1. NFPA 72.
         2. UL 521.
      b. General Characteristics:
         1. Temperature sensors must test for and communicate sensitivity range of device.
      c. Actuated by fixed temperature of 135 deg F or rate of rise that exceeds 15 deg F per minute unless otherwise indicated.

d. Mounting: Twist-lock base interchangeable with smoke-detector bases.
e. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
f. Detector must have functional humidity range of 10 to 90 percent relative humidity.

B. Fixed-Temperature-Type Heat Detectors:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Bosch Security Systems, Inc.
b. Edwards; Carrier Global Corporation.
c. Gamewell-FCI; Honeywell International, Inc.
d. Notifier; Honeywell International, Inc.
e. Potter Electric Signal Company, LLC.
f. Siemens Industry, Inc., Building Technologies Division.
g. Simplex; brand of Johnson Controls International plc, Building Solutions North America.
h. Or approved equal
2. Performance Criteria:
a. Regulatory Requirements:
1. NFPA 72.
2. UL 521.
b. General Characteristics:
1. Actuated by temperature that exceeds fixed temperature of 190 deg F .
2. Mounting: Twist-lock base interchangeable with smoke-detector bases.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
4. Detector must have functional humidity range of 10 to 90 percent.

2.7 FIRE-ALARM NOTIFICATION APPLIANCES

A. Fire-Alarm Voice/Tone Notification Appliances:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Bosch Security Systems, Inc.
b. Edwards; Carrier Global Corporation.
c. Gamewell-FCI; Honeywell International, Inc.
d. Notifier; Honeywell International, Inc.
e. Potter Electric Signal Company, LLC.
f. Siemens Industry, Inc., Building Technologies Division.
g. Simplex; brand of Johnson Controls International plc, Building Solutions North America
h. Or approved equal.
2. Description: Notification appliances capable of outputting voice evacuation messages.
3. Performance Criteria:
a. Regulatory Requirements:
1. NFPA 72.
2. UL 1480.
b. General Characteristics:
1. Speakers for Voice Notification: Locate speakers for voice notification to provide intelligibility requirements of "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
2. High-Range Units: Rated 2 to 15 W.
3. Low-Range Units: Rated 1 to 2 W.
4. Mounting: Flush or surface mounted and bidirectional per the plans.
5. Matching Transformers: Tap range matched to acoustical environment of speaker location.
6. Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

B. Fire-Alarm Visible Notification Appliances:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Edwards; Carrier Global Corporation.
b. Notifier; Honeywell International, Inc.
c. Potter Electric Signal Company, LLC.

d. Siemens Industry, Inc., Building Technologies Division.
e. Simplex; brand of Johnson Controls International plc, Building Solutions North America.
f. Or approved equal

2. Performance Criteria:
   a. Regulatory Requirements:
      1. NFPA 72.
      2. UL 1971.
   b. General Characteristics:
      1. Rated Light Output:
         a) 15/30/75/95/110 cd, selectable in field.
      2. Clear or nominal white polycarbonate lens mounted on aluminum faceplate.
      3. Mounting: Wall mounted unless otherwise indicated.
      4. For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
      5. Flashing must be in temporal pattern, synchronized with other units.
      6. Strobe Leads: Factory connected to screw terminals.
      7. Mounting Faceplate: Factory finished, red.

2.8 FIRE-ALARM REMOTE ANNUNCIATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bosch Security Systems, Inc.
   2. Or approved equal

B. Performance Criteria:
   1. Regulatory Requirements:
      a. NFPA 72.
   2. General Characteristics:
      a. Annunciator functions must match those of FACP for alarm, supervisory, and trouble indications. Manual switching functions must match those of FACP, including acknowledging, silencing, resetting, and testing.
         1. Mounting: Surface cabinet, NEMA 250, Type 1.
      b. Display Type and Functional Performance: Alphanumeric display and LED indicating lights must match those of FACP. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.9 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bosch Security Systems, Inc.
   2. Notifier; Honeywell International, Inc.
   3. Or approved equal

B. Performance Criteria:
   1. Regulatory Requirements:
      a. NFPA 72.
   2. General Characteristics:
      a. Include address-setting means on module.
      b. Store internal identifying code for control panel use to identify module type.
      c. Listed for controlling HVAC fan motor controllers.
      d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
      e. Integral Relay: Capable of providing direct signal to elevator controller to initiate elevator recall .
         1. Allow control panel to switch relay contacts on command.
         2. Have minimum of two normally open and two normally closed contacts available for field wiring.
      f. Control Module:
         1. Operate notification devices.
         2. Operate solenoids for use in sprinkler service.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
   1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.
B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service in accordance with requirements indicated:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
   2. Do not proceed with interruption of fire-alarm service without Owner's written permission.
C. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION OF EQUIPMENT

A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
   1. Devices placed in service before other trades have completed cleanup must be replaced.
   2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.
B. Install wall-mounted equipment, with tops of cabinets not more than 78 inch above finished floor.
C. Manual Fire-Alarm Boxes:
   1. Install manual fire-alarm box in normal path of egress within 60 inch of exit doorway.
   2. Mount manual fire-alarm box on background of contrasting color.
   3. Operable part of manual fire-alarm box must be between 42 and 48 inch above floor level. Devices must be mounted at same height unless otherwise indicated.
D. Smoke- and Heat-Detector Spacing:
   1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
   2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
   3. Smooth ceiling spacing must not exceed 30 ft. .
   4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A or Annex B in NFPA 72.
   5. HVAC: Locate detectors not closer than 36 inch from air-supply diffuser or return-air opening.
   6. Lighting Fixtures: Locate detectors not closer than 12 inch from lighting fixture and not directly above pendant mounted or indirect lighting.
E. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.
F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than 36 inch long must be supported at both ends.
   1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
G. Remote Status and Alarm Indicators: Install in visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
H. Audible Alarm-Indicating Devices: Install not less than 6 inch below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.
I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inch below ceiling. Install devices at same height unless otherwise indicated.

J. Device Location-Indicating Lights: Locate in public space near device they monitor.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate must be laminated acrylic or melamine plastic signs with black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."
C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.6 PATHWAYS

A. Any and all fire alarm cabling shall be routed in EMT conduit at a minimum. No free air cabling is allowed. Pathways above recessed ceilings and in inaccessible locations may be routed exposed.
   1. Exposed pathways located less than 96 inch above floor must be installed in EMT.
B. Exposed EMT must be painted red enamel.

3.7 CONNECTIONS

A. Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than 36 inch from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
   1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
   2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
   3. Smoke dampers in air ducts of designated HVAC duct systems.
   4. Magnetically held-open doors.
   5. Electronically locked doors and access gates.
   6. Supervisory connections at valve supervisory switches.
   7. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
   8. Supervisory connections at elevator shunt-trip breaker.
   9. Data communication circuits for connection to building management system.
   10. Supervisory connections at fire-extinguisher locations.

3.8 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems."
B. Install framed instructions in location visible from FACP.

3.9 GROUNDING

A. Ground FACP and associated circuits in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.10 FIELD QUALITY CONTROL

A. Field tests must be witnessed by authorities having jurisdiction .
B. Administrant for Tests and Inspections:
   1. Administer and perform tests and inspections.
C. Tests and Inspections:
   1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.

2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.
E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.
G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Provide video recording of training to Owner.

3.12 MAINTENANCE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
1. Include visual inspections in accordance with "Visual Inspection Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in "Test Methods" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per "Testing Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

END OF SECTION 28 46 21

SECTION 31 05 00
COMMON WORK RESULTS FOR EARTHWORK

PART 1 - GENERAL

1.1 SCOPE

A. This section provides information common to two or more technical site work specification sections or items that are of a general nature, and not included in other sections. This section applies to ALL site work, as applicable. Included are the following topics:

- PART 1 - GENERAL
  - Scope
  - Related Work
  - Referenced Organizations
  - Referenced Documents
  - Quality Assurance
  - Safety
  - Permits
  - Construction Limits
  - Submittals
  - Off-Site Storage
  - Codes
  - Certifications and Inspections
- PART 2 - MATERIALS
  - Barricades, Signs, and Warning Devices
  - Temporary Plastic Barrier Fencing
- PART 3 - EXECUTION
  - Maintenance of Site Access/Egress
  - Continuity of Existing Traffic/Parking and Traffic Control
  - Protection and Continuity of Existing Utilities
  - Protection of Existing Work and Facilities
  - Stormwater/Excavation Water Management

1.2 RELATED WORK

A. Applicable provisions of Division 1 govern work under this Section. Related sections include:

1. Section 31 20 00 - Earthmoving
2. Section 31 22 16.15 - Subgrade Preparation
3. Section 32 91 19 - Topsoil-Select Fill Materials and Application

1.3 REFERENCED ORGANIZATIONS

A. Applicable provisions of Division 1 shall govern all work under this section.

B. Abbreviations of organizations referenced in these specifications are as follows:

AASHTO	American Association of State Highway and Transportation Officials
ACPA	American Concrete Pipe Association
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
FHA	Federal Highway Administration
EPA	Environmental Protection Agency
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
STI	Steel Tank Institute
UL	Underwriters Laboratories Inc.

WDNR	State of Wisconsin Department of Natural Resources
WISDOT	State of Wisconsin Department of Transportation

1.4 REFERENCED DOCUMENTS

A. Where reference is made to the "Construction Standards," it shall be construed to mean the City of Madison's Construction Standards, as they may pertain, except the method of measurement and basis of payment shall not apply.

B. Where reference is made to the "Standard Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Sewer and Water Construction in Wisconsin," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

C. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Highway and Structure Construction," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

D. Where reference is made to the "Geotechnical Report," it shall be construed to mean the geotechnical report provided in Section 02 32 00.

1.5 QUALITY ASSURANCE

A. Provide materials and products as required by individual specification sections. Refer to General Conditions of the Contract regarding substitutions.

B. Provide quality assurance testing and reporting as required by individual specification sections.

1.6 SAFETY

A. Contractor is solely responsible for worksite safety.

B. Perform all work in accordance with applicable OSHA, state, and local safety standards.

C. Contact Diggers Hotline at 1-800-242-8511 in accordance with statutory requirements. Request that non-member utilities and private utilities be located by the appropriate parties.

1.7 PERMITS

A. Unless otherwise noted in the Contract Documents, Owner shall be responsible for obtaining and paying for all permits necessary to complete the work.

1.8 CONSTRUCTION LIMITS

A. Construction Limits are defined by lines denoted as Construction Fencing/Limits of Disturbance as indicated on the Drawings. In the absence of such a designation on the Drawings, confine work to the minimum area reasonably necessary to undertake the work as determined by the City's Construction Representative. In no case shall construction activities extend beyond property lines or construction easements.

B. The Contractor shall restore all disturbed areas in accordance with the Drawings and Specifications. If the Drawings and Specifications do not address restoration of specific areas, these areas will be restored to pre-construction conditions as approved by the City's Construction Representative.

C. Coordinate work under this project with work by City's Construction Representative and other contractors providing separate work on the site related to other contracts.

1.9 SUBMITTALS

A. Refer also to the General Conditions of the Contract section and Division 1.

B. Submit manufacturer's shop drawings, product data, samples, substitutions and Operation and Maintenance (O&M) data for approval as required by individual specification sections.

C. Submittals shall be provided to the Owner's Construction Representative for review and approval, unless otherwise directed. Submittals shall be sent electronically by email in *.pdf format unless otherwise directed.

1.10 OFF-SITE STORAGE

A. Refer to Division 1.

B. In general, the payments for materials stored off-site will only be considered in instances where there is limited space available for storage on the site. Prior approval by the Owner's Construction Representative, together with the execution of a Storage Agreement will be required.

1.11 CODES

A. Comply with the requirements of all applicable local, state, and federal codes.

1.12 CERTIFICATIONS AND INSPECTIONS

A. Refer to the General Conditions of the Contract.

B. Obtain and pay for all required sampling, testing, inspections, and certifications except those expressly listed as provided by the Owner or City in the Contract Documents. Deliver originals of certificates and documents to the City's Construction Representative within three (3) days; provide copies to the Owner's Construction Representative. Include copies of the certifications and documents in the O&M Manual.

PART 2 - MATERIALS

2.1 BARRICADES, SIGNS, AND WARNING DEVICES

A. Traffic barricades, traffic signs, and warning devices shall meet the requirements of current applicable OSHA standards and MUTCD.

2.2 TEMPORARY PLASTIC BARRIER FENCING

A. UV stabilized high-density polyethylene barrier fence free of holes tears and other defects. Provide 5-foot tall fence in diamond or rectangular pattern. Fencing shall be a "safety orange" color, unless otherwise noted.

B. Posts for temporary plastic barrier fencing shall be 5 feet tall, minimum 12-gauge, painted metal posts.

PART 3 - EXECUTION

3.1 MAINTENANCE OF SITE ACCESS/EGRESS

A. Unless otherwise shown or directed, maintain existing access and egress to the facility throughout construction. Contact the City and Owner prior to any construction activities to obtain directives for preferred access to the site. Maintain ANSI A117 compliant access to the site for disabled persons, delivery access, emergency vehicle access, and emergency egress. Do not interrupt access and egress without prior written approval from the Owner's Construction Representative.

3.2 CONTINUITY OF EXISTING TRAFFIC/PARKING AND TRAFFIC CONTROL

A. Refer also to Section 02 20 00 - General Sitework Requirements.

B. Do not interrupt or change existing traffic, delivery, or parking without prior written approval from the City or Owner's Construction Representative. When interruption is required, coordinate schedule with the City and Owner's Construction Representative to minimize disruptions. When working in public right-of-way, obtain all necessary approvals and permits from the City if not provided by the Owner.

C. When Contractor's activities impede or obstruct traffic flow, Contractor shall provide traffic control devices, signs, and flaggers in accordance with other Contract Documents and current applicable OSHA standards and MUTCD. Contractor shall be responsible for all costs associated with temporary traffic control. All barricades, signs, and warning devices shall be included under the traffic control bid item.

D. Access to the future high school construction site must be maintained at all times. Two-way traffic must be maintained on all existing roadways at all times. Flagging will be permitted, as necessary, for work during daylight hours if approved by the City's Construction Representative.

3.3 PROTECTION AND CONTINUITY OF EXISTING UTILITIES

A. Verify the locations of any water, drainage, gas, sewer, electric, drainage, gas, sewer, electric, telephone/communication, fuel, steam lines or other utilities and site features which may be encountered in any excavations or other sitework. All lines shall be properly underpinned and supported to avoid disruption of service.

B. Do not interrupt or change existing utilities without prior written approval from the City's Construction Representative, affected utilities, and users. Notify all users impacted by outages a minimum of 48 hours in advance of outage. Notification shall be provided in writing and describe the nature and duration of outages and provide the name and number of Contractor's foreman or other contact.

C. Any service connections encountered which are to be removed shall be cut off at the limits of the excavation and capped in accordance with the requirements of applicable codes and any specifications governing such removals.

3.4 PROTECTION OF EXISTING WORK AND FACILITIES

A. Verify the locations of, and protect, any signs, paved surfaces, buildings, structures, landscaping, streetlights, utilities, and all other such facilities that may be encountered or interfered with during the progress of the work. Take measures necessary to safeguard all existing work and facilities that are outside the limits of the work or items that are within the construction limits but are intended to remain. Report any damage to existing facilities to the City's Construction Representative immediately. Correct and pay for all damages.

3.5 STORMWATER/EXCAVATION WATER MANAGEMENT

A. Control grading around structures, pitch ground to prevent water running into excavated areas.

B. Pits, trenches within building line, and other excavations shall be maintained and free of water.

C. Provide trenching, pumping, other facilities required.

D. Notify Owner's Construction Representative in the event that springs or running water are encountered in excavation; provide discharge by trenches, drains, pumping to point outside of excavation. Provide information to Owner's Construction Representative of points and areas that water will be discharged. At the Owner and City's Construction Representative's option, the Contractor shall drain the spring to the storm sewer system by the use of field tile.

E. Establish and maintain an on-site Erosion Control Maintenance Log. The log shall document erosion control installation locations and date of establishment, rainfall event dates and amounts, erosion control failure locations, corrective measures taken, and weekly inspection documentation. This log shall be available on-site during the entire construction process and available to the Owner, Owner's Construction Representative, Governing Municipality, and authorized WDNR staff.

F. Be responsible for control measures to prevent damage from flooding, erosion, and sedimentation to on-site and off-site areas.

END OF SECTION

SECTION 31 10 00
SITE CLEARING

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Section 02 20 00 - General Sitework Requirements
B. Section 02 32 00 - Geotechnical Investigation
C. Section 31 25 00 - Erosion Control

1.2 REFERENCE STANDARDS

A. Where reference is made to the "Construction Standards," it shall be construed to mean the City of Madison's "Standard Specifications for Public Works Improvements."
B. Where reference is made to the "Standard Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Sewer and Water Construction in Wisconsin," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
C. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Highway and Structure Construction," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
D. Where reference is made to the "Geotechnical Report," it shall be construed to mean the Geotechnical Report provided in Section 02 32 00 - Geotechnical Investigation.

1.3 DEFINITIONS

A. Clearing:
   1. Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including down timber, snags, brush, and rubbish occurring in the areas to be cleared.
B. Grubbing:
   1. Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas.

1.4 SUBMITTALS

A. The following shall be submitted:
   1. Written permission to dispose of such products on private property shall be filed with the City's Construction Representative.
   2. Submit documentation from the disposal facility to verify that it is licensed to accept the material.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 CLEARING

A. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation as may be indicated or directed to be left standing.
B. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 1½ inches or more in diameter and shall be trimmed of all branches below the heights indicated or directed.
   1. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches.
   2. Cuts more than 1½ inches in diameter shall be painted with an approved tree-wound paint.
   3. Trees and vegetation to be left standing shall be protected from damage incidental to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require.
C. Clearing shall also include the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work.
D. Disposal of Elm and Ash trees, roots, or branches shall be in accordance with local and state regulations.

3.2 GRUBBING

A. Remove material to be grubbed, together with logs and other organic or metallic debris not suitable for roadway construction in accordance with Section 201.3 of the State Specifications, except the minimum depths for removal shall be as follows:
   1. In cut areas, 18 inches below final subgrade.
   2. In embankments areas, 18 inches below the existing grade.

B. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform to the proposed surface of the ground.

C. Burning or burying as a means of disposal is prohibited.

3.3 TREE REMOVAL

A. Where indicated or directed, individual trees and stumps that are designated shall be removed from areas outside those areas designated for clearing and grubbing.

B. This work shall include the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING.

C. Dispose of materials as specified in paragraph CLEAN UP.

3.4 TOPSOIL

A. Topsoil: Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material. Refer to Section 32 91 19 - Topsoil-Select Fill Materials and Application for further information.
   1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.
   2. Stockpile topsoil in storage piles in areas indicated or directed. Construct storage piles to provide free drainage of surface water.

3.5 CLEAN UP

A. Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations, shall be disposed of outside the limits of the project at the Contractor's responsibility, except when otherwise approved in writing

B. All waste and debris shall be disposed of in compliance with state and local regulations within five (5) days of being cut or removed.

C. Disposal of Elm trees shall be in accordance with local regulations.

D. Submit the location of any disposal facility located outside the limits of the project to the City’s Construction Representative prior to removal from the project site.

E. Submit documentation from the disposal facility to verify that it is licensed to accept the material.

F. No material shall be removed from the project site without prior approval from the City’s Construction Representative.

G. Burning or burying as a means of disposal is prohibited.

END OF SECTION

SECTION 31 20 00
EARTHMOVING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Stripping of topsoil and stockpiling.
   2. Excavation, preparation, backfilling, and compaction of subgrades per the Geotechnical Report.
   3. Cutting, filling, grading, and compaction for drives, walks, roads, and parking subgrade.
   4. Cutting, filling, grading, and compaction for landscaping area subgrade ready for topsoil.

1.2 RELATED SECTIONS include the following:

A. Section 02 20 00 - General Sitework Requirements
B. Section 31 10 00 - Site Clearing
C. Section 31 25 00 - Erosion Control

1.3 STANDARD SPECIFICATIONS

A. Where reference is made to the "Construction Standards," it shall be construed to mean the City of Madison's Construction Standards, as they may pertain, except the method of measurement and basis of payment shall not apply.
B. Where reference is made to the "Standard Specifications," it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, Current Edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
C. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, Current Edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
D. Where reference is made to the "Geotechnical Report," it shall be construed to mean the geotechnical report in Section 02 32 00.
E. All construction of public facilities and/or work within public lands or rights-of-way shall conform to the requirements and conditions of the Standard Specifications stated above with the most stringent applying.
F. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.
   1. ASTM International (ASTM):
      - ASTM D422 — Particle Size Analysis of Soil
      - ASTM D698 — Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft/lbf/ft3 (600 kN.m/m3))
      - ASTM D1557 — Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 Kn.m/m3))
      - ASTM D2487 — Classification of Soils for Engineering Purposes (Unified Soil Classification System)
      - ASTM D2488 — Description and Identification of Soils (Visual-Manual Procedures)
      - ASTM D4318 — Liquid Limit, Plastic Limit, and Plasticity Index of Soils
      - ASTM D6938 — In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
   2. American Association of State Highway and Transportation Officials (AASHTO):
      - AASHTO T 88 — Particle Size Analysis of Soils
   3. National Fire Protection Association (NFPA):
      - NFPA 70 National Electrical Code
   4. American Water Works Association (AWWA):
      - AWWA C200 — Standard for Steel Water Pipe - 6 In. (150 mm) and Larger
      - AWWA C206 — Field Welding of Steel Water Pipe

1.4 SUBMITTALS

A. Submit documentation of materials meeting the required specifications.

B. Testing:
1. The City shall provide testing for work performed for public improvements.
2. The Contractor shall provide quality control testing as defined in the Contract Documents.
3. The Contractor shall coordinate work and testing requirements with the Owner's Construction Representative and City's testing agency.

1.5 DEFINITIONS

A. Backfill: Soil materials used to fill an excavation.
B. Base Course: Course placed between the sub-grade and the hot-mix asphalt, concrete pavement, walks, or curbs.
C. Breaker Run Stone: Meet the requirements defined in Wisconsin Department of Transportation (WisDOT) Section 311.
D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
E. Excavation: Removal of material encountered above the subgrade elevations and to lines and dimensions indicated.
1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Owner's Construction Representative. Authorized additional excavation and replacement material will be paid for according to Contract provisions.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction of Owner's Construction Representative. Unauthorized excavation, as well as remedial work directed by the Owner's Construction Representative, shall be without additional compensation.
F. Fill: Soil materials used to raise existing grades.
G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
H. Topsoil: Excavated on-site material, free of large tree roots, rocks, subsoil, debris, and weeds.

1.6 CONTOURS (GRADE ELEVATIONS)

A. Contours indicated on the Drawings are the finished grade elevations. Contractor shall review all grade elevations before commencing to ensure that proper slopes for drainage, slope for drives, walks, paving, etc., are maintained. If Contractor believes a deficiency is apparent, they shall notify the City or Owner's Construction Representative for clarification.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: All materials shall conform to requirements of the Geotechnical Report.
B. Materials:
1. Fill and Backfill. Satisfactory materials excavated from the site.
2. Imported Fill Material: Satisfactory material provided from off-site borrow areas when sufficient satisfactory materials are not available from required excavations.
3. Trench Backfill: ASTM D2321 and the Standard Specifications, unless otherwise specified or shown on the Drawings.
4. Subgrade Sub-base Material: As required by the Geotechnical Report and/or Section 31 22 16.15.
5. Building Sub-base Material: Sub-base for building and appurtenances slabs on ground is specified in Section 03 30 00 or the Geotechnical Report, as applicable.
6. Bedding: Aggregate type as indicated on the plans or naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100% passing a 1-inch sieve and not more than 8% passing a No. 200 sieve.
7. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100% passing a 1½-inch sieve and 0% to 5% passing a No. 8 sieve.
8. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100% passing a 1-inch sieve and 0% to 5% passing a No. 4 sieve.
9. Topsoil: Topsoil shall consist of stripping material excavated from the site. Topsoil shall consist of organic surficial soil found in depth of not more than 6 inches. Topsoil shall be as further defined in Section 32 91 19 - Topsoil-Select Fill Materials and Application.

C. Where conflicts between this specification, the Drawings, and the Geotechnical Report exist, requirements of the Geotechnical Report shall govern.
D. Source Quality Control:
1. Laboratory testing of off-site materials proposed for use in the project shall be provided by the Contractor's testing consultant. Test results shall be provided to the Owner's Construction Representative for approval before incorporation into the work.
2. The following tests shall be performed on each type of imported soil material used as compacted fill:
a. Moisture and Density Relationship: ASTM D698 or ASTM D1557
b. Mechanical Analysis: AASHTO T88 or ASTM D422
c. Plasticity Index: ASTM D4318

PART 3 - EXECUTION

3.1 GENERAL

A. General: All work shall be executed and conform to requirements of the Geotechnical Report.
1. Where conflicts between this specification and the Geotechnical Report exist, requirements of the Geotechnical Report shall govern.
2. For any material provided by the Owner, the Contractor shall provide a minimum of five days' notice for the material and shall include the quantity of material and delivery location requested for each day. Delivered material shall be available Monday-Friday 7:00 a.m. to 3:30 p.m. unless otherwise agreed upon by both the Owner and Contractor."

3.2 PREPARATION

A. Subgrades, fill material, and grading for pavement, ramps, sidewalks, and structures shall conform to the recommendations in the Geotechnical Report.
B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
C. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
D. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 CLEARING AND GRUBBING

A. Limits of clearing and grubbing shall be areas which are affected by excavation and grading.
B. Refer to Section 31 10 00 - Site Clearing.
C. Remove trees, stumps, roots, brush, other vegetation, debris, existing foundations, pavements, fences, and other items which interfere with new construction.
D. Remove stumps, logs, roots, and other organic material including existing structure occurring outside the structure excavation to depths below the following:
1. Walks: 18 inches
2. Roads and Drives: 18 inches
3. Parking Areas: 36 inches
4. Lawn Areas: 12 inches
5. Concrete Pads: 24 inches
6. Depressions within areas shall be filled and compacted as specified under Controlled Backfill.
E. Removal of existing trees which are to remain will not be permitted. Notify Owner's Construction Representative if existing trees create a difficulty when grades are raised or lowered in excess of 6 inches.

3.4 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
B. All dewatering activities must meet all the requirements set forth in the WDNR Construction Site Erosion & Sediment Control Technical Standard 1061. The Contractor shall obtain any necessary permits for dewatering.
C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation:
1. Reroute surface water runoff away from excavated areas.
a. Do not allow water to accumulate in excavations.
b. Do not use excavated trenches as temporary drainage ditches.

2. Install a dewatering system to keep subgrades dry and convey groundwater away from excavations. Maintain until dewatering is no longer required.

D. Provide dewatering systems as required for excavations:
1. Design and provide dewatering system using accepted and professional methods consistent with current industry practice to eliminate water entering the excavation under hydrostatic head from the bottom or sides. Design system to prevent differential hydrostatic head, which would result in floating out soil particles in a manner, termed as a "quick" or "boiling" condition. System shall not be dependent solely upon sumps or pumping water from within the excavation where differential head would result in a quick condition, which would continue to worsen the integrity of the excavation's stability.
2. Provide dewatering system of sufficient size and capacity to prevent ground and surface water flow into the excavation and to allow Work to be installed in a dry condition.
3. Control, by acceptable means, all water regardless of source. The Contractor shall be responsible for disposal of the water.
4. Control groundwater in a manner that preserves strength of foundation soils, does not cause instability or raveling of excavation slopes, and does not result in damage to existing structures. Where necessary, lower water level in advance of excavation utilizing wells, well points, jet educators, or similar positive methods. The water level as measured by piezometers shall be maintained a minimum of 3 feet below prevailing excavation level.
5. Commence dewatering prior to any appearance of water in excavation and continue until Work is complete to the extent that no damage results from hydrostatic pressure, flotation, or other causes.
6. Open pumping with sumps and ditches will be allowed provided it does not result in boils, loss of fines, softening of the ground, or instability of slopes.
7. Install wells or well points, if required, with suitable screens and filters so that continuous pumping of fines does not occur. Arrange discharge to facilitate collection of samples by the Owner or municipal agencies. During normal pumping and upon development of wells, levels of fine sand or silt in the discharge water shall meet WDNR discharge standards.
8. Control grading around excavations to prevent surface water from flowing into excavation areas.
9. Designate and obtain the services of a qualified dewatering specialist to provide dewatering plan as may be necessary to complete the Work.
10. Contractor shall be responsible for the accuracy of the Drawings, design data, and operational records required.
11. Contractor shall be responsible for the design, installation, operation, maintenance, and any failure of any component of the system.

E. Maintaining Excavation in Dewatering Condition:
1. Dewatering shall be a continuous operation. Interruptions due to power outages or any other reason will not be permitted.
2. Continuously maintain excavation in a dry condition with positive dewatering methods during preparation of subgrade, installation of pipe, and construction of structures until the critical period of construction or backfill is completed to prevent damage of subgrade support, piping, structure, side slopes, or adjacent facilities from flotation or other hydrostatic pressure imbalance.
3. Provide standby equipment on site, installed, wired, and available for immediate operation if required to maintain dewatering on a continuous basis in the event any part of the system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform such work as may be required to restore damaged structures and foundation soils at no additional cost to the Owner.
4. System maintenance shall include but not be limited to 24-hour supervision by personnel skilled in the operation, maintenance, and replacement of system components and any other work required to maintain excavation in dewatered condition.

3.5 EXPLOSIVES

A. Blasting of materials classified as rock shall be permitted only when authorized by the Owner's Construction Representative and municipality. Contractor shall meet all federal, state, and local requirements

B. Blasting shall be done with explosives of quantity and power, and fired in such sequence and locations as to not injure personnel, damage or crack rock against which concrete is to be placed, damage property, or damage existing work or other portions of new work. Contractor shall be responsible for damage caused by blasting operations.

C. The Contractor shall submit a Blasting Plan, prepared and sealed by a registered professional engineer that includes calculations for overpressure and debris hazard. Blasting mats shall be provided and non-electric

blasting caps shall be used. The Contractor shall obtain written approval prior to performing any blasting and shall notify the Owner's Construction Representative a minimum of 24 hours prior to blasting. The plan shall contain provisions for storing, handling, and transporting explosives as well as for the blasting operations.

3.6 STRIPPING OF SITE

A. Strip the site in conformance with the requirements of the Geotechnical Report referenced in Section 02 32 00.

B. Strip those portions of the site which will occupy walks, roads, drives, parking areas, and where grade changes are to be made, by a minimum of depth of topsoil indicated by the soils report plus additional soil as required to reach soil free of roots or organic debris subject to rotting and settling.

C. Stockpile reusable topsoil for use in finish grading and restoration. Reusable topsoil shall be fertile, friable agricultural soil capable of sustaining vigorous plant growth and suitable for growth of grass, neither excessively alkaline or acidic, free from subsoil, clay lumps, gravel, brush, objectionable weeds, litter, stones larger than 1 inch in diameter, and other material. Do not permit surplus topsoil to leave the project site until the finish grading is nearing completion or unless otherwise approved in writing by the Owner's Construction Representative.

D. Do not excavate, grade, or work topsoil in frozen or muddy conditions.

3.7 ROCK IN EXCAVATIONS

A. When rock as defined above is encountered before the proper subgrade is reached, work shall proceed as follows:

1. The excavation shall stop at this point and it shall be determined if such material is classified as rock.
2. Material classified as rock shall be removed to the lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
   a. 24 inches outside of concrete forms.
   b. 6 inches outside of minimum required dimensions of concrete cast against grade.
   c. 6 inches beneath the bottom of concrete slabs on grade.

3.8 UTILITY ROCK EXCAVATIONS

A. When rock as defined above is encountered when excavating for water main or storm sewer, work shall proceed as follows:

1. The excavation shall stop at this point and it shall be determined if such material is classified as rock.
2. Material classified as rock shall be removed to 6 inches below the proposed utility location to permit installation of the utility without exceeding the following dimensions:
   a. 8 feet in width centered on the proposed utility.
   b. 6 inches beneath the bottom of the proposed water main or storm sewer.
   c. Utility rock excavations shall be completed in accordance with Section 608 of the State Specifications.

3.9 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavations shall be in conformance with the requirements of the Geotechnical Report referenced in Section 02 32 00.

B. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

3.10 SUBGRADE INSPECTION

A. Notify Owner's Construction Representative when excavations have reached subgrade.

B. If Owner's Construction Representative determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll shall be completed in accordance with Geotechnical Report referenced in Section 02 32 00 and in accordance with Section 31 22 16.15 - Subgrade Preparation.

D. Authorized additional excavation and replacement material will be paid for according to the Contract provisions.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Owner's Construction Representative, without additional compensation from the Owner.

3.11 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust. Provide necessary erosion control devices as shown on the Erosion Control Plan.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.12 BACKFILL

A. Backfill shall be in conformance with the requirements of the Geotechnical Report referenced in Section 02 32 00.

B. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Removing trash and debris.
   2. Removing deleterious materials.

3.13 FILL

A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

B. Plow, scarify, bench, or breakup sloped surfaces steeper than one vertical to four horizontal so fill material will bond with existing material.

C. Place and compact fill material in layers to required elevations per the Geotechnical Report.

D. Fill areas to contours and elevations shown on the Drawings with materials deemed satisfactory.

E. Place fills in continuous lifts specified herein.

F. Fill within proposed building subgrade, paving subgrade, and outparcel subgrades shall not contain rock or stone greater than 6 inches in any dimension.

G. Unless otherwise specified for rock fill, rock or stone less than 12 inches in largest dimension may be used in fill below structures, paving, outparcels, and graded areas, up to 24 inches below surface of proposed subgrade of hard surface paved areas or 24 inches below finish grade of landscape and turf graded areas when mixed with satisfactory material. Rock or stone less than 4 inches in largest dimension may be used in fill within the upper 24 inches of proposed subgrade or finish grade of graded areas when mixed with satisfactory material.

H. Rocks larger than 12 inches in diameter shall be separated and stockpiled at an on-site location determined by the Owner's Construction Representative.

I. Fill materials used in preparation of subgrade shall be placed in lifts or layers not to exceed 12 inches.

3.14 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2% of optimum moisture content.
   1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2% and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF BACKFILLS AND FILLS

A. Place backfill and fill materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact as follows:

	Percent (%) of Maximum Laboratory Density	
Location	ASTM D698	ASTM D1557
Subgrade and fill below foundations, slab-on-grade, and upper 12 inches of area to be paved	98	95
Subgrade and fill in all other areas	95	92

D. Maintain moisture content of not less than 1% below and not more than 2% above optimum moisture content of fill materials to attain required compaction density.

E. Exercise proper caution when compacting immediately over top of pipes or conduits. Water jetting or flooding is not permitted as method of compaction.

F. Corrective Measures for Non-Complying Compaction: Remove and re-compact deficient areas until proper compaction is obtained.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Lawn or Unpaved Areas: ±1 inch (25 mm).
   2. Walks: ±1 inch (25 mm).
   3. Pavements: ±1/2 inch (13 mm).

3.17 FINISH GRADING

A. Grade areas where finish grade elevations or contours are indicated on the Drawings, other than paved areas, outparcels, and buildings, including excavated areas, filled and transition areas, and landscaped areas. Graded areas shall be uniform and smooth, free from rock, debris, or irregular surface changes. Ground surfaces shall vary uniformly between indicated elevations. Grade finished ditches to allow for proper drainage without ponding and in manner that will minimize erosion potential. For topsoil, sodding, and seeding requirements refer to Section 32 92 00 and Section 32 92 19.

B. Correct settled and eroded areas within one year after date of completion at no additional expense to the City. Bring grades to proper elevation.

3.18 MAINTENANCE OF SUBGRADE

A. Verify finished subgrades to ensure proper elevation and conditions prior to construction above subgrade.

B. Protect subgrade from excessive wheel loading during construction, including concrete trucks, dump trucks, and other construction equipment. If rutting or damage to the subgrade does occur, regrade and compact to project specified tolerances.

C. Construct temporary ditches and perform such grading as necessary to maintain positive drainage away from subgrade at all times. Contractor shall be responsible for maintaining grades and subgrades throughout construction from frost, moisture and excessive wheel loading. Contractor shall be responsible for choosing means, methods and best management practices to protect the subgrade.

3.19 BORROW AND SPOIL SITES

A. Comply with WPDES and local erosion control permitting requirements for any and all on-site and off-site, disturbed spoil and borrow areas. Upon completion of spoil or borrow operations, clean up spoil or borrow areas in a neat and reasonable manner to the satisfaction of the Developer or off-site property owner, if applicable.

B. Topsoil stripping and re-spread will be paid for at the quantity and unit price noted on the Bid Form. Excavation shall be paid as part of the Lump Sum price for Excavation Common as noted on the Bid Form. Seeding and mulching shall also be paid at the unit prices noted in the Bid Form.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by Owner's Construction Representative; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

3.22 FIELD QUALITY CONTROL

A. Field quality control shall be the responsibility of the Owner's Construction Representative. Except for specified mandatory testing, field quality control testing and inspection shall be at the discretion of the Contractor as necessary to assure compliance with Contract requirements.

B. The Owner's testing agency will perform retesting and re-inspection as necessary until corrections are fully completed by the Contractor at the Contractor's expense.

END OF SECTION

SECTION 31 22 16.15
SUBGRADE PREPARATION

PART 1 - GENERAL

1.1 SCOPE

A. The work under this section shall consist of providing all work, materials, labor, equipment, and supervision necessary to complete roadway and parking lot grading, as required in these specifications, on the Drawings and as otherwise deemed necessary to complete the work.

1.2 RELATED WORK

A. Applicable provisions of Division 1 govern work under this Section. Related sections include:
   1. Section 02 20 00 - General Sitework Requirements
   2. Section 02 32 00 - Geotechnical Investigation
   3. Section 31 20 00 - Earthmoving
   4. Section 31 23 16.13 - Trenching
   5. Section 31 25 00 - Erosion Control
   6. Section 31 32 00 - Soil Stabilization

1.3 QUALITY ASSURANCE

A. The Contractor shall retain the services of a geotechnical consulting engineer to conduct sampling testing and analysis as required by this section and elsewhere in the Contract Documents. The geotechnical consulting engineer shall meet the requirements of ASTM E329-00b.

Material	Test Required	Test/Sample Frequency
Granular Fill	D422-63 (1998) - Standard Test Method for Particle Size Analysis of Soils	1 test/500 cy placed
Granular Fill	ASTM D1557 - Optimum Moisture-Maximum Density Determination (Modified Proctor)	1 test per type of material

Table 31 22 16.15 - 1

1.4 REFERENCES

A. Where reference is made to the "Construction Standards," it shall be construed to mean the City of Madison's Construction Standards, except the method of measurement and basis of payment shall not apply.

B. Where reference is made to the "Standard Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Sewer and Water Construction in Wisconsin," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

C. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Highway and Structure Construction," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

D. Where reference is made to the "Geotechnical Report," it shall be construed to mean the Geotechnical Report in Section 02 32 00.

E. ASTM International (ASTM):
   1. ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbs/ft³ (600 kN-m/m³))
   2. ASTM D1557 Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbs/ft³ (2,700 kN-m/m³))
   3. ASTM D6938 In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.5 PERMITS/FEES

A. Contractor shall be solely responsible for obtaining all permits necessary to complete the work that are not provided by the Owner. Contractor shall pay all fees associated with obtaining permits. These include, but are not limited to, permits for work within public right-of-way, and building permits.

B. The Owner will obtain and provide the WDNR WRAPP permit, City Erosion Control and Stormwater permits, and Wisconsin Department of Safety and Professional Services (WDSPS) Exterior Plumbing permit.

1.6 PROVISIONS FOR FUTURE WORK

None.

1.7 SURVEY AND STAKING

A. Owner will provide benchmarks and control points for the project as defined in Division 1.

B. Contractor shall be responsible for transferring benchmarks, control points, lines, and grades as necessary to complete his work.

PART 2 - MATERIALS

2.1 AGGREGATE MATERIALS - GENERAL

A. Alternate crushed aggregate material blends that are locally available will be considered on a project by project basis for crushed aggregate base courses, and will be subject to the City's approval. The Owner's Construction Representative will require the Contractor to furnish a gradation report on the materials.

2.2 SPECIAL FILL

A. In certain cases, special fill materials may be required for specific purposes, such as stabilizing subgrades, backfilling, undercut excavations or filling behind retaining walls. Fill materials shall meet the requirements of the following sections of the State Specifications: Section 209 for Granular Backfill, Section 210 for Structure Backfill, Section 305 for Dense Graded Base Course, Section 312 for Select Crushed Material, and Section 311 for Breaker Run of the State Specifications.

2.3 GEOTEXTILE FABRIC

A. Refer to Section 31 32 00 - Soil Stabilization.

PART 3 - EXECUTION

3.1 PREPARATION

A. Review plans and prepare work plan and schedule. Coordinate any necessary interruptions in site access with Owner's Construction Representative, in accordance with other specification sections.

B. Contact Diggers Hotline. Locate and protect utilities, structures, pavement, trees, landscaping, benchmarks, and other features in the work area.

C. Layout work. Establish and transfer line and grade as necessary to complete the work.

D. Remove topsoil from work area. Sawcut and remove pavement from work area.

E. Grade roadways and parking areas to drain water away.

3.2 PREPARE FOUNDATION FOR ASPHALTIC PAVEMENT

A. Provide all labor, materials, and equipment necessary to prepare the foundation for to a condition suitable for constructing and supporting asphaltic pavement in accordance with these Specifications and Section 211 of the State Specifications.

3.3 EXCAVATION

A. Excavate to elevations and dimensions as shown on the Drawings and as necessary to complete construction. Excavations shall be sufficiently deep to provide for all proposed base course and pavement.

B. Notify the Owner's Construction Representative if correction of unauthorized excavation or over-excavation is necessary. Said excavations will be corrected based on recommendations of the Owner's Construction Representative or Owner's Geotechnical Consultant. Contractor will be responsible for all costs associated with correcting these excavations, including fees charged by City and/or Owner's Geotechnical Consultant.

C. Segregate the various materials excavated. Reserve material meeting the requirements of backfill for the location. Excavated material that does not meet the requirements of backfill, and excess excavated material, shall be removed from the site and disposed by the contractor, unless directed otherwise by other specification sections or the Owner's Construction Representative.

D. Locate spoil piles in accordance with OSHA requirements, and so that it does not interfere with public travel, adjacent landowners or other construction activities.

3.4 FILL AND COMPACTION

A. Excavation shall be reasonably free of water prior to beginning filling. Do not place material on frozen surfaces or use frozen material.

B. Fill areas using the material specified on Table 31 22 16.15 - 2, or as shown on the Drawings.

C. Place and compact material to minimize settlement and avoid damage to structures, pipes, utility lines and other features. Hand-place and compact material as necessary.

D. Place backfill simultaneously on both sides of structures.

E. Moisture condition backfill material as necessary to achieve density required for given use.

F. Compact fill material as required by Table 31 22 16.15 - 2 for the given use. Compaction requirements based on Modified Proctor Dry Density (ASTM D1557).

G. It is the responsibility of the Contractor to provide all necessary compaction equipment and other grading equipment that may be required to obtain the specified density. Vibratory plate or tamping type walk behind compactors will be required whenever backfill is placed adjacent to structures, pipes, utility lines confined spaces (i.e., backfilling undercut areas) and other features.

Area	Percent (%) Compaction (1)	
	Clay/Silt	Sand/Gravel
Within 10 ft. of building lines		
Footing bearing soils	95	95
Under floors, steps and walks		
- Lightly loaded floor slab	95	95
- Heavily loaded floor slabs and thicker fill zones	95	95
Beyond 10 ft. of building lines		
Under walks and pavements - Granular Fill		
- Less than 2 ft. below subgrade	95	95
- Greater than 2 ft. below subgrade	92	92

Table 31 22 16.15 - 2

H. Where additional filling or excavation is necessary, or placement of base course will be delayed, roll surface of proposed roadway with a smooth drum roller to provide relatively impervious surface and promote drainage. Roll with a smooth single drum vibratory roller having a minimum operating static weight of 12,000 pounds and a minimum centrifugal force of 22,000 pounds to provide relatively impervious surface and promote drainage. In the event the material is deficient in moisture content for readily obtaining the necessary density, it shall be moistened to the degree necessary by means of approved equipment. The compaction operation shall continue until the Engineer observes no visible displacement of material laterally or longitudinally under the compaction equipment or hauling equipment.

3.5 SUBGRADE APPROVAL/PROOF-ROLLING

A. Prior to undercutting or excavating below subgrade (EBS) or placing any base course, contact the Owner's Construction Representative to schedule inspection of subgrade and proof-rolling. Provide minimum of 24 hours confirmed notice. All proof-rolling shall be completed in the presence of the Owner's Construction Representative or Owner's Geotechnical Consultant.

B. To complete proof-rolling, entire roadway subgrade shall be provided with a relatively smooth surface, suitable for observing soil reaction during proof-rolling.

C. Contractor shall schedule and provide a fully loaded tri-axle dump truck for proof-rolling. Loaded truck shall have a minimum gross operating weight of 30 tons. Test shall be conducted with "tag" or "pusher" axles retracted from the ground.

D. Test rolling shall be accomplished in a series of traverses parallel to the centerline of the street or parking area. The truck shall traverse the length of the street or parking area once for each 12 feet of width. Additional passes along the traverse shall be completed as directed by the Owner's Construction Representative, to further define unsatisfactory subgrade.

E. Soft areas, yielding areas, cracked areas or areas where rolling or wave action is observed shall be considered indicative of an unsatisfactory subgrade. Such areas shall be undercut as outlined in subsequent subsections of this specification.

F. Once the subgrade has been proof-rolled and approved, protect the soils from becoming saturated, frozen, or adversely altered.

3.6 UNDERCUTTING/EXCAVATION BELOW SUBGRADE (EBS)

A. Undercutting/EBS shall be completed only when directed by the Owner's Construction Representative. The Contractor shall not be compensated for any unauthorized undercutting/EBS. Measure and document undercut areas and depths in consultation with Owner's Construction Representative.

B. Payment for undercutting/EBS shall be made on a unit price (cubic yard) basis measured in place at the rate as defined in the Contract. Payment will be made only for the measured quantity of undercutting/EBS directed by the Owner's Construction Representative to be performed. The unit price shall include all costs for labor and materials necessary to remove and replace undercut areas including providing backfill materials and disposal of excavated materials off-site.

C. Excavate undercut areas to the depth specified using equipment with smooth cutting edge. Excavated undercut material that does not meet the specifications for fill needed elsewhere on site shall be removed from the site and legally disposed.

D. Undercut areas shall be backfilled with 3-inch dense graded base course, as directed by the Owner's Construction Representative in maximum of 6-inch thick lifts (compacted) or as directed by the Owner's Construction Representative. Three-inch dense graded base course shall be compacted in thin lifts with a vibratory compactor until no further consolidation is evident.

3.7 GEOTEXTILE FABRIC

A. When required by the Owner's Construction Representative geotextile fabric shall be installed over the subgrade layer and prior to installing base aggregates. The Owner's Construction Representative shall determine if geotextile fabric installation is required at the time of subgrade proof-rolling.

END OF SECTION

SECTION 31 23 16.13
TRENCHING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Excavation of trenches, pipe bedding, backfilling, and compaction for storm sewer, culverts, and water service.

1.2 RELATED SECTIONS

A. Applicable provisions of Division 1 govern work under this Section. Related sections include:
   1. Section 02 20 00 – General Sitework Requirements
   2. Section 02 32 00 – Geotechnical Investigation
   3. Section 31 20 00 – Earthmoving
   5. Section 33 40 00 – Storm Sewer Construction

1.3 REFERENCED ORGANIZATIONS

A. American Society for Testing and Materials:
   1. ASTM C33-586 Specification for Concrete Aggregate
   2. ASTM C136-84a Method for Sieve Analysis of Fine and Coarse Aggregate
   3. ASTM D698-78 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-lb (2.49-kg) Rammer and 12-in. (304.8 mm) Drop
   4. ASTM D1557-78 Test Methods for Moisture-Density Relations of Soil-Aggregate Mixtures Using 10-lb. (4.54- kg) Rammer and 18-in. (457-mm) Drop
   5. ASTM D2487-85 Classification of Soils for Engineering Purposes
   6. ASTM D2922-81 Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
   7. ASTM D3017-78 Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

B. Where reference is made to the "Construction Standards", it shall be construed to mean the City of Madison's Construction Standards, except the method of measurement and basis of payment shall not apply.

C. Where reference is made to the "Standard Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Sewer and Water Construction in Wisconsin," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

D. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Highway and Structure Construction," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

E. Where reference is made to the "Geotechnical Report," it shall be construed to mean the geotechnical report in Section 02 32 00.

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Field Testing Reports:
   1. Density and Moisture Tests: Submit within 14 days of test date.

PART 2 - PRODUCTS

2.1 GENERAL

A. Conform to the requirements of the Standard Specifications:
   1. Where conflicts between this specification, the Standard Specifications, and the Construction Standards exist, the most stringent requirements shall apply.

2.2 BEDDING AND COVER MATERIALS

A. Water Mains:
   1. Bedding and cover material shall conform to the Construction Standards and Standard Specifications.

2.3 BASE MATERIAL

A. Crushed Stone: Hard, durable particles of crushed stone or gravel substantially free from shale or lumps of clay or loam. When crushed stone base is required under sewer, water main, or structures, gradation shall meet the requirements of Type 1 below. When crushed stone for trench bottom stabilization is required to affect soil stability or drainage, it shall meet the gradation requirements of Type 2 below.

Type 1: 1½-Inch Crushed Stone

Sieve Size	Percent Passing by Weight
2 Inch	100
1½ Inch	90-100
1 Inch	20-55
3/4 Inch	0-15
1/2 Inch	0-5

Type 2: 2-Inch Crushed Stone

Sieve Size	Percent Passing by Weight
2½ Inch	100
2 Inch	90-100
1½ Inch	35-70
1 Inch	0-15
1/2 Inch	0-5

2.4 BACKFILL

A. Granular Backfill: Durable particles ranging from fine to coarse in a substantially uniform combination. Sufficient fine material shall be present to fill all the voids of the coarse material. Some fine clay or loam particles are desirable, but clay or loam lumps shall not be present. Conform to the following gradation:

Granular Backfill

Sieve Size	Percent Passing by Weight
3 Inch	100
2 Inch	95-100
No. 4	35-60
Finer than No. 200	5-15

B. Excavated Material: Natural soils classified in ASTM D2487 as Gravels (GW, GP GM and GC), Sands (SW, SP, SM and SC), and Silts and Clays (ML and CL). Silts and Clays classified as OL, MH, CH, OH, and PT are not acceptable unless specifically allowed by Engineer. Soil material shall be free from vegetable or other organic matter, trash, debris, stones larger than three inches and frozen material.

C. Use of excavated material for backfill of public utilities shall be subject to approval of the Owner's Construction Representative and Owner's Geotechnical Consultant prior to its use.

PART 3 EXECUTION

3.1 GENERAL

A. Conform to the requirements of the Standard Specifications.

1. Where conflicts between this specification, the Standard Specifications, and the Construction Standards exist, the most stringent requirements shall apply.

3.2 EXAMINATION

A. Verify fill materials to be used are acceptable.

3.3 PREPARATION

A. Identify required lines, levels, contours and datum.
B. Maintain and protect existing utilities remaining, which pass through work area.
C. Protect plant life, lawns, and other features remaining as a portion of the final landscaping.
D. Protect bench marks, existing structures, shore protection structures and base materials, sidewalks, paving and curbs from excavation equipment and vehicular traffic.
E. Protect above and below grade utilities which are to remain.
F. Strip topsoil and stockpile on-site for re-use.
G. When excavating across or within existing pavement, saw cut in neat straight lines.

3.4 DEWATERING

A. Do not allow water to accumulate in the trench.
B. Provide all dewatering equipment needed to accomplish the Work. Unless indicated otherwise, no additional compensation will be made for dewatering.
C. No additional compensation will be made for crushed stone used for trench drainage.
D. Dispose of water in a suitable manner without damage to property.
E. Install, operate and abandon dewatering equipment in accordance with applicable state and local codes.
F. Contact the Wisconsin Department of Natural Resources (WDNR) for a permit if the quantity of water to be pumped from dewatering equipment is in excess of 70 GPM.

Wisconsin Department of Natural Resources
Private Water Supply Section
P.O. Box 7921
Madison, WI 53707-7921

3.5 EXCAVATION

A. Excavate subsoil to required depth and grade.
B. Cut trenches sufficiently wide to enable installation of the utilities and allow inspection. Normal trench width below the top of the pipe shall be the nominal pipe diameter plus 24 inches. Do not undercut trench walls.
C. Trench walls above the top of the pipe shall be as dictated by soil type and safety requirements. Provide shoring and bracing as required to maintain safe working conditions.
D. Stockpile excavated material in area designated on-site.

3.6 BEDDING

A. Place bedding in trench before installing pipe.
B. Support pipe during placement and compaction of bedding.
C. Provide a minimum of 4 inches of bedding material under the pipe barrel and under the bell.
D. Lightly consolidate the material so that it fills and supports the haunch area and encases the pipe to the limits shown on the Drawings.
E. If excavation is carried deeper than 6 inches below the pipe barrel, backfill the excess depth with 1½-inch crushed stone meeting the requirements of paragraph 2.3-A. of this section.
F. After the pipe has been laid and jointed, place bedding materials by hand or equally careful means around the sides of the pipe and up to a level 12 inches above the pipe. Lightly consolidate the material.

3.7 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen materials.
B. Do not backfill over wet, frozen, or spongy subgrade surfaces.
C. Granular Backfill: Place and compact materials in continuous layers not exceeding 12 inches compacted depth.
D. Natural Soil Backfill: Place and compact material in continuous layers not exceeding 8 inches compacted depth.
E. Maintain optimum moisture content of backfill materials to attain required compaction density.
F. Utilize surplus backfill materials on project or remove surplus backfill material from site.
G. Leave fill material stockpile areas completely free of excess fill materials.
H. At all manholes, 3/4-inch crusher run stone shall be installed from the top of the cone to the top of the casting.

3.8 TOLERANCES

A. Top Surface of Backfilling Under Paved Areas: Plus or minus (±) .05 feet from required elevations
B. Top Surface of General Backfilling: Plus or minus (±) 0.2 feet from required elevations

3.9 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under the provisions of Division 1 by the Owner's testing agency.

B. Density/moisture relationship will be determined in accordance with ASTM D1557 (Modified Proctor).

C. Compaction testing will be performed by Owner's testing agency and will be in accordance with ASTM D2922 and ASTM D3017.

D. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest at no cost to the Owner. Additional testing of the removed and replaced Work will be at the expense of the Contractor.

E. Frequency of Tests:

1. For trenches under paved areas, one test per 100 linear feet of trench.
2. For trenches under unpaved areas, one test per 250 linear feet of trench.

3.10 COMPACTION SCHEDULE

A. For paved areas compact to at least 95% of optimum density in accordance with ASTM D1557.

B. For unpaved areas compact to at least 92% of optimum density in accordance with ASTM D1557.

END OF SECTION

SECTION 31 25 00
EROSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Related sections include:
   1. Section 31 20 00 - Earthmoving
   2. Section 31 32 00 - Soil Stabilization
   3. Section 32 92 19 - Seeding and Sodding

1.2 REFERENCE STANDARDS

A. Where reference is made to the "Construction Standards," it shall be construed to mean the City of Madison's Construction Standards, except the method of measurement and basis of payment shall not apply.

B. Where reference is made to the "Standard Specifications," it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, Current Edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

C. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, current Edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

D. Where reference is made to the "Geotechnical Report," it shall be construed to mean the geotechnical report in Section 02 32 00.

1.3 SUBMITTALS

A. Provide a detailed Erosion Control and Sequencing Plan for approval by the Owner's Construction Representative, if differing from the approved sequencing and erosion control plans issued as part of the Contract Documents.

B. Provide manufacturer's data and WisDOT Product Acceptability List verification for silt fence, temporary ditch checks and erosion mat for review and approval by Owner's Construction Representative prior to procurement.

C. Identify seed supplier and provide seed source, purity and germination specifications, for all seed mixes specified for installation in this section, to Owner's Construction Representative for approval prior to procurement.

D. Provide manufacturer's data for fertilizer for review and approval by Owner's Construction Representative prior to procurement.

1.4 QUALITY ASSURANCE

A. Contractor shall ensure that the General Provisions and Special Conditions of the following permits issued for the project shall be complied with at all times:
   1. City of Madison Stormwater Management and Erosion Control Permit.
   2. WDNR General Permit to discharge under the Wisconsin Pollutant Discharge Elimination System, for land disturbing construction activities.

B. Inspect erosion control materials and supplies after delivery to verify that no damage has occurred.

C. The status of erosion control measures will be an item of discussion in every weekly construction meeting. All corrective actions required during construction meetings shall be accomplished within three working days of the meeting date.

D. Contractor shall provide weekly written reports on the erosion control system for the previous week to the Owner's Construction Representative for the duration of construction in a format approved by the Engineer. These reports shall be provided at each weekly construction meeting and shall be reported to the City's erosion control reporting representative (electronic PDF preferred). The weekly erosion control report shall describe:
   1. The extent of erosion control system installed.
   2. The condition of erosion control measures for that week, based on field observations.
   3. Any accidental release of sediment.
   4. A summary of daily rainfall/snowmelt data for the week.
   5. Any specific corrective action taken.
   6. Corrective action that needs to be taken.
   7. The person that conducted the observations shall sign the report.

1.5 WARRANTY

A. Work conducted under this section shall be subject to the one-year warranty provisions described in the General Conditions of contract.

1.6 SEQUENCING AND SCHEDULING

A. The sequencing of project construction activities will be generally as described in the plans and Contract Documents. The specific sequence for construction within a particular area shall be agreed upon with Owner's Construction Representative prior to construction within that area.

B. All erosion control measures shall be completely installed for each construction area and approved by Owner's Construction Representative before any other construction activity takes place.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Silt Fence:
   1. Silt fence shall be as specified in the WDNR Construction Site Erosion & Sediment Control Technical Standard 1056.

B. Erosion Mat - Class I, Type B and Class II, Type B:
   1. Erosion control mat shall be to the requirements of WDNR Construction Site Erosion & Sediment Control Technical Standard 1052.
   2. WisDOT Erosion Mat Class I, Type B erosion mat meeting the requirements of Section 628.2.2 of the State Specifications shall be used for all seeded areas within the public right-of-way unless noted otherwise on the plans.

C. Seeding Temporary:
   1. Temporary seed shall be 100% Annual Ryegrass, with purity and germination requirements as specified in Section 630.2.1.5.1.2 of the State Specifications or as indicated in the WDNR Construction Site Erosion & Sediment Control Technical Standard 1059. Temporary seeding will be incidental to the grading items in the contract.

D. Mulch:
   1. Mulch proposed for use shall be clean straw, with no weed material or seeds, and shall be approval Engineer before use.
   2. Mulch shall meet the standards set forth within the WDNR Construction Site Erosion & Sediment Control Technical Standard 1058.

E. Tracking Pads:
   1. Stone for use in temporary access pads shall range in size from 3 to 6 inches in diameter.
   2. Pad shall be a minimum of 50 feet long.
   3. Pad shall meet the requirements of WDNR Construction Site Erosion & Sediment Control Technical Standard 1057.

F. Fertilizer - Type A:
   1. Fertilizer shall be as specified in Section 629.2.1.2 of the State Specifications for Fertilizer, Type A.

G. Riprap:
   1. Provide riprap as specified in Section 606.2.1 of the State Specifications for the size and type indicated on the construction drawings or bid form. If the size is not specified, medium riprap shall be used.

H. Temporary Ditch Checks:
   1. Provide temporary ditch checks of material found on WisDOT's PAL list.
   2. Submit a written copy of the proposed material and manufacturer's specification for installing the product on slopes channels, and next to live traffic lanes as applicable to the project to the Owner's Construction Representative for approval prior to installation.
   3. Erosion Bales shall not be used on this project as a sole means of perimeter erosion control. Erosion bales may be used to reinforce or support other primary means of perimeter erosion control, like silt fence.

I. Inlet Protection - Rigid Framed:
   1. Use FlexStorm Catch-It rigid framed temporary inlet protection complying with ASTM D8057. Contractor shall provide inlet protection to fit the existing drainage structures.

J. Rock Check Dams:
   1. Provide rock check dams in accordance with the standard detail drawings at locations identified in the plans and as directed by the Owner's Construction Representative.

PART 3 - EXECUTION

3.1 GENERAL

A. Establish all heights and grades to properly execute work from benchmark established by others.
B. Contractor shall provide all surveys to accurately locate the construction on the site.
C. Provide temporary erosion control measures in accordance with the Contractor's approved erosion control and sequencing plan. These measures may include temporary sedimentation basins, diversion berms and swales and other measures constructed in accordance with the WDNR Technical Standards.

3.2 EROSION CONTROL STRUCTURES

A. Runoff diversion berms shall be constructed of clean topsoil 2 feet high with 3H:1V side slopes and seeded and mulched immediately after installation.
B. Silt fence shall be placed according to the WDNR Construction Site Erosion & Sediment Control Technical Standard 1056.

3.3 SEEDING TEMPORARY AND MULCHING

A. Temporary seeding shall be conducted as described in Section 630.3.3 of the State Specification, with sowing using either Method A or Method B. Temporary seeding areas shall receive fertilizer at the rate of 10 pounds/1,000 square feet.
B. Temporary seed shall receive mulch at the rate of 2,500 pounds/acre, and shall be crimped into the soil using WisDOT Procedure specified in Section 627.3.2.3 of the State Specifications.
C. Disturbed areas within the construction site shall be graded, prepared for seeding, and seeded to conform to the following requirement for the maximum duration of bare-ground conditions:
    1. Areas within 100 feet of and draining directly to wetlands or watercourses, with slopes less than 5%: seven days
    2. Areas within 100 feet of and draining directly to wetlands or water courses, with slopes between 5% and 25%: three days
    3. Areas in the interior of the site that do not drain directly to wetlands and water courses: 30 days.

3.4 EROSION MAT CLASS I TYPE B and CLASS II TYPE B

A. Erosion control mat shall be applied according to WDNR Technical Standards 1052 or 1053 as applicable and manufacturer's requirements.

3.5 TRACKING PAD

A. Install tracking pads at the locations as shown in the plans or as directed by the Owner's Construction Representative.
B. Tracking Pads shall be installed and maintained in accordance with Section 628.3.16 of the State Specification.
C. Tracking Pads shall be maintained throughout construction and removed once construction is completed or the adjacent work area is stabilized.

3.6 FERTILIZER TYPE A

A. Fertilizer applied to temporary seeding areas shall be applied as specified in Section 629.2.1.2 of the State Specification at locations where temporary seeding is required.

3.7 RIPRAP

A. Place riprap of the specified size at locations as shown in the construction drawings.
B. Place riprap in accordance with Section 606.3 of the State Specifications.
C. Riprap at outfall locations shall be placed immediately after or concurrent with the placement of the apron endwall. Riprap at the outfalls is intended to be left in place as a permanent erosion control measure.

3.8 TEMPORARY DITCH CHECKS

A. Place and maintain temporary ditch checks at the locations shown on the construction drawing and as directed by the Owner's Construction Representative
B. Place and maintain temporary ditch checks in accordance the manufacturer's instructions and Section 628.3.14 of the State Specifications, except erosion bales are not to be used as temporary ditch checks on this project.
C. Remove ditch checks after the slope ditches are stabilized in accordance with Section 628.3.14 of the State Specifications.

3.9 INLET PROTECTION - RIGID FRAMED

A. Furnish install and maintain ridged framed inlet protection in accordance with Flex-Storm Catch-it manufactures specifications, and City of Madison and Dane County requirements.

B. Inlet protection shall be maintained throughout construction, and removed once the area adjacent to the inlet has been stabilized and as directed by the Owner's Construction Representative.

3.10 MAINTENANCE AND CLEANUP

A. The erosion control system shall be maintained throughout the duration of the construction project, in accordance with the procedures identified in Section 628.3.4.2 of the State Specifications.

B. The erosion control system shall be inspected immediately after each rainfall of more than 0.5 inch, and daily during prolonged rainfall. All inspections shall be reported to the Owner's Construction Representative in the weekly erosion control system report.

C. Accumulated sediment within the erosion control system shall be removed before one-half of the storage capacity of the erosion control measure is used, or as specified by the Owner's Construction Representative.

D. Accumulated sediment in riprap shall be removed as directed by the Owner's Construction Representative during the project, and as a final condition of acceptance if deficiencies are noted at final walk through.

3.11 ROCK CHECK DAMS

A. Place and maintain rock check dams at the locations shown on the construction drawing and as directed by the Owner's Construction Representative

B. Remove sediment deposits when the build-up reaches approximately one-third of the height of the rock check dam, and as directed by the Owner's Construction Representative. Contractor may also remove and replace the stone check with sediment and replace with new stone at their discretion. Each location will be paid for initial placement only maintenance is incidental to this item.

C. Remove rock check dams after the slopes and ditches are stable and turf develops enough to make future erosion unlikely. The Owner's Construction Representative will determine when the contractor meets this criteria.

END OF SECTION

SECTION 31 32 00
SOIL STABILIZATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Geotextile fabric and geogrid for stabilization of subgrade.

B. Related requirements, refer to the following section:
   1. Section 31 20 00 - Earthmoving

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.

B. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

1.3 SUBMITTALS

A. Submit manufacturer's specifications for geotextile fabric and geotextile grid.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide products from one of the following manufacturers as specified in the Materials paragraph below:
   1. TenCate Geosynthetics North America (Mirafi), Pendergrass, GA - (706) 693-2226, www.tencate.com
   2. Hanes Geo Components (WEBTEC), Winston Salem, NC - (336) 747-1600, www.hanesgeo.com
   3. Tensar International Corp., Atlanta, GA - (888) 828-5126, www.tensarcorp.com
   4. Thrace-LINQ Inc., Summerville, SC - (843) 873-5800, www.thracelinq.com
   5. DuPont (Typar), Summerville, SC - (843) 832-6860, www.typargeo.com
   6. Synteen Technical Fabrics, Lancaster, SC - (800) 796-8336, www.synteen.com

2.2 MATERIALS

A. Aggregate:
   1. Coarse Aggregate: Crushed carbonate, crushed gravel, crushed air-cooled slag, granulated slag, a mixture of crushed and granulated slag, or other types of suitable material meeting the gradation requirements of Section 305 of "State of Wisconsin Standard Specifications for Highway and Structure Construction," latest edition.
   2. Fine Aggregate: Sand - Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter meeting the gradation requirements of Section 305 of "State of Wisconsin Standard Specifications for Highway and Structure Construction," latest edition.
   3. Subsoil: Existing to be re-used.

2.3 ACCESSORIES

A. Geotextile Fabric for Stabilization - provide one of the following:
   1. Mirafi HP 370 or HP 570, by TenCate
   2. SF40 or SF65, by DuPont
   3. GTF-200 or 300, by Thrace-LINQ
   4. TerraTex HD, by Hanes

B. Geogrid for Stabilization - provide one of the following:
   1. Biaxial Geogrid Type 1 (formerly BX 1100), by Tensar
   2. Biaxial Geogrid Type 2 (formerly BX 1200), by Tensar
   3. Mirafi BXG 11, by TenCate
   4. Mirafi BXG 12, by TenCate
   5. SF 11, by Synteen
   6. SF 12, by Synteen

PART 3 - EXECUTION

3.1 PREPARATION

A. Start stabilization only when weather and soil conditions are favorable for successful application of proposed material.

B. Proof-roll subgrade to identify areas in need of stabilization.

3.2 EQUIPMENT

A. Perform operations using suitable, well maintained equipment capable of excavating subsoil, mixing and placing materials, wetting, consolidating, and compacting of material.

3.3 EXCAVATION

A. Excavate subsoil to depth sufficient to accommodate soil stabilization.

B. Remove lumped subsoil, boulders, and rock that interfere with achieving uniform subsoil conditions.

C. Notify Owner's Construction Representative in writing of unexpected subsurface conditions. Discontinue affected work in area until notified to resume work.

D. Remove excess excavated material from site.

3.4 GEOTEXTILE FABRIC AND/OR GEOGRID

A. Place geotextile fabric and/or geogrid over subsoil surface, lap edges and ends in accordance with manufacturer's recommendations in those areas that are shown on Construction Drawings or in those areas that need additional stabilization prior to placement of base course. Place geotextile fabric and/or geogrid in accordance with manufacturer's recommendations.

3.5 FIELD QUALITY CONTROL

A. Field quality control shall be the responsibility of the Contractor in accordance. Except for specified mandatory testing, field quality control testing and inspection shall be at the discretion of the Contractor as necessary to assure compliance with Contract requirements. The Owner's Construction Representative specified below shall not be considered a substitute for the Contractor's responsibility to perform similar routine, necessary, and customary testing and inspection of the methods and frequency suitable for the type of work involved.

3.6 TESTING

A. Field Density: Field in-place density shall be determined as specified in Section 31 20 00 - Earthmoving.

END OF SECTION

SECTION 32 05 00
COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section provides information common to two or more technical sitework specification sections or items that are of a general nature, and not included in other sections.

1.2 RELATED WORK

A. Applicable provisions of Division 1 govern work under this Section. Related sections include:
   1. Section 31 23 16 13 - Trenching
   2. Section 31 25 00 - Erosion Control
   3. Section 32 91 19 - Topsoil-Select Fill Materials and Application

1.3 REFERENCED ORGANIZATIONS

A. Abbreviations of organizations referenced in these specifications are as follows:

AASHTO	American Association of State Highway and Transportation Officials
ACPA	American Concrete Pipe Association
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
FHA	Federal Highway Administration
EPA	Environmental Protection Agency
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
STI	Steel Tank Institute
UL	Underwriters Laboratories Inc.
WDNR	State of Wisconsin Department of Natural Resources
WISDOT	State of Wisconsin Department of Transportation

1.4 REFERENCED DOCUMENTS

A. Where reference is made to the "Construction Specifications," it shall be construed to mean the pertinent section of the City of Madison's "Standard Construction Specifications," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

B. Where reference is made to the "Standard Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Sewer and Water Construction in Wisconsin," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

C. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the WisDOT "Standard Specifications for Highway and Structure Construction," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

D. Where reference is made to the "Geotechnical Report," it shall be construed to mean the geotechnical report in Section 02 32 00.

1.5 QUALITY ASSURANCE

A. Provide materials and products as required by individual specification sections. Refer to General Conditions of the Contract for Construction regarding substitutions.

B. Provide quality assurance testing and reporting as required by individual specification sections.

1.6 SAFETY

A. Contractor is solely responsible for worksite safety.
B. Perform all work in accordance with applicable OSHA, state, and local safety standards.
C. Contact Diggers Hotline at 1-800-242-8511 in accordance with statutory requirements. Request that non-member utilities and private utilities be located by the appropriate parties.

1.7 PERMITS

A. Unless otherwise noted in the Contract Documents, Contractor shall be responsible for obtaining and paying for all permits necessary to complete the work.

1.8 CONSTRUCTION LIMITS

A. Construction Limits are indicated on the Drawings. In the absence of such a designation on the Drawings, confine work to the minimum area reasonably necessary to undertake the work as determined by the Owner's Construction Representative. In no case shall construction activities extend beyond state property lines or construction easements.
B. The Contractor shall restore all disturbed areas in accordance with the Drawings and Specifications. If plans and specifications do not address restoration of specific areas, these areas will be restored to pre-construction conditions as approved by the Owner's Construction Representative.

1.9 SUBMITTALS

A. Refer also to General Conditions of the Contract for Construction and Division 1.
B. Submit manufacturer's shop drawings, product data, samples, substitutions, and operation and maintenance (O&M) data for approval as required by individual specification sections.
C. Submittals shall be provided to the Owner's Construction Representative for review and approval, unless otherwise directed. Submittals shall be submitted electronically by email in *.pdf format unless otherwise directed.

1.10 OFF-SITE STORAGE

A. Refer to Division 1.
B. In general, the payments for materials stored off site will only be considered in instances where there is limited space available for storage on the site. Prior approval by the Owner's Construction Representative, together with the execution of a Storage Agreement, will be required.

1.11 CODES

A. Comply with the requirements of all applicable local, state, and federal codes.

1.12 CERTIFICATIONS AND INSPECTIONS

A. Refer to General Conditions of the Contract for Construction.
B. Obtain and pay for all required sampling, testing, inspections, and certifications except those expressly listed as provided by the Architect/Engineer (A/E) or other third-party in the Contract Documents. Deliver originals of certificates and documents to the Owner's Construction Representative within three (3) days; provide copies to the City Engineer. Include copies of the certifications and documents in the O&M Manual.

PART 2 - MATERIALS

2.1 BARRICADES, SIGNS, AND WARNING DEVICES

A. Traffic barricades, traffic signs, and warning devices shall meet the requirements of applicable OSHA standards and the FHA Manual of Uniform Traffic Control Devices (MUTCD).

2.2 TEMPORARY PLASTIC BARRIER FENCING

A. UV stabilized high-density polyethylene barrier fence free of holes tears and other defects. Provide 4-foot tall fence in diamond or rectangular pattern. Fencing shall be a "safety orange" color, unless otherwise noted.
B. Posts for temporary plastic barrier fencing shall be 5-foot tall, minimum 12-gauge, painted metal posts.

PART 3 - EXECUTION

3.1 MAINTENANCE OF SITE AND BUILDING ACCESS/EGRESS

A. Unless otherwise shown or directed, maintain existing access and egress to the facility throughout construction. Maintain ANSI A117 compliant access for disabled persons, delivery access, emergency vehicle access, and emergency

egress. Do not interrupt access and egress without prior written approval from the Owner's Construction Representative.

3.2 CONTINUITY OF EXISTING TRAFFIC/PARKING AND TRAFFIC CONTROL

A. Refer also to General Conditions of the Contract for Construction; or in the specifications, particularly in the General Requirements (Division 1).

B. Do not interrupt or change existing traffic, delivery, or parking outside the requirements of the staging plan without prior written approval from the Owner's Construction Representative. When interruption is required, coordinate schedule with the Owner's agency to minimize disruptions. When working in public right-of-way, obtain all necessary approvals and permits from applicable municipalities and WISDOT.

C. When Contractor's activities impede or obstruct traffic flow, Contractor shall provide traffic control devices, signs and flaggers in accordance with other Contract Documents and the current version of the MUTCD, or as shown on the Drawings.

3.3 PROTECTION AND CONTINUITY OF EXISTING UTILITIES

A. Verify the locations of any water, drainage, gas, sewer, electric, drainage, gas, sewer, electric, telephone/communication, fuel, steam lines or other utilities and site features which may be encountered in any excavations or other sitework. All lines shall be properly underpinned and supported to avoid disruption of service.

B. Do not interrupt or change existing utilities without prior written approval from the Owner's Construction Representative, affected utilities and users. Notify all users impacted by outages a minimum of 48 hours in advance of outage. Notification shall be provided in writing and describe the nature and duration of outages and provide the name and number of Contractor's foreman or other contact.

C. Any service connections encountered which are to be removed shall be cut off at the limits of the excavation and capped in accordance with the requirements of applicable codes and any specifications governing such removals.

3.4 PROTECTION OF EXISTING WORK AND FACILITIES

A. Verify the locations of and protect any signs, paved surfaces, buildings, structures, landscaping, streetlights, utilities, and all other such facilities that may be encountered or interfered with during the progress of the Work. Take measures necessary to safeguard all existing Work and facilities that are outside the limits of the Work or items that are within the construction limits but are intended to remain. Report any damage to existing facilities to the Owner's Construction Representative immediately. Correct and pay for all damages.

3.5 STORMWATER/EXCAVATION WATER MANAGEMENT

A. Control grading around structures; pitch ground to prevent water running into excavated areas.

B. Pits and other excavations shall be maintained free of water.

C. Provide trench pumping and other dewatering facilities required.

D. Notify A/E if springs or running water are encountered in excavation; provide discharge by trenches, drains, pumping to point outside of excavation. Provide information to A/E of points and areas that water will be discharged. At the Engineer's option, the Contractor shall drain the spring to the storm sewer system by the use of field tile.

E. Be responsible for control measures to prevent damage from flooding, erosion, and sedimentation to on-site and off-site areas.

END OF SECTION

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SECTION 32 11 23
AGGREGATE BASE COURSE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes provisions for providing aggregate base course as the foundation for hot-mixed asphalt paving, concrete curb and gutter, and concrete sidewalk.

1.2 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 - Specification Sections, apply to this Section.

B. The following sections contain requirements that relate to this Section:

1. Section 02 20 00 - General Sitework Requirements
3. Section 31 20 00 - Earthmoving
4. Section 31 22 00 - Soil Stabilization
5. Section 32 91 19 - Topsoil-Select Fill Materials and Application

1.3 REFERENCES

A. Where reference is made to the "Construction Specifications," it shall be construed to mean the pertinent section of the City of Madison's Standard Construction Specifications, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

B. Where reference is made to the "Standard Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Sewer and Water Construction in Wisconsin," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

C. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the WisDOT "Standard Specifications for Highway and Structure Construction," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

D. Where reference is made to the "Geotechnical Report," it shall be construed to mean the geotechnical report in Section 02 32 00.

E. American Society for Testing and Materials (ASTM):

1. ASTM D1557-78: Test Methods for Moisture-Density relation of Soil and Soil-Aggregate Mixtures Using 10 lbs. (4.54-kg) Rammer and 18-in. (457 mm) Drop
2. ASTM D698: Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbs./ft³ (600 kN-m/m³))
3. ASTM D1557: Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbs./ft³ (2,700 kN-m/m³))
4. ASTM D6938: In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:

1. Submit 50-pound samples of each type of aggregate to testing laboratory for materials not obtained from on-site stockpiles and for blended aggregate.
2. Weight slips of each load showing the net weight of the aggregate.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide materials meeting the requirements of the Geotechnical Report and WisDOT Sections 301, 305, and 306 and as shown in the Drawings.

1. Reclaimed or recycled asphalt products will not be an acceptable alternative or equal to 1¼ Dense Grade Base material.

B. Hot-Mix Sand Asphalt Bases: Asphalt Institute Type VI, VII, or VIII Mixes for Hot-Mix Sand Asphalt Bases. Hot-mix base shall be used only under asphaltic concrete surfaces.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare the subgrade in accordance with the Geotechnical Report and Section 31 20 00 - Earthmoving as necessary for undercut.

3.2 EQUIPMENT

A. Meet requirements of WisDOT Section 301.3.1.

3.3 SPREADING AND SHAPING

A. Meet requirements of WisDOT Section 305.3.4.

B. Construct to thickness indicated on Construction Drawings. The minimum base thickness as shown on Drawings shall be achieved throughout all pavement areas.

1. Aggregate Base: Apply in lifts or layers not exceeding 8 inches, measured loose.
2. Sand Base: Apply in lifts or layers not exceeding 6 inches, measured loose.
3. Hot-Mix Sand Asphalt Bases: Apply in lifts or layers not exceeding 3 inches, measured loose.

3.4 COMPACTION

A. Meet requirements of WisDOT Section 305.3.2.2, except as modified below.

1. Compact base material to not less than 98% of optimum density as determined by ASTM D698 or 95% of optimum density, as determined by ASTM D1557 unless otherwise indicated on the Drawings.

3.5 TOLERANCES

A. Smoothness: Maximum variation of 3/8 inch when measured with a 10-foot straight edge

B. Compacted thickness: within 1/4 inch

3.6 FIELD QUALITY CONTROL

A. Field inspection and testing will be done by the City/County in public right-of-way or the Owner's Construction Representative.

B. Repair or remove and replace unacceptable base course as directed by the Owner's Construction Representative.

END OF SECTION

SECTION 32 12 16.13
PLANT-MIX ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes hot-mix asphalt paving, hot-mix asphalt patching, and pavement-marking paint.

B. Related sections include:

1. Section 02 20 00 - General Sitework Requirements
2. Section 31 20 00 - Earthmoving
3. Section 32 11 23 - Aggregate Base Course

1.2 REFERENCES

A. ASTM International (ASTM):

1.	ASTM D1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
2.	ASTM D2041	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
3.	ASTM D2950	Density of Bituminous Concrete in Place by the Nuclear Methods
4.	ASTM D2726	Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixture
5.	ASTM D5444	Mechanical Size Analysis of Extracted Aggregate

B. American Association of State Highway and Transportation Officials (AASHTO):

1.	AASHTO M017	Mineral Filler for Bituminous Paving Mixtures
2.	AASHTO M140	Emulsified Asphalt
3.	AASHTO M208	Cationic Emulsified Asphalt
4.	AASHTO M320	Performance-Graded Asphalt Binder
5.	AASHTO M323	Superpave Volumetric Mix Design
6.	AASHTO T164	Quantitative Extraction of Asphalt Binder from Hot-Mix Asphalt (HMA)
7.	AASHTO T166	Bulk Specific Gravity of Compacted Hot-Mix Asphalt Mixtures Using Saturated Surface-Dry Specimens
8.	AASHTO T209	Theoretical Maximum Specific Gravity and Density of Hot-Mix Asphalt (HMA)
9.	AASHTO T245	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
10.	AASHTO T275	Bulk Specific Gravity of Compacted Hot-Mix Asphalt Mixtures Using Paraffin-Coated Specimens
11.	AASHTO T308	Asphalt Content of Hot-Mix Asphalt (HMA) by the Ignition Method
12.	AASHTOT312	Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
13.	AASHTO T331	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

C. National Asphalt Pavement Association (NAPA):

1. IS 123 - Recycling Hot-Mix Asphalt Pavements
2. IS 128 - HMA Pavement Mix Type Selection Guide

1.3 STANDARD SPECIFICATIONS

A. Where reference is made to the “Standard Specifications,” it shall be construed to mean the pertinent section of the Wisconsin Department of Transportation (WisDOT) “Standard Specifications for Road and Structure Construction,” current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

B. Where reference is made to the “Geotechnical Report,” it shall be construed to mean the geotechnical report in Section 02 32 00.

C. All construction of public facilities and/or work within public lands or rights-of-way shall conform to the requirements and conditions of the City of Madison’s “Standard Specifications for Public Works Construction,” current edition.

1.4 SUBMITTALS

A. Job-Mix Designs for each job mix proposed for the work.

B. Material Certificates, signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

C. Load Tickets shall be submitted if payment is to be by tonnage.

1.5 DEFINITIONS

A. Plant-Mix Asphalt Paving Terminology: Refer to ASTM D8 for definitions of terms.

1.6 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of WisDOT.

1.7 QUALITY ASSURANCE

A. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot-Mix Asphalt Pavements," unless more stringent requirements are indicated.

B. Pre installation Meeting: Convene a pre installation meeting at the site at least two (2) weeks prior to commencing work of this Section. Require attendance of parties directly affecting work of this Section, including, but not limited to, Developer, Developer's Engineer and Inspector, Contractor, paving sub-contractor, and job foreman.

1. Contact Developer' Engineer and the City/County three (3) weeks prior to pre-installation conference to confirm schedule.
2. Record discussions of meeting and decisions and agreements (or disagreements) reached, and furnish copy of record to each party attending. Review foreseeable methods and procedures related to paving work, including the following:
   a. Review preparation and installation procedures and coordinating and scheduling required with related work.
   b. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
   c. Tour, inspect and discuss condition of subgrade, drainage structures, and other preparatory work.
   d. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
   e. Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   f. Review paving requirements (drawings, specifications, and other contract documents).
   g. Review required submittals, both completed and yet to be completed.
   h. Review required inspections, testing procedures.
   i. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.
   j. Review safety precautions relating to placement of paving.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing Manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by Manufacturer. Protect stored materials from direct sunlight.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp.

B. Paving under conditions when surface temperatures approximately 3 feet above grade are at or below 40 degrees F (40˚F) shall be in accordance with Cold Weather Paving provisions in the State Specifications—specifically Section 450.

C. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 degrees F (40°F) for oil-based materials, 50 degrees F (50°F) for water-based materials, and not exceeding 95 degrees F (95°F). Paint color shall be as specified on the Drawings.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and methods for on-site pavement shall conform to WisDOT Standard Specifications. Where conflicts between this specification and the WisDOT Standard Specifications exist, requirements of the WisDOT shall govern.

B. All materials and methods for public roadways shall conform to City of Madison's "Standard Specifications for Public Works Construction," current edition.

2.2 MATERIALS AND MIXES

A. Provide asphaltic pavement per WisDOT Standard Specifications, Sections 460.2 and 460.3, and the Pavement Design section of the Geotechnical Report, but excluding limitations in Section 460.3.2 restricting layer thickness by aggregate size.

B. Pavement thickness: See pavement sections in Drawings:

1. Bituminous Concrete: Refer to Section 460-3
2. Base Course: Refer to Section 301.3.4.2 - Standard Compaction

C. Mixture Type: See Drawing sections; Table 460-2 of the WisDOT Standard Specifications.

D. Bituminous Material: Per WisDOT Standard Specifications—of suitable grade and consistency for application.

E. Tack Coat: Per WisDOT Standard Specifications—of suitable grade and consistency for application.

F. Water: Potable.

2.3 MARKING MATERIALS

A. Type S or Type N Traffic Paint in accordance with AASHTO Designation M248. Regular set drying time.

B. Waterborne Paint: Paints shall conform to FS TT-P-1952.

C. Solvent Borne Paint: Paint shall conform to FS A-A-2886 or AASHTO M248. Paint shall be non-bleeding, quick drying, and alkyd petroleum base paint suitable for traffic bearing surface and be mixed in accordance with manufacturer's instructions before application for colors White, Yellow, Blue, and Red.

D. Epoxy marking from the WisDOT approved products list and in accordance with Section 646.2.4.

E. Glass Beads: AASHTO M 247, Type 1 or FS TT-B-1325, Type 1, Gradation A

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction per Geotechnical Report.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

A. Hot-Mix Asphalt Pavement: Sawcut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Place hot-mix asphalt binder course in number of lifts and thicknesses indicated.
   2. Spread mix at minimum temperature of 250 degrees F (250°F).
   3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
   4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless in-fill edge strips of a lesser width are required.
   1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt binder course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
   1. Clean contact surfaces and apply tack coat to joints.
   2. Offset longitudinal joints, in successive courses, a minimum of 6 inches. Coat longitudinal joints that are not completed before the previously laid mixture has cooled to a temperature below 140 degrees F (140°F), with liquid asphalt just before paving is continued.
   3. Offset transverse joints, in successive courses, a minimum of 24 inches. If placing of material is discontinued or if material in place becomes cold, make a joint running perpendicular to the direction traveled by the paver. Before placement continues, trim the edge of the previously placed pavement to a straight line perpendicular to the paver and cut back to expose an even vertical surface for the full thickness of the course. When placement continues, position the paver on the transverse joint so that sufficient hot mixture will be spread in order to create a joint after rolling that conforms to the required smoothness. If the temperature of the previously placed pavement material drops below 140 degrees F (140°F) before paving is resumed, give the exposed vertical face a thin coat of liquid asphalt just before paving is continued.
   4. Construct transverse joints as described in AI MS-22, “Construction of Hot Mix Asphalt Pavements.”
   5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
   6. Compact asphalt at joints to a density within 2% of specified course density.

B. Construction joints shall have same texture, density, and smoothness as other sections of asphalt concrete course.

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 degrees F (185°F).

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
   1. Average Density: 96% of reference laboratory density according to AASHTO T 245, but not less than 94% nor greater than 100%.
   2. Average Density: 92% of reference maximum theoretical density according to ASTM D2041, but not less than 92% nor greater than 97%.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked. Any masked or marred finish surfaces shall be repaired or smoothed.

G. Compaction at Unsupported Edges of Pavements: Start the first roller pass 12 to 15 inches from the unsupported edge. Allow the uncompacted asphalt to act as a dike to hold the mat in place. The final pass over the uncompacted dike should not slough off if the roller is supported on the compacted mat.

H. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

I. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

J. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCE

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Binder Course: Plus or minus (±) 1/4 inch.
   2. Surface Course: Plus (+) 1/4 inch, no minus (-).

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
   1. Binder Course: 1/4 inch
   2. Surface Course: 1/8 inch
   3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: The Owner's Construction Representative will engage a testing agency to perform field tests and inspections and to prepare test reports.
   1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness:
   1. In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D3549.
   2. The CTL will measure thickness of each core sample taken. At each core location, the thickness of the course shall meet or exceed the thickness shown. If the thickness of a lower course of asphalt is less than the thickness shown, it shall be identified as a deviation and recorded. The Contractor shall either remove and replace the deficient pavement or increase the thickness of the upper course so that the total thickness of the pavement meets or exceeds the design thickness, provided that the specified compaction of the lower lift is achieved.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances. In areas of obvious depressions or bumps, suspect areas of each lift shall be checked with a 10'-0" straightedge both parallel with, and at right angles to, centerline of the paved area. The variation of the surface between two (2) contact points shall not exceed 1/4 inch.

E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.9 SPLIT PAVING

A. Where specified, paving of the binder course and surface course are to be performed in same construction seasons.

B. If paving of binder and surface course are done in successive construction season, the Contractor shall be responsible for damage to the binder course and curbs until the surface course is placed and accepted by the Owner as appropriate.

3.10 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

B. Do not allow excavated materials to accumulate on-site.

3.11 MARKING APPLICATION - PAINT

A. Pavement markings shall be placed at locations and to dimensions shown on Drawings.

B. Applied lines shall have a uniform cross section.
C. Lines shall have sharp cut-off defined edges on both side and ends.
D. Pavement markings applied to new asphaltic pavement surfaces shall be applied to surface course within seven (7) days of placement.
E. Pavement markings applied to new concrete surfaces shall be applied prior to allowance of any traffic on surface.
F. Agitate paint for 5-10 minutes prior to application to ensure even distribution of paint pigment.
G. Paint shall be applied in accordance with manufacturer's recommendations and apply two coats of same color of paint as specified without addition of thinner, with maximum of 100 square feet per gallon or as required to provide a minimum wet film thickness of 15 mils and dry film thickness of 7½ mils per coat.
H. Dispense paint at ambient degrees Fahrenheit to wet-film thickness of 15 mils.
I. Apply markings to indicated dimensions at indicated locations.
J. Prevent splattering and over spray when applying markings.
K. Apply glass beads at pedestrian crosswalk striping and at lane striping and arrows at driveways connecting to public streets. Broadcast glass beads uniformly into wet markings at a rate of 6 lbs./gal.
L. Unless material is track free at end of paint application convoy, use traffic cones to protect markings from traffic until track free. When vehicle crosses a marking and tracks it or when splattering or over spray occurs, eradicate affected marking and resultant tracking and apply new markings.
M. Collect and legally dispose of residues from painting operations.

3.12 MARKING APPLICATION - EPOXY

A. Application shall be in accordance with Section 646.3.3.2 of the State Specifications.

END OF SECTION

SECTION 32 16 00
CONCRETE PAVEMENT, CURB, AND SIDEWALKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Portland cement concrete pavements, curbs, gutters, and sidewalks, except sidewalks on structural footings and stoops and/or specified by the Architectural or Structural Drawings.

B. Related requirements:
   1. Section 02 20 00 - General Sitework Requirements
   2. Section 02 32 00 - Geotechnical Investigation
   3. Section 31 20 00 - Earthmoving
   4. Section 31 22 16.15 - Subgrade Preparation
   5. Section 32 11 23 - Aggregate Base Course

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.

B. American Concrete Institute (ACI):

1.	ACI 305R	Hot Weather Concreting
2.	ACI 306R	Cold Weather Concreting
3.	ACI 306.1	Cold Weather Concreting
4.	ACI 308	Curing Concrete

C. ASTM International (ASTM):

1.	ASTM A185	Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
2.	ASTM A615	Deformed and Plain Billet-Steel for Concrete Reinforcement
3.	ASTM C31	Making and Curing Concrete Test Specimens in the Field
4.	ASTM C39	Comprehensive Strength of Cylindrical Concrete Specimens
5.	ASTM C42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
6.	ASTM C94	Ready-Mixed Concrete
7.	ASTM C138	Test Method for Unit Weight, Yield, and Air Content (Gravemetric) of Concrete
8.	ASTM C143	Slump of Hydraulic Cement Concrete
9.	ASTM C231	Air-Content of Freshly Mixed Concrete by the Pressure Method
10.	ASTM C172	Sampling Freshly Mixed Concrete
11.	ASTM C173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
12.	ASTM C260	Air-Entraining Admixtures for Concrete
13.	ASTM C309	Liquid Membrane-Forming Compounds for Curing Concrete
14.	ASTM C618	Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete
15.	ASTM C989	Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
16.	ASTM C1064	Temperature of Freshly Mixed Portland Concrete Cement
17.	ASTM C1218	Water-Soluble Chloride in Mortar and Concrete
18.	ASTM D98	Calcium Chloride
19.	ASTM D994	Preformed Expansion Joint Filler for Concrete (Bituminous)
20.	ASTM D1190	Concrete Joint Sealer, Hot Poured, Elastic Type
21.	ASTM D1751	Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
22.	ASTM D2628	Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements

D. Federal Specifications (FS):

1.	FS HH-F-341	Fillers, Expansion Joint: Bituminous (Asphalt and Tar)

E. Wisconsin Department of Transportation (WisDOT):
   1. State of Wisconsin Standard Specifications for Highway and Structure Construction, latest edition.

1.3 SUBMITTALS

A. Mix Design:
   1. Fill out and submit attached Concrete Mix Design Submittal Form.
   2. Submit three (3) copies of each proposed mix.

3. Submit separate mix design for concrete to be placed by pumping in addition to the mix design for concrete to be placed directly from the truck chute.
4. Include applicable information shown on the Mix Design Submittal Form and the following:
    a. Proportions of cementitious materials, fine and coarse aggregate, and water.
    b. Water-cementitious material ratio, 28-day compressive design strength, slump, and air content.
    c. Type of cement, fly ash, slag and aggregate.
    d. Aggregate gradation.
    e. Type and dosage of admixtures.
    f. Special requirements for pumping.
    g. Range of ambient temperature and humidity for which design is valid.
    h. Special characteristics of mix which require precautions in mixing, placing, or finishing techniques to achieve finished product specified.
    i. Materials and methods for curing concrete.

B. Submit certified laboratory test data or manufacturer's certificates and data for the items listed below certifying that materials are in conformance requirements specified herein. Submit to the Engineering Consultant of Record and the Construction Testing Laboratory for review and approval and within seven calendar days after receipt of Notice to Proceed.
1. Concrete mix design(s)
2. Type and source of Portland cement, fly ash, and slag
3. Aggregate gradations
4. Preformed expansion joint filler
5. Field molded/poured sealant
6. Dowel bars
7. Expansion sleeves
8. Tie bars
9. Reinforcing steel bars
10. Welded wire fabric
11. Air entraining admixtures
12. Water-reducing, set-retarding and set-accelerating admixtures (if used)

C. Test Reports: Submit field quality control test reports.

1.4 PROJECT CONDITIONS

A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Forms shall be of wood or metal and shall be straight and of sufficient strength to resist springing, tipping or other displacement during the process of depositing and consolidating the concrete. If of wood, forms shall be surfaced plank of at least 2-inch nominal thickness stock except for sharply curved sections; and if of metal, they shall be of approved section. The forms shall be of the full depth of the required curb or curb and gutter, driveway or sidewalk sections and shall be designed to permit secure fastening. Face boards, if used, shall be so constructed and shaped that their lower edge conforms to the lines and radius indicated by the cross section for the pertinent structure as shown on the plans. Flexible or curved forms of proper radius shall be used for curves of 100-foot radius or less. All forms shall be cleaned thoroughly and oiled before the concrete is placed against them.

B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A185 and AASHTO M31 Grade 60. Furnish in flat sheets.

C. Reinforcing Steel: Deformed steel bars, ASTM A615, Grade 60.

D. Epoxy Coating: ASTM A775 where noted in the Drawings.

E. Portland Cement: Shall conform to ASTM C150, Type I unless Type III is specified.

F. Exterior Pavement Joint Materials:
1. Preformed Expansion Joint Filler shall be 3/4 inch in thickness and shall conform to AASHTO M-213.
2. Joint Back-up Material: Polyethylene foam, 100% closed cell.
3. Sealant:
    a. Dow 888, by Dow Corning
    b. 301 NS by Pecora

c. Spectrum 800 or 900 by Tremco

G. Aggregate: ASTM C33

H. Water: Clean and potable

I. Dowel Bars: ASTM A615, Grade 60, and plain steel bars

J. Air Entrainment:

1. Air entrained concrete shall be used for all concrete construction. Slip formed concrete pavement shall contain 7.0% air, ±1.5%. Other concrete shall contain 6.0% air, ±1.5%.
2. ASTM C260:
   a. Air-Mix or AEA-92, by Euclid Chemical Corp.
   b. MB-VR MB-AE 90, or Micro-Air, by BASF
   c. Daravair or Darex Series, by W.R. Grace
   d. Equivalent approved products

K. Liquid Membrane Curing and Sealing Compound: ASTM C1315, Type I, Class A or Class B, 25% minimum solids content, clear non-yellowing with no styrene-butadiene. Specifications for Liquid Membrane-Forming Compounds for Curing Concrete, AASHTO M-148, Type 2 shall also apply if more stringent.

1. Water Based, VOC less than 350 g/l:
   a. Super Aqua Cure, by Euclid Chemical Corp.
   b. Kure 1315 by BASF
2. Solvent Based:
   a. Super Rez-Seal, by Euclid Chemical Corp.
   b. Kure-N-Seal 30 by BASF

L. Polyethylene Sheeting: Polyethylene sheeting for curing concrete shall conform to the requirements for white opaque polyethylene film of the Specification for Sheet Materials for Curing Concrete, AASHTO M-171.

M. Synthetic Reinforcement: Novomesh 950 Marco Synthetic Fiber Blend, or equivalent, complying with ASTM C1116/C1116M, Type III, Fiber Reinforced Concrete.

2.2 CONCRETE MIXING

A. Mix concrete and deliver in accordance with ASTM C94. Design mix shall produce normal weight concrete consisting of Portland cement, supplementary cementitious materials, aggregates, admixtures and water to produce the following:

1. Compressive Strength: 3,500 psi minimum at 28 days unless otherwise indicated on the Drawings.
2. Slump Range: 2 to 4 inches for hand placed concrete, 1¼ to 3 inches for machine placed (slip-form) concrete.

B. Supplementary Cementitious Materials (SCM):

1. Concrete mix shall contain SCM at the amounts specified unless other amounts are approved by the Owner's Civil Engineer. Either fly ash or ground granulated blast furnace slag (GGBFS) may be used for the SCM, but shall not be used together to form a ternary mix. Use of fly ash or GGBFS in the concrete mix is mandatory.
2. Fly Ash:
   a. Substitute fly ash for Portland cement at 15% of the total cementitious content. ASTM C618, Class C.
   b. Use only one (1) type and source throughout project.
3. Ground Granulated Blast Furnace Slag (GGBFS): Substitute GGBFS for Portland cement at 20% of the total cementitious content.
   a. If required to mitigate potential sulfate exposure or aggregate reactivity, up to 50% substitution of Portland cement is allowed.
   b. ASTM C989, Grade 100 or 120. Use only one (1) type and source throughout project.
4. Maintain air-entrainment at specified levels.

C. Calcium chloride:

1. Not allowed.

PART 3 - EXECUTION

3.1 PREPARATION

A. Begin paving work only after unsuitable areas have been corrected and are ready to receive paving.

B. Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

3.2 INSTALLATION

A. Form Construction:
   1. Set forms to required grades and lines, rigidly braced and secured.
   2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place minimum of 24 hours after concrete placement.
   3. Check completed formwork for grade and alignment to following tolerances:
      a. Top of forms not more than 1/8 inch in 10'-0".
      b. Vertical face on longitudinal axis, not more than 1/4 inch in 10'-0".
   4. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.

B. Reinforcement:
   a. Fasten reinforcing bars or welded wire fabric (if required) accurately and securely in place with suitable supports and ties. Remove from reinforcement all dirt, oil, loose mill scale, rust, and other substances that will prevent proper bonding of the concrete to the reinforcement.
   b. Incorporate synthetic fiber reinforcement into the concrete mix design, as recommended by the manufacture's specifications and guidelines.

C. Concrete Placement:
   1. Concrete shall be mixed and placed when the air temperature in the shade and away from artificial heat is a minimum of 35 degrees F (35°F) and rising.
   2. Hot and cold weather concreting shall be in accordance with ACI 305R (hot weather) and 306.1 and 306R (cold weather). Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until set at required finish elevation and alignment.
   3. Place concrete using methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
   4. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than a half hour, place construction joint. Automatic machine may be used for curb and gutter placement. Machine placement shall be at required cross section, line, grade, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified herein.

D. Joint Construction:
   1. Contraction Joints: Construct concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, in uniform sections of length specified on Construction Drawings. Form joints between sections either by steel templates, 1/8 inch in thickness, of length equal to width of curb and gutter, and with depth which will penetrate at least 2 inches below surface of curb and gutter; or with 3/4-inch thick performed expansion joint filler cut to exact cross section of curb and gutter; or by sawing to depth of at least 1/4 (one-quarter) of the poured thickness of concrete while concrete is between 4 and 24 hours old. If steel templates are used, they shall be left in place until concrete has set enough to hold its shape, but shall be removed while forms are still in place. Contraction joints in concrete curb and gutter shall be at a maximum spacing of 10 feet. Contraction joints in concrete sidewalk or pavement shall be at spaced at a length to width ratio not exceeding 1.5:1, with no dimension greater than 15 feet unless approved by the Engineer.
   2. Longitudinal Construction Joints: Tie concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, to concrete pavement with 1/2-inch round deformed reinforcement bars of length and spacing shown on Construction Drawings.
   3. Transverse Expansion Joints: Concrete curb, combination concrete curb and gutter, or concrete sidewalk shall have filler cut to exact cross section of curb, gutter, or sidewalk. Joints shall be similar to type of expansion joint used in adjacent pavement. Expansion joints to be located at high points, utility structures, curb returns, cold joints, or 100-foot maximum spacing.

E. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2 inch or more than 1 inch below finished surface where joint sealer is indicated. Furnish joint fillers in one piece lengths for full width being placed, wherever possible. Where more than one length is required, lace or clip joint filler sections together.

F. Joint Sealants: Install in accordance with manufacturer's recommendations.

3.3 CONCRETE FINISHING

A. After striking off and consolidating concrete, smooth surface by screeding and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10'-0" straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.

B. Work edges of sidewalks, gutters, back top edge of curb, and formed joints with edging tool, rounding edge to 1/2-inch radius. Eliminate tool marks on concrete surface. After completion of floating and troweling excess moisture or surface sheen has disappeared, complete surface finishing as follows:

1. Curbs, gutters, and sidewalks: Broom finish by drawing fine-hair broom across surface perpendicular to flow of traffic. Repeat operation as necessary to produce fine line texture.
2. Concrete Pavement: Broom finish by drawing medium-hair broom across surface parallel to direction of vehicle traffic. Repeat operation as necessary to produce even textured finish.

C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up minor honeycombed areas. Remove and replace areas or sections with major defects as directed by Developer.

D. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable work as directed by Developer.

3.4 NIGHT CONCRETING

A. Concreting operations shall be discontinued due to insufficient natural light, unless an adequate and approved artificial lighting system is provided and operated.

3.5 CURING AND PROTECTION

A. Protect and cure finished concrete paving using curing compound or with acceptable moist-curing methods in accordance with "water-curing" section of ACI 308. Cure for a period not less than seven days.

B. Use solvent based curing compound when compound is applied below 40 degrees F (40°F).

3.6 BACKFILL

A. After concrete has set sufficiently, spaces on either side of concrete pavements, by curb, combination concrete curb and gutter, or concrete sidewalk shall be refilled to required elevation with suitable material compacted in accordance with WisDOT Standard Specifications Section 02300.

3.7 CLEANING AND PROTECTION

A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.

B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

3.8 FIELD QUALITY CONTROL

A. Field quality control shall be the responsibility of the Owner's Construction Representative in accordance with Division 1 and this section. Other field quality control testing and inspection shall be at the discretion of the Contractor as necessary to assure compliance with Contract requirements.

END OF SECTION

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SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Traffic line paint and thermoplastic material for traffic striping and marking.
B. Application of traffic striping and control markings.

1.2 RELATED SECTIONS
A. Asphalt pavement is specified in Section 31 22 16.15 - Subgrade Preparation and Section 32 11 23 - Aggregate Base Course.
B. Concrete pavement is specified in Section 32 16 00 - Concrete Pavement, Curb, and Sidewalks.

1.3 MEASUREMENT AND PAYMENT
A. Measurement: Pavement markings will be measured for payment by the lump sum method, acceptably performed and completed.
B. Payment: Pavement markings will be paid for at the indicated Contract lump sum price, as indicated in the Bid Schedule of the Bid Form.

1.4 REFERENCES
A. State of California, Department of Transportation (Caltrans), Standard Specifications, latest edition:
   1. Section 84: Traffic Stripes and Pavement Markings
B. California Air Resources Board (CARB):
   1. Latest regulations governing permissible content of Volatile Organic Compounds (VOC) in paints

1.5 SUBMITTALS
A. General: Refer to Section 01 33 23 - Submittals for submittal requirements and procedures.
B. Shop Drawings: Submit drawings and diagrams, indicating stripe width of roadway divider stripes and parking stalls, configuration and dimensions of directional arrows, style and size of letters for "compact car" designation, configuration and dimensions of international handicapped symbol, and any other traffic control markings on pavement, such as “in” and “out” or “enter” and “exit” designations as indicated.
C. Certificate of Compliance: Submit evidence or affidavit that certifies that paint to be used complies with latest CARB/VOC regulations.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Type S or Type N traffic paint in accordance with AASHTO Designation M248. Regular set drying time.
B. Waterborne Paint: Paints shall conform to FS TT-P-1952.
C. Solvent Borne Paint: Paint shall conform to FS A-A-2886 or AASHTO M248. Paint shall be non-bleeding, quick drying, and alkyd petroleum base paint suitable for traffic bearing surface and be mixed in accordance with manufacturer’s instructions before application for colors of white, yellow, blue, and red.
D. Epoxy marking from the WisDOT approved products list and in accordance with Section 646.2.4.
E. Glass Beads: AASHTO M 247, Type 1 or FS TT-B-1325, Type 1, Gradation A.

2.2 APPLICATION
A. Apply no paint or thermoplastic material until pavement has cured for at least three (3) days or for the number of days as recommended by the manufacturer, whichever is longer. Ensure that pavement has cured sufficiently to carry application equipment without damage.
B. Provide traffic striping and control markings on pavement, parking stalls, and curbs in accordance with the layout, configurations, and dimensions indicated on the Contract Drawings and approved Shop Drawings.
C. Application equipment and procedures shall conform to the applicable requirements of the Caltrans Standard Specifications. Keep paint thoroughly mixed throughout application.
D. Traffic control markings and parking stalls shall be applied with the use of substantial cutout patterns and templates, or with striping equipment that applies straight, uniform width, sharp lines. Coverage shall be thorough and complete in accordance with the paint and thermoplastic manufacturer's instructions and recommendations and the Caltrans Standard Specifications.

1. Provide three (3) coats for painted striping and pavement markings. Application rate per coat shall match that specified in the Caltrans Standard Specifications for each coat of two-coat system.
2. Apply thermoplastic material at a minimum thickness of 0.125 inch or at the manufacturer's recommended minimum thickness, whichever is greater.

E. Traffic control markings and parking stalls shall be sharp and accurate, straight where required, without fuzziness at edges of lines.

F. Accessible parking stalls shall include the International Symbol for Accessibility.

G. At completion, the Contractor shall check the work thoroughly and shall touchup traffic control markings and parking stalls that are not distinct or thorough in coverage, or are not uniform in color.

2.3 TOLERANCES AND APPEARANCE

A. In addition to the tolerances and appearance requirements specified in the Caltrans Standard Specifications, edges shall be uniform with local variations not exceeding 1/8 inch per foot and surfaces shall be smooth and uniform.

B. Letter sizes and patterns shall be as indicated on the Contract Drawings with variations of not more than ±15% in dimension.

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 32 91 13.50
STORMWATER RAIN GARDEN

PART 1 - GENERAL

1.1 SCOPE

A. The work under this section shall consist of providing all work, materials, labor, equipment and supervision necessary to construct Stormwater Rain Garden Devices. The work under this section does not include providing all work, materials, labor, equipment, and supervision necessary to install plantings for the Stormwater Rain Garden Device. Included are the following topics:

- PART - GENERAL
  - Scope
  - Related Work
  - Reference Standard
  - Submittals
  - Quality Assurance
- PART 2 - MATERIALS
  - Geotextile Fabric
  - Aggregates
  - Sand
  - Compost
  - Engineered Soil
  - Erosion Mat
- PART 3 - EXECUTION
  - Protection Measures
  - Temporary Erosion and Sediment Controls
  - Excavation
  - Storage Layer
  - Engineered Soil
  - Erosion Mat

1.2 RELATED WORK

A. Applicable provisions of Division 1 govern work under this Section. Related sections include:

1. Section 31 20 00 – Earthmoving
3. Section 32 91 19 – Topsoil-Select Fill Materials and Application
4. Section 32 92 00 – Trees, Shrubs, and Other Plantings
5. Section 32 92 19 – Seeding and Sodding

1.3 REFERENCE STANDARDS

A.	WISDOT PAL	Wisconsin Erosion Control Product Acceptability List (PAL)
B.	WISDOT SSHSC	Standard Specifications for Highway and Structure Construction
C.	WDNR	Standard 1002 - Site Evaluation for Stormwater Infiltration
D.	WDNR	Standard 1004 - Bioretention for Infiltration
E.	WDNR	S100 Specification for Compost

1.4 SUBMITTALS

A. Provide product data for the following materials:

1. Geotextile Fabrics
2. Pipe
3. Aggregates
4. Sand
5. Compost
6. Engineered Soil
7. Erosion Mat

B. Provide product data for engineered soil blend components: Sand and Compost in compliance with WDNR Standard 1004 – Bioretention for Infiltration for review and approval by the Owner's Construction Representative.

1.5 QUALITY ASSURANCE

A. Contractor shall submit, in writing to the Owner's Construction Representative, a certification from compost supplier that any compost used on the project is in compliance with the requirements outlined in WDNR Specification S100.

B. Contractor shall submit, in writing to the Owner's Construction Representative, a certification from engineered soil supplier that any engineered soil used on the project is in compliance with the requirements outlined in WDNR Standard 1004 Bioretention for Infiltration.

PART 2 - MATERIALS

2.1 GEOTEXTILE FABRIC

A. Pipe Sock:

1. The openings of the geotextile fabric shall be small enough to prevent sand particles from entering the underdrain pipe. The fabric shall meet the requirements of the WisDOT SSSHC Section 612.2.8.

B. Filter Fabric:

1. The fabric shall meet the requirements of WisDOT SSSHC Section 645.2.4, Geotextile Fabric Type DF, Schedule B.

2.2 AGGREGATES

A. All aggregates used in the construction of Stormwater Rain Garden devices shall be double washed and free of organic material and fines.

1. Storage Layer Aggregate:

a. The aggregate used for the storage layer shall meet the following gradation requirements:

Sieve Size	Percent Passing by Weight
2-inch	100
1½-inch	90-100
1-inch	20-55
3/4-inch	0-15
3/8-inch	0-5

b. A layer of sand may also used in lieu of aggregates specified and shall be in accordance with the requirements outlined in WDNR Standard 1004 Bioretention for Infiltration and sand specifications outlined in this specification.

B. Clear Stone Bedding

1. Washed angular stone or pea gravel shall be used to cover the underdrain pipe. Washed angular stone or pea gravel, graded from 3/8 inch to 1/4 inch.

2.3 SAND

A. The preferred sand component consists of mostly SiO_2, but sand consisting of dolomite or calcium carbonate may also be used.

B. Manufactured sand or stone dust is not allowed.

C. The sand shall be washed and drained to remove clay and silt particles prior to mixing.

D. Sand shall meet one of the following gradation requirements:

1. USDA Coarse Sand (0.02-0.04 inches)
2. ASTM C33 (Fine Aggregate Concrete Sand)
3. WisDOT SSHSC Section 501.2.5.3.4 (Fine Aggregate Sand)

2.4 COMPOST

A. Compost shall meet the requirements of WDNR Specification S100 - Compost.

2.5 ENGINEERED SOIL

A. Engineered Soil shall comply with WDNR Standard 1004. Engineered Soil hall be a blend of Sand and Compost.

B. Engineered Soil shall consist of a mixture of 70 to 85% Sand and 15 to 30% Compost. The percentages are based on volume.

C. Engineered soil mix shall be free of rocks, stumps, roots, brush or other material over 1 inch in diameter. No other materials shall be mixed with the planting soil that may be harmful to plant growth or prove a hindrance to planting or maintenance.

D. Engineered soil mix shall have a pH between 5.5 and 8.0.
E. Do not fertilize.
F. Thoroughly blend engineered soil off-site before delivering to site and installing.
G. Engineered soil shall be delivered to the site and stored on plastic sheeting.
H. The moisture content shall be low enough to prevent clumping and compaction during placement.

2.6 EROSION MAT

A. Erosion Mat shall comply with the PAL for Urban, Class 1, Type B, as defined by "Standard Specifications for Highway and Structure Construction" and the PAL.
B. Erosion Mat shall be American Excelsior-Curlex Net-Free, Erosion Control Blanket-S32BD, Western Excelsior-Excel SS-2 All Natural, Ero-Guard EG-25 (NN), Erosion Tech ETRS2BN, or approved equal.

PART 3 - EXECUTION

3.1 PROTECTION MEASURES

A. Pre-Installation Meeting:
   1. Prior to the installation of the Stormwater Rain Garden Device, the Architect/Engineer (A/E), the Owner's Construction Representative, and the Contractor shall conduct a pre-installation meeting.
B. Stabilization:
   1. Construction of the Stormwater Rain Garden Device shall not begin until after the contributing drainage area has been stabilized with vegetation and/or hardscapes. Construction site runoff from disturbed areas shall not be allowed to enter the Stormwater Rain Garden Device.
C. Weather:
   1. Construction shall be suspended during periods of rainfall or snowmelt. Construction shall remain suspended of ponded water is present or if residual soil moisture contributes significantly to the potential for soil smearing, clumping, or other forms of compaction.
   2. Delays resultant from weather shall not serve as a basis for a Change Order.
D. Compaction Avoidance:
   1. Compaction and smearing of the soils beneath the floor and side slopes of the Stormwater Rain Garden area, and compaction of the soils used for backfill shall be minimized.
   2. During construction, the area dedicated to the Stormwater Rain Garden Device shall be cordoned off to prevent access by heavy equipment.
   3. Acceptable equipment for constructing the Stormwater Rain Garden Device includes excavation hoes, light equipment with turf type tires, marsh equipment, or wide-track loaders.
E. Compaction Remediation:
   1. If compaction occurs at the base of the Stormwater Rain Garden Device, the soil shall be refractured to a depth of at least 24 inches.
   2. If smearing occurs, the smeared areas shall be corrected by raking or roto-tilling.
   3. Compaction and smearing remediation shall be conducted by the Contractor at no additional cost to the Owner.
F. Field Infiltration Confirmation:
   1. Immediately after rough grading of Stormwater Rain Garden Devices, the Geotechnical Representative or Engineer shall confirm that correct subgrade is reached for adequate infiltration.
   2. Confirmation shall be obtained prior to continuing work on the Rain Garden Device.

3.2 TEMPORARY EROSION AND SEDIMENT CONTROLS

A. The Contractor shall install temporary erosion and sediment controls prior to beginning construction of the Stormwater Rain Garden Device. The temporary erosion and sediment controls shall divert stormwater runoff away from the Stormwater Rain Garden Device until it is completed.

3.3 EXCAVATION

A. Excavation equipment shall work from the sides of the Stormwater Rain Garden Device to excavate the area to the depths and dimensions as shown on the Drawings. Excavation equipment shall have adequate reach so that they do not need to be located within the footprint of the Stormwater Rain Garden Device to excavate it.
B. Any accidental compaction shall be remediated as prescribed above.
C. Over-excavate clay soils down to well-draining soils as direct by Engineer.

3.4 STORAGE LAYER

A. Place the Storage Layer Aggregate to the depth as indicated in the Drawings.

3.5 ENGINEERED SOIL

A. Verify moisture condition of Engineered Soil is low enough to prevent clumping and compaction during placement. Engineered Soil shall not be placed unless it meets these conditions.

B. Place Engineered Soil in lifts not to exceed 12 inches in depth until the desired elevation of the Stormwater Rain Garden Device is achieved.

C. Re-examine the surface within 48 to 72 hours following placement of Engineered Soil. Place additional Engineered Soil until desired elevation of the Stormwater Rain Garden Device is achieved at no additional costs to the Owner.

D. Steps may be taken to induce mild settling of the Engineered Soil as needed to prepare a stable planting medium and to stabilize the ponding depth.

E. Vibrating plate style compactors shall not be used to induce settling.

F. No equipment travel on or across placed Engineered Soil is permitted.

G. Install silt fence or other means of erosion control around the perimeter of the engineered soil to protect from siltation or contamination from adjacent landscape or paved surfaces and construction activities. Leave erosion control in place until site landscape establishment and construction is complete.

3.6 EROSION MAT

A. Install Erosion Mat on top of surface prior to installation of vegetation.

END OF SECTION

SECTION 32 91 19
TOPSOIL-SELECT FILL MATERIALS AND APPLICATION

PART 1 - GENERAL

1.1 SCOPE

A. The work under this section shall consist of providing all topsoil, labor, material and equipment required to complete the work described herein in strict accordance with the drawings and/or terms of the contract.

B. All work on the public lands and/or public rights-of-way shall conform to the applicable City of Madison's Standard Construction Specifications stated below.

C. All work shall be in accordance with applicable manufacturer's instructions.

1.2 RELATED WORK AND PROVISIONS

A. Applicable provisions of Division 1 shall govern all work. Related sections include:

1. Section 02 20 00 - General Sitework Requirements
2. Section 31 20 00 - Earthmoving
3. Section 31 25 00 - Erosion Control
4. Section 32 92 19 - Seeding and Sodding

1.3 REFERENCES

A. Where reference is made to the "Construction Specifications," it shall be construed to mean the pertinent section of the City of Madison's "Standard Construction Specifications," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

B. Where reference is made to the "Standard Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Sewer and Water Construction in Wisconsin," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

C. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the WisDOT "Standard Specifications for Highway and Structure Construction," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

D. Where reference is made to the "Geotechnical Report," it shall be construed to mean the geotechnical report in Section 02 32 00.

1.4 QUALITY ASSURANCE

A. Pre-Work Meeting: Convene a pre-work meeting minimum 30 days prior to commencing work on this Section. Review conditions of operations, procedures, and coordination with related work. The pre-work meeting shall be setup as a conference call or virtual meeting with the Landscape Architect.

1. Review planting schedule and maintenance.
2. Review required inspections, schedule of topsoil testing, and environmental procedures.

B. Soil-Testing Laboratory Qualifications:

1. Multi-Residue Herbicide/Pesticide Screen: A NELAC (National Environmental Laboratory Accreditation Conference) certified independent soil testing laboratory with the experience and capability to conduct the testing indicated based on local conditions.
2. Topsoil Analysis: Independent soil testing laboratory employing a landscape or soil agronomist familiar with the final use of the material and construction practices for large earthwork sites.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Select fill shall be a loamy sand, sandy loam, clay loam, loam, silt loam, sandy clay loam or other soil approved by the Owner's Construction Representative. It shall not have a mixture of subsoil and shall contain no slag, cinders, stones, lumps of soil, sticks, roots, trash or other extraneous materials larger than 1.5 inches in diameter. Select fill must also be free of viable plants or plant parts of common Bermuda grass, quack grass, Johnson grass, nutsedge, poison ivy, Canada thistle, or others as may be specified. All select fill shall be tested by a reputable laboratory for pH and soluble salts. If needed, pH correction material shall be applied at a rate sufficient to correct the pH to a range of 6.0 to 7.0. Soluble salts shall not be higher than 500 parts per million.

B. No turfgrass sod shall be placed on soil which has been chemically treated until sufficient time has elapsed to permit dissipation of all toxic materials. The general contractor shall assume full responsibility for any loss or damage to turfgrass sod arising from improper use of chemicals or due to his failure to allow sufficient time to permit dissipation of toxic residues, whether or not such materials are specified herein.

C. Topsoil on the existing site may often be used; however, it should meet the same standards as set forth in these specifications.

D. Refer to Drawings for Specifications on Engineered Soils and Sand Storage Layers, as specified by Wisconsin Department of Natural Resources (WDNR).

PART 3 - EXECUTION

3.1 GRADING

A. The select fill shall be uniformly distributed on the designated area(s) and it shall be a minimum of 6 inches deep after firming.

B. No grading shall be done beyond the limits specified within the Grading and Erosion Control Plan.

C. Spreading shall be performed in such a manner that sod installation can proceed with a minimum of additional soil preparation and tillage.

D. Any irregularities in the surface resulting from top-soiling or other operations shall be corrected in order to prevent the formation of depressions or water pockets.

E. Select fill shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or in a condition that may otherwise be detrimental to proper grading or proposed for seeding.

3.2 CLEAN UP

A. After the select fill has been spread and the final grade approved, it shall be cleared of all grade stakes, surface trash or other objects that would hinder seeding and other plantings.

B. Paved areas over which hauling operations are conducted shall be kept clean and any soil which may be brought upon the surfacing shall be promptly removed.

C. The wheels of all vehicles shall be kept clean to avoid tracking soil on the surfacing of roads, walks, or other paved areas.

3.3 ACCEPTANCE

A. Acceptance will be given by the Owner's Construction Representative, upon satisfactory completion of each section or area(s), as indicated on the Drawings or as otherwise specified.

END OF SECTION

SECTION 32 92 00
TREES, SHRUBS, AND OTHER PLANTINGS

PART 1 - GENERAL

1.1 SCOPE

A. These specifications, along with contract drawings and lists of plant materials, apply to those items necessary for and incidental to the preparation, execution, completion and maintenance of the landscape planting activities (excluding lawn areas) specified in the contract. The scope includes the planting of trees, shrubs, perennials, and grasses, and the maintenance activities of fertilizing, pruning, and watering.

1.2 RELATED WORK

A. Applicable provisions of Division 1 govern work under this Section. Related sections include:
   1. Section 02 20 00 - General Sitework Requirements
   2. Section 31 20 00 - Earthmoving
   3. Section 31 25 00 - Erosion Control
   4. Section 32 91 19 - Topsoil-Select Fill Materials and Application
   5. Section 32 92 19 - Seeding and Sodding

1.3 REFERENCE STANDARDS

A. American Standards for Nursery Stock, ANSI Z60.1, current edition (American Association of Nurserymen, Inc.).

B. Standardized Plant Names, Second Edition (1942). American Joint Committee on Horticulture Nomenclature, Horace McFarland Company, Harrisburg, PA.

C. American National Standard for Tree Care Operations - Tree, Shrub and Other Woody Plant Maintenance - Standard Practices, ANSI A300, current edition.

D. Where reference is made to the "Geotechnical Report," it shall be construed to mean the geotechnical report in Section 02 32 00.

1.4 QUALITY ASSURANCE

A. All plant material shall conform to the American Standards for Nursery Stock, unless noted otherwise herein.

B. All plant material shall be true to the species and variety/hybrid/cultivar specified, and nursery-grown in accordance with good horticultural practices, and under climatic conditions similar to those of the site location. Specimens' nursery-dug to be replanted shall have been freshly dug and properly prepared for planting.

C. Trees and Shrubs:
   1. Shall be trained in development and appearance as to be superior in form, compactness and symmetry. Trees with multiple leaders, unless specified otherwise, and shrubs with damaged or cut mainstem(s), will be rejected.
   2. With a damaged, cut or crooked leader, abrasion of bark, sunscald, frost crack, disfiguring knots, insects (including eggs and larvae) or insect damage, cankers/cankerous lesions or fungal mats, mold, prematurely-opened buds, or cuts of limbs over 3/4 inches (1.9 cm) in diameter that are not completely callused will be rejected.
   3. Shall have healthy, well-developed root systems, and be free from physical damage or other hindrances to healthy growth.
   4. Balled and burlapped plants shall be dug with solid balls of a diameter not less than that recommended by the American Standards for Nursery Stock, and of sufficient depth to include both fibrous and feeding roots. Balls shall be securely wrapped with burlap, and tightly bound with rope or twine. No plant shall be bound with rope or wire in such manner as to damage bark or break branches. The root flare should be within the top 2 inches (5.1 cm) of the soil ball. Balled and burlapped plants will not be accepted if the ball is dry, cracked, or broken before or during planting.
   5. Containerized plants are to be well-established within the container, with a root system sufficiently developed to retain its shape and hold together when removed from the container. Soil within the container should be held together by the roots, in form and whole. Plants shall not be pot-bound, nor have kinked, circling, or bent roots.

D. Herbaceous perennials and grasses shall only be supplied from nurseries certified by State Plant Inspectors.

1.5 MEASUREMENT

A. Plants shall conform to the measurements specified within the Contract Documents. Specified height and spread dimensions will refer to the main body of the plant and not from branch tip to branch tip. Plants meeting

a specified measurement, but judged to lack the balance between height and spread characteristic of the species, will be rejected.

B. Plants shall be measured when branches are in their normal position.

C. No plant shall be less than the minimum size specified, and no less than 50% of the plants shall be as large as the maximum size specified.

D. Caliper measurements shall be taken 54 inches (1.4 m) above ground level

E. Containerized shrubs shall be measured by height and width for conformity with the plant list

F. Herbaceous perennials and grasses shall be measured by pot size, not by top growth

G. All other measurements, such as number of canes, ball sizes, and quality designations, shall conform to American Standards for Nursery Stock (ASNS).

1.6 SUBSTITUTIONS

A. The substitution of plant materials is not permitted unless authorized, in writing, by the Owner's Construction Representative. If written proof is submitted by the Contractor that a plant of specified species, variety, or size is unavailable, consideration will be given towards the nearest available size or variety, or towards an alternate species selection, with a corresponding adjustment of the contract price.

1.7 DELIVERY, STORAGE, AND HANDLING

A. The Contractor is to arrange for the acceptance and unloading of plants at the project site.

B. All plants are to be labeled by plant name and size. Labels shall be attached securely to all plants, bundles, and containers of plant materials when delivered. Labels shall be durable and legible, with information given in weather-resistant ink or embossed process lettering. The Owner should verify all plant labels; upon approval, the plant labels shall be removed by the Contractor.

C. All plant materials, shipments, and deliveries shall comply with current state and federal laws and regulations governing the inspection, shipping, selling, and handling of plant stock. If required by law or regulation, a Certificate of Inspection, or a copy thereof, for injurious insects, plant diseases, and other plant pests shall accompany each shipment or delivery of plant material. The certificate shall bear the name(s) and address(es) of the source of the plant stock.

D. During transport, no plant shall be bound with rope or wire in a manner that damages trunks or breaks branches. Plants shall also not be dragged, lifted, or pulled by the trunk, branches, or foliage in a damaging way. No plant shall be thrown off of a truck or loader to the ground.

E. Prior to installation, all plants must be protected from sun and drying winds.

F. Containerized or balled and burlapped plants not being installed immediately must be kept in a shaded area, well-covered with wood chips, soil, or other approved material, and kept well-watered. Install all plants within three (3) days of delivery.

G. Fertilizer shall be delivered to the site in original, sealed containers, and stored in a waterproof space. Containers shall bear the manufacturer's name, analysis, trademark, and guarantee as per standards of the Wisconsin Department of Agriculture.

H. Contractor shall protect all plants, lawns, and grass from damage at all times. Damaged plants, lawns, or grass areas shall be replaced or treated as required to conform to specifications herein for fresh stock. Damage incurred as a result of replacement or installation operations shall be repaired by Contractor at no cost to Owner.

1.8 PLANTING SCHEDULE

A. Plants shall be installed as appropriate for that specific plant species to ensure healthy vigorous growth.

B. All plants shall be guaranteed to be in healthy and flourishing condition for one (1) full year after installation and acceptance by the Owner.

C. Plants not thriving shall be replaced at no cost to the Owner. The Contractor may suggest substitutions for replacement plants.

E. At any time during the guarantee period the Contractor shall remove or replace, without cost to the Owner and within a specified planting period, all plants not in healthy and flourish conditions as determined by the Owner.

1.9 MAINTENANCE

A. The Contractor shall maintain plantings and lawn for at least a period of 60 days, or until final acceptance from the Owner. The Contactor is responsible for adequately watering plants and lawn during this 60-day period or after a satisfactory stand of grass has been established.

B. Fertilizing: Any and all chemical applications are to be performed in accordance with current federal, state and local laws, through EPA-registered materials and application techniques, and performed under the supervision of

a licensed certified applicator. Apply fertilizer to planted areas at the specified rate, and as per manufacturer's recommendations.

C. Watering: All plant materials installed under the contract shall be watered within the first 24 hours of initial planting and not less than twice weekly until final acceptance by the Owner. Water used shall be of sufficient quality for irrigation and free of materials harmful to plant growth

D. Pesticide: Any use of pesticides during the contracted maintenance period, as determined by the Owner, shall utilize the minimum amount of approved pesticide needed to control pests on plant materials installed under the contract. Pesticide applications are to be performed in accordance with current federal, state, and local laws, through EPA-registered materials and application techniques, and performed under the supervision of a licensed certified applicator. Apply at the specified rate and as per manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Plant Materials: A complete list of plant materials, including a schedule of quantities, sizes, and other requirements, shall be included in the contract documents. If discrepancies occur between the printed plant list and the contract drawings, the printed list will take precedent.

B. Topsoil: Naturally fertile, agricultural soil, capable of sustaining vigorous growth, of uniform composition throughout, without admixtures of subsoil, free of clay, stones larger than 1 inch (2.5 cm) in diameter, roots, trash, and debris of any kind, supplied by Contractor at their expense, and subject to approval by the Owner's Construction Representative.

C. Planting Mixture: Material used in tamping around balls and roots during the planting operation shall be prepared on-site by mixing two parts topsoil, one part sand, and one part compost. All mixing shall be done by mechanical means subject to the approval of the Owner's Construction Representative.

D. Fertilizer: Granular, non-burning product composed of not less than 50% organic slow-acting, guaranteed analysis professional fertilizer. Commercial fertilizer shall conform to Wisconsin State Statutes, Section 94.64, and meet the standards of the Wisconsin Department of Agriculture as to registration and labeling. Fertilizer shall be specified in the Contract Documents as to composition, but is subject to revision to suit project site conditions.

E. Shredded Hardwood Bark Mulch: Shredded hardwood bark mulch, free of material detrimental to healthy plant growth. Mulch shall be finely shredded, weed free, and dye-free.

F. Stone Mulch: Planted stone mulch areas shall follow the plan specifications and be spread to a minimum and consistent depth of 3 inches. Stone mulch areas shall receive woven weed barrier fabric.

PART 3 - EXECUTION

3.1 INSPECTION

A. Topsoil: Refer to Topsoil-Select Fill Materials and Application technical specifications.

B. Verify that prepared soil base is ready to receive the work of this Section.

C. Beginning of installation means acceptance of existing site conditions.

3.2 PREPARATION OF SUBSOIL

A. Prepare subsoil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove foreign materials, weeds, and undesirable plants and their roots. Remove any contaminated subsoil. Plants can be removed through application of glyphosphate. Follow manufacturer's instructions for proper use.

C. Scarify subsoil to a depth of 3 inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

3.3 PLACING TOPSOIL

A. Refer to Topsoil-Select Fill Materials and Application Section specifications.

B. Spread any needed amendments per soil test and till soil to a depth of 3 to 4 inches. Ideal seed bed will be a combination of soil particles ranging from approximately a 1/4 inch to a full 1 inch in size.

C. Topsoil compaction should be below 250 psi. If topsoil compactions are greater, soil should be ripped, disced, or otherwise loosened to a depth of at least 12 inches.

3.4 PREPARATION

A. Stake all planting areas and notify Diggers Hotline (1-800-242-8511 statewide) to verify location of all underground utilities prior to excavation.
B. Excavate planting areas as shown in included specifications.
C. Adequately barricade with proper warning devices any planting pit left open when planting work is not in progress, and that poses a hazard to vehicles and/or pedestrians.
D. Maintain site housekeeping to provide for a safe and orderly project site. Collect and dispose of debris as they accumulate.
E. The planting pit for containerized and balled and burlapped plants shall be at least 2.5 to 3 times the diameter of the soil ball, or to a dimension otherwise specified.
F. The planting pit for a single shrub shall be 12 inches (30.5 cm) wider than the root ball.
G. Loosen the soil beyond the edge of the planting pit. The soil at the base of the planting pit is to remain undisturbed, the depth of which shall correspond to the distance from the bottom of the soil ball to the root flare, or slightly less.
H. Fence and/or box in all trees and plant material which are to remain at the drip line before work is started. Do not permit heavy equipment or stockpiles within branch spread. Remove interfering branches without injury to trunks; cover scars with tree paint.
I. For a shrub mass planting, the entire bed area is to be tilled to a depth of 4 to 6 inches (10.2 to 15.2 cm). Excavate individual shrub pits to the proper depth.

3.5 PLANTING OF TREES AND SHRUBS

A. Remove plant containers by cutting or carefully inverting the container. For plants grown in plastic containers, slash the edges of the root ball from top to bottom with vertical 1-inch (2.5 cm) cuts using a sharp blade.
B. Root balled plants shall have rope, string, wire baskets, burlap and other wrapping material removed from the top half of the ball after the plant has been set in the hole. Remaining wrappings, other than those made from plastic or synthetic material, may be left around the bottom half of the ball.
C. Shrubs grown using root containment material shall have the containment bag removed prior to setting.
D. Set trees and shrubs straight and upright and in the center of the planting hole and on the unexcavated base of the planting pit with the most desirable face towards the most prominent view.
E. Root-balled shrubs are to be carried and set in the hole by the root ball.
F. Backfilling: Backfill pits with excavated soil. No soil in frozen or muddy condition shall be used for backfilling.
G. When pit is approximately two-thirds backfilled, tamp down and water to eliminate air pockets. After initial watering, add remainder of the soil to the top of pit, water without puddling, and firmly tamp without over-compacting. Form a 2- to 3-inch (5.1 to 7.6 cm) high saucer around the outer rim of the pit prior to mulching.
H. All trees shall be installed with 5-foot diameter tree ring with 3-inch mulch layer. Tree rings shall have shovel edging.
I. All parking islands shall receive a minimum of 18 inches of topsoil.

3.6 PLANTING OF PERENNIALS, FORBS, AND GRASSES

A. Preparation: Loosen soil of the planting bed to a depth of 4 to 6 inches (10.2 to 15.2 cm) by mechanical or hand tilling while soil is dry. For bulbs, the depth of loosened soil will be determined by the type of bulb planted and specified in the contract or landscape plan.
B. After soil is loosened, till organic material into the soil across the planting bed to a uniform depth of 2 inches (5.1 cm) for peat moss or 1 inch (2.5 cm) for compost.
C. Fertilizer, at amounts determined by the soil test, shall be topdressed to the soil.
D. Apply approved mulch uniformly across the entire planting bed to a depth of 1 to 2 inches (2.5 to 5.1 cm).
E. Planting: Space as described in the landscape plan.
F. Unless otherwise specified, install plants no closer than 12 inches (30.5 cm) to the trunks of trees or shrubs within planting bed and to within 6 inches (15.2 cm) of the edge of the bed.
G. Prior to planting, biodegradable plant containers shall be split and non-biodegradable containers removed. The root systems of all such plants shall be split or crumbled by hand.
H. All parking islands that contain perennials (not including bio-infiltration area) shall have a minimum of 18 inches of topsoil. These areas shall also have 3 inches of mushroom compost spread uniformly over the parking island and tilled into the top 6 inches of the soil.

3.7 FINISHING

A. Finish-grade planting areas to required elevations after plants have fully settled.

B. No soil is to cover the top of the root ball. All plants shall be completely mulched over the root system with a 3-inch (7.6 cm) layer of specified mulching material immediately after planting. Pull back mulch no less than 3 inches (7.6 cm) and no more than 6 inches (15.2 cm) from the trunk.

C. Thoroughly water plants immediately after planting and before mulching, primarily within and filling the saucer.

D. Prune any dead or broken branches. Prune in accordance with NAA Guidelines conforming to the American Standard for Tree Care Operations. Prune shrubs in accordance with standard horticultural practices. On cuts of 3/4 inches in diameter and bruises or scars on bark, trace the inured cambium layer back to living tissues and remove. Smooth and shape wounds so as not to retain water and coat the treated area within approved antiseptic tree paint.

E. Remove all twine and rope after planting, along with any labels attached around trunks or branches.

3.8 CLEANING

A. Dispose of excess soil. Remove all cuttings and waste materials.

B. Soil, branches, binding, and wrapping material, rejected plants, or other debris resulting from plant installation shall be promptly cleaned up and removed. New landscape construction in and around the planting areas are to be especially well cleaned.

C. Under no condition/circumstance shall the accumulation of soil, branches, or other debris be allowed upon a public property in such a manner as to result in a public hazard. Likewise, under no circumstances shall any debris or incidental materials be allowed upon adjacent private property.

END OF SECTION

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SECTION 32 92 19
SEEDING AND SODDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Preparation of subsoil
B. Placing topsoil
C. Fertilizing
D. Seeding
E. Seed Protection
F. Mulching

1.2 RELATED WORK

A. Applicable provisions of Division 1 govern work under this Section. Related sections include:
   1. Section 02 20 00 - General Sitework Requirements
   2. Section 31 20 00 - Earthmoving
   3. Section 31 25 00 - Erosion Control
   4. Section 32 91 19 - Topsoil-Select Fill Materials and Application
   5. Section 32 92 00 - Trees, Shrubs, and Other Plantings

1.3 DELIVERY, STORAGE, AND HANDLING

A. Seed shall be delivered to the site in its original, unopened container and labeled as to weight, analysis, and manufacturer. Seed in damaged packaging is not acceptable. Store any seed delivered prior to use in a manner safe from damage from heat or any other deleterious weather conditions.

1.4 REFERENCE SPECIFICATIONS

A. Where reference is made to the "Construction Specifications," it shall be construed to mean the pertinent section of the City of Madison's "Standard Construction Specifications," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
B. Where reference is made to the "Standard Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Sewer and Water Construction in Wisconsin," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
C. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the WisDOT "Standard Specifications for Highway and Structure Construction," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
D. Where reference is made to the "Geotechnical Report," it shall be construed to mean the geotechnical report in Section 02 32 00.

1.5 GUARANTEE

A. Guarantee plant material for a period of 12 months following the Substantial Completion Date in accordance with the Extended Maintenance/Warranty Chart included in Part 3 hereinafter.
   1. A limit of one (1) replacement of each plant shall be required, except for losses or replacements due to failure to comply with requirements.
   2. Remove from site any plant that is dead or unsatisfactory to the Owner or Landscape Architect. Replace plants during normal planting season.

1.6 SUBMITTALS

A. Submittals shall be available at all times to the Owner.
B. Grower/Nursery Information: Submit name, address, phone number ,and contact person for each Grower/ Nursery 30 days prior to plant material selection meeting.
C. Materials Test Reports: Submit topsoil borrow area test reports to the Owner a minimum six (6) weeks prior to delivery to site.
   1. Provide location of topsoil area tested.
   2. Provide name of independent soil testing laboratory.

3. Provide date of sampling and testing.

D. Product Data:
1. Submit certification tags from sod and seed verifying type and purity to the Owner

E. Closeout Submittals:
1. Submit meeting and inspection logs prior to Final Completion of the Project.
2. Certification of Conformance: Provide Certificate of Satisfactory Performance of Planting Operations signed by the Contractor and Landscape Architect.

1.7 MAINTENANCE

A. The Contractor shall maintain lawn for at least a period of 60 days, or until final acceptance from the Owner. The Contractor is responsible for adequately watering the lawn during this 60-day period. Contractor is responsible for establishing healthy vigorous lawn growth. Long-term maintenance is the responsibility of the Owner.

PART 2 - PRODUCTS

2.1 SEED MIXTURE

A. Grass Seed: All grass seed shall conform to the requirements of Wisconsin State Statutes, Chapter 94 (Seed Law), and the Wisconsin Administrative Code Chapter ATCP 20, regarding noxious weed seed content and labeling. Seed shall not be used later than one year following the test date labeled.

B. Public Seed Mixture: Use State Specifications Mix 40 in the right-of-way.

C. Grounds Seed Mixture:
1. Use seed mixtures as specified on Drawings.

D. Detention Basin Seeding:
1. See drawings for rain garden seeding, plug plantings or native vegetative mat requirements.

2.2 SOIL MATERIALS

A. Topsoil: Refer to Section 32 91 19 - Topsoil-Select Fill Materials and Application.

2.3 SOD

A. Provide sod species suitable as lawn turf for the region. Sod shall be strongly rooted, weed, disease, and pest free, and uniform in thickness.

2.4 ACCESSORIES

A. Mulching Material:
1. Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable
2. Where necessary to maintain erosion control, seed shall be applied using Method B, Hydroseeding from the State Specifications.

B. Fertilizer: Standard commercial packaged or bulk product in granular form conforming to the requirements of Dane County and the Wisconsin Statutes and of the Wisconsin Administrative Code Chapter Agriculture 17.

C. Water: Clean, fresh, and free of substances or matter which could inhibit vigorous growth of grass.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify that prepared soil base is ready to receive the work of this Section.

B. Beginning of installation means acceptance of existing site conditions.

3.2 PREPARATION OF SUBSOIL

A. Prepare subsoil to eliminate uneven areas and low spots. Maintain lines, levels, profiles, and contours. Make changes in grade gradually. Blend slopes into level areas.

B. No seeding shall occur on frozen ground or at temperatures lower than 32 degrees F (32°F).

C. Remove foreign materials, weeds, and undesirable plants and their roots. Remove any contaminated subsoil. Plants can be removed through application of glyphosate. Follow manufacturer's instructions for proper use.

D. Scarify subsoil to a depth of 3 inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

E. Unsuitable Subsoils: Locations containing unsuitable subsoil shall be treated by one or more of the following:

1. Where unsuitability is deemed by the Owner to be due to excessive compaction caused by heavy equipment and where natural subsoil is other than AASHTO classification of A6 or A7, loosen such areas with spikes, discing, or other means to loosen soil to condition acceptable to the Owner. Loosen soil to minimum depth of 12 inches with additional loosening as required to obtain adequate drainage. Contractor may introduce peat moss, sand, or organic matter into the subsoil to obtain adequate drainage. Such remedial measures shall be considered as incidental, without additional cost to the Owner.
2. Where unsuitability is deemed by the Owner to be due to presence of boards, mortar, concrete, or other construction materials in subgrade and where natural subsoil is other than AASHTO classification of A6 or A7, remove debris and objectionable material. Such remedial measures shall be considered as incidental, without additional cost to the Owner.
3. Where unsuitability is deemed by the Owner to be because natural subsoil falls into AASHTO classification of A6 or A7 and contains moisture in excess of 30%, then installation of sub-drainage system or other means described elsewhere in these Specifications shall be used. Where such conditions have not been known or revealed prior to planting time and they have not been recognized in preparation of the Drawings and Specifications, then the Owner shall issue pricing order to install proper remedial measures.

3.3 PLACING TOPSOIL

A. Refer to Section 32 91 19 - Topsoil-Select Fill Materials and Application.
B. Spread any needed amendments per soil test and till soil to a depth of 3 to 4 inches. Ideal seed bed will be a combination of soil particles ranging from approximately a 1/4 inch to a full 1 inch in size.

3.4 FERTILIZING

A. Apply seed starter fertilizer at the rate specified by the product manufacturer.
B. Fertilizer must be phosphorus free and meet Dane County requirements.
C. Apply after smooth raking of topsoil.
D. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
E. Mix thoroughly into upper 2 inches of topsoil.
F. Lightly water to aid the dissipation of fertilizer.

3.5 SEEDING

A. Firm up soil with light irrigation—lightly dampen soil before seeding.
B. Sow seed using either Method A or Method B as defined in Section 630.3.3 of the Standard Specifications for Highway Construction.
C. Protect seeded slopes of 4:1 or greater against erosion with erosion control materials specified on grading and erosion control plan.
D. Apply seed evenly in two directions at a rate specified by the product manufacturer. Rake in lightly. A cultipacker or similar equipment shall be used to enhance soil/seed contact. Care shall be taken to avoid damage to erosion mat in areas where erosion mat is specified. Do not seed areas in excess of that which can be mulched on the same day.
E. Do not sow immediately following rain, when ground is too dry, or during windy periods.
F. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
G. Do not use seed that is wet, moldy, or otherwise damaged in transit or storage.
H. Sow seed at a rate of 1½ pounds per 1,000 square feet. In addition to lawn seed, annual rye shall be applied to all disturbed areas at a rate of 1½ pounds per 1,000 square feet.
I. Roll seeded area with 24-inch width roller not exceeding 112 pounds.
J. Immediately following seeding and compacting, apply mulch to a thickness of 1/8 inches.
K. Apply water with a fine spray immediately after each area has been mulched keeping the top 1 to 2 inches of soil moist but not soaking. Water adequately to achieve a healthy stand of weed free lawn. Do not let soil dry out.
L. Apply a second application of seed starter fertilizer at the rate specified by the product manufacturer three (3) weeks after seeding.
M. Begin weekly mowing when first seedlings reach 2 inches. Do not mow right after watering. Raise mowing height to 3 inches after six (6) weeks. Never remove more than 1/3 (one third) of the grass blade at a time.
N. Begin standard fertilization and irrigation programs after eight (8) weeks. Do not apply any weed control products until lawn has been mowed at least four times and a minimum of eight (8) weeks have passed. Follow manufacturer's recommendations for new lawns.

3.6 SEED PROTECTION

A. Identify seeded areas with stakes around area periphery. Refer to Drawings for signage.

3.7 SODDING

A. Cut and lay sod on same day. Only healthy vigorous growing sod shall be laid.
B. Lay sod across slope and tightly together to result in solid coverage free of gaps.
C. Roll or firmly but lightly tamp new sod with suitable wooden or metal tamper sufficiently to set or press sod into underlying soil.
D. All finished sodding shall be smooth and free of lumps and depressions.
E. After sodding has been completed, clean up and thoroughly water newly sodded areas.

3.8 MAINTENANCE DURING CONSTRUCTION

A. Begin maintenance operations immediately after each plant is planted and continue as required until acceptance. Water, mulch, weed, prune, spray, fertilize, cultivate, and otherwise maintain and protect plants. Reset settled plants to proper grade and position, restore planting saucers, and remove dead, diseased, or unhealthy plant material. Tighten and repair stakes and wires. Correct defective work as soon as possible after it becomes apparent and weather and season permit.
B. Upon completion of the planting operations, clean up landscaped areas to be free of stones, containers, trash, and other waste and debris to leave area in a neat and well-groomed appearance.
C. Supplement rainfall as required to provide an equivalent of 1 inch of water per week until the plants have rooted and are established.
D. Make weekly inspections to determine moisture content of soil and adjust watering schedule established by irrigation system installer to fit conditions.
E. After grass growth has started, reseed or sod areas that fail to show uniform stand of grass in accordance with the Drawings and as specified herein. Continue reseeding and sodding such areas repeatedly until areas are covered with satisfactory growth of grass. Perform removal and replacement or topsoil conditioning if required to facilitate establishment of grass.
F. Water in such manner and as frequently as is deemed necessary by the Owner to assure continued growth of healthy grass. Water areas of site in such a manner as to prevent erosion due to excessive quantities applied over small areas and to avoid damage to finished surface due to watering equipment.
G. Provide water for execution and maintenance at no expense to the Owner. Furnish portable tanks, pumps, hose, pipe, connections, nozzles, and any other equipment required to transport water from available outlets and apply it to seeded areas in an approved manner.
H. Mowing:
    1. Initiate mowing of turf grass areas when grass has attained height of 3 inches and roots are firmly established. Maintain turf grass height at 2½ to 3 inches at subsequent cuttings depending on time of year. Remove no more than one-third (1/3) of grass leaf at any cutting and cutting shall not occur more than ten (10) days apart.
    2. Mow native grass areas no more than three times per year to a height of no less than 6 inches.
    3. Remove heavy cuttings to prevent destruction of underlying turf. If weeds or other undesirable vegetation threaten to smother planted species, such vegetation shall be mowed or, in case of rank growths, shall be uprooted, raked, and removed from area by methods approved by the Owner.
I. Remove weeds and other undesirable vegetation by applying herbicides as recommended by the manufacturer or by uprooting. Rake and remove uprooted vegetation from area by methods approved by the Owner.
J. Protect seeded area from pedestrian or vehicular trespassing while grass is germinating. Provide fences, signs, barriers, or other necessary temporary protective devices. Repair damage resulting from trespass, erosion, washout, settlement, or other causes.
K. Remove fences, signs, barriers, or other temporary protective devices after final acceptance.
L. Grassed areas damaged during process of work shall be restored or repaired to condition satisfactory to the Owner. Fill, grade, re-fertilize, replant, or mulch as required to restore to contract requirements.

END OF SECTION

SECTION 33 30 00
SANITARY SEWER UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. The work under this section shall consist of providing all work, materials, labor, equipment, and supervision necessary to provide for the sanitary sewer work required in these specifications and on the Drawings. This specification shall apply to all sanitary sewer work beginning at a point five 5 feet outside of the building wall, unless otherwise specified.

B. Related sections include the following:

1. Section 31 20 00 - Earthmoving
2. Section 31 23 16.13 - Trenching

1.2 STANDARD SPECIFICATIONS

A. Where reference is made to the "Construction Specifications," it shall be construed to mean the pertinent section of the City of Madison's "Standard Construction Specifications," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

B. Where reference is made to the "Standard Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Sewer and Water Construction in Wisconsin," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

C. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Highway and Structure Construction," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

1.3 SUBMITTALS

A. Refer to Division 1.

B. The Owner shall provide testing agency do all testing. The Contractor shall coordinate the tests with the Owner's testing agency.

1.4 REFERENCE

A. Applicable provisions of Division 1 shall govern all work under this section.

B. Reference Standards:

1. American Society for Testing and Materials (ASTM):

D1784-03	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
D2564-04	Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
D2680-01	Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
D3034-04a	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D3212-96a(2003)e1	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
F477-02e1	Standard Specification for Elastomeric Seals (Gaskets) for Joining Elastic Pipe
F679-03	Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings

2. American Water Works Association (AWWA):

C104/ANSI A21.4-95	Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
C151/ANSIA21.53-00	Standard for Ductile Iron Pipe, Centrifugally Cast for Water or Other Liquids
C153/A21.53	Standard for Ductile Iron Compact Fittings for Water Service

1.5 SUBMITTALS

A. Provide manufacturers product information (cut sheets), shop drawings and O&M information for sewer materials, including:
   1. Pipe
   2. Fittings
   3. Structures
   4. Castings

B. Provide reports documenting pressure testing, mandreling, and televising.

C. Provide copies of record drawings.

1.6 RECORD DRAWINGS

A. Maintain record drawings that show the actual locations, sizes and types of utilities and other features encountered.

B. Note any modifications to proposed sewer system size, location or elevation. Record any other deviations from the Drawings.

PART 2 - MATERIALS

2.1 GENERAL

A. Conform all materials to the size and type shown on the plans or as called for in the specifications and to applicable Laws, Codes, and Ordinances.

B. All products and materials are to be new, undamaged, clean, and in good condition. Existing products and materials are not to be reused unless specifically indicated.

C. Be responsible for the safe storage and handling of all materials utilized in the work. Store all materials in areas designated by the Construction Representative in cooperation with the Owner.

D. Perform all work in accordance with any applicable manufacturer's instructions.

2.2 PIPE

A. Provide the size, type and class/schedule of pipe as indicated on the Drawings.

B. Use only pipe supplied from the same manufacturer, and of the same type, unless otherwise specified or approved in advance by the Engineer.

C. Only pipe, joints, material and installation approved by Wisconsin Department of Natural Resources (WDNR) and/or the Wisconsin Department of Safety & Professional Services (WDSPS) for the intended use in the State of Wisconsin shall be used.

2.3 PVC PIPE

A. Conform to ASTM D3034 with solvent weld or elastomeric joints. Pipe shall be SDR-35 or 26, unless otherwise noted on the Drawings.

B. Do not mix different manufacturer's products or fittings.

C. Joints in PVC sewer pipe and fittings shall be elastomeric. Fittings shall be of standard manufacture, injection molded, and shall have a maximum standard dimension ratio (SDR) of 26.

D. PVC pipe and fittings manufacturer shall have an experience record substantiating acceptable performance of the materials to be furnished.

E. PVC pipe shall not be discolored.

2.4 BEDDING/INITIAL COVER

A. Provide 3/4-inch clear stone bedding and initial cover in accordance with the applicable requirements of Section 31 23 16.13 - Trenching.

B. Sanitary sewer and sewer services shall be provided with 6 inches of bedding material and 12 inches of initial cover material (both measured at the bell of the pipe). Crushed stone bedding shall be used for both bedding and initial cover.

C. Backfilling shall include 12 inches of gravel under roadways, consolidation by mechanical means to 95 percent Standard Proctor density for imported granular material and 95 percent for excavated materials of existing material in the adjacent trench wall.

2.5 CONNECTIONS FOR DISSIMILAR PIPE MATERIALS

A. Where new sewer connects to and existing dissimilar pipe, the connection shall be made with a no hub type coupling meeting the requirements of CISPI 310. Couplings shall have neoprene gaskets with stainless steel

shield, and multiple stainless steel clamps with worm gear tightening device. The couplings shall be made specifically for the type and size of pipe materials being connected. Couplings shall be Fernco Strongback RC series with stainless steel hardware or approved equal.

2.6 MANHOLES

A. General:
1. Provide precast concrete manholes. Concrete block or cast-in-place manholes may only be used after receiving written approval by the City of Madison's Construction Representative and the Engineer for customized manhole sizes and shapes.
2. Submit manufacturer's preproduction (shop) Drawings for approval prior to the start of manufacturing.
3. Contractor shall carefully locate all pipe locations, sizes, orientation and elevation prior to ordering new manholes. For sewer re-lays, verify if each pipe encountered is active. In- active pipe shall not be connected to the new sewer.

B. Precast Manhole Sections:
1. Precast concrete manhole sections, including bottom and top shall meet the requirements of ASTM C478.
2. Unless otherwise noted, provide four, 4 foot diameter manholes. If field conditions require a larger structure, contact the Owner's Project Representative or Engineer.
3. For 4-foot diameter manholes, provide eccentric cone top sections with a minimum clear opening of 24 inches. Flat top slabs may be used on manholes greater than 4 feet in diameter.
4. Manhole wall thickness shall be minimum of 5 inches for 4-foot diameter manholes, 6 inches for 5-foot diameter manholes, and 7 inches for 6-foot and 7-foot diameter manholes.
5. Manhole bottom section shall be pre-cast with integral base having a minimum thickness of 6 inches unless otherwise noted.

C. Joints:
1. Provide manhole riser and barrel sections, cones, and flat tops, with standard pipe section tongue and groove joints.
2. Seal joints watertight with prefabricated rubber or plastic gaskets or formed in place butyl rubber seal.
3. Joint sealers: EZ-stick, Kent Seal, Ram-Nek, or Mas-Stik butyl rubber gaskets or butyl rubber ropel, or approved equal.
4. External Seals: The City of Madison's Construction Representative will determine which new manholes will receive an exterior joint wrap. If called for, the wrap shall be Mar-Mac Manufacturing Company MacWrap or an equal approved by the City prior, in writing.

D. Connections:
1. Openings for connections shall be cast-in-place or cored and appropriately sized for the type and size of pipe being connected.
2. Provide flexible, watertight, pipe-to-manhole connections (or "boots") for sanitary sewers; Kor-N-Seal, Interpace, A-Lok, or an approved equal.

E. Manhole Steps:
1. Provide steps at 16-inch O.C. and project approximately 6 inches from wall.
2. Unless otherwise indicated on the Drawings, locate manhole steps over the downstream pipe opening.
3. Manhole steps shall be steel reinforced polypropylene with 1/2-inch diameter deformed reinforcing bar. Steps shall be permanently secured in the manhole wall. Manhole steps shall be American Step Company, M.A. Industries, or approved equal.

F. Bench and Flowline:
1. Provide either a pre-cast or cast-in-place bench or flowline.
2. Unless otherwise indicated on the Drawings, bench height shall be 3/4 the diameter of the downstream pipe. Slope bench towards flowlines at a minimum 1/2 inch per foot. Provide light broom finish on bench. The bench shall extend to the top of the downstream pipe.
3. Flowlines shall be formed with gradual, uniform sweeps directed towards the downstream pipe. Provide smooth, troweled finish for flowlines.
4. When cast-in-place benches and flowline are used, lay the sewer pipe through the manhole.

G. Adjusting Rings:
1. All final grade adjustment of manhole covers and frame assemblies shall be completed utilizing precast concrete adjusting rings, high density polyethylene (HDPE) or expanded polypropylene (EPP) as manufactured by LADTECH, Cretex (Pro-Ring), or an approved equal.
2. Adjusting rings shall be mortared (for concrete rings) or sealed with butyl rubber sealant or gaskets(HDPE and EPP).

2.7 CASTINGS

A. General:

1. All manhole castings shall be heavy duty iron conforming to ASTM A48, Class 20 and rated for AASHTO H-20 loading. Provide water-tight, gasketed, self-sealing, non-rocking lids with two (2) concealed pickholes. If discrepancies exist between the specific castings in this specification and the plans, the plans shall govern.
2. Standard Manhole Frame and Casting:
   a. Neenah Foundry R-1550, with Type B lid; or approved equal.
3. Low Profile Manhole Frame and Casting:
   a. Neenah Foundry R-1689, with Type B lid; or approved equal.
4. Standard Security Manhole Frame and Casting (Solid Lid):
   a. Neenah Foundry Company R-1916-C with bolt down Type B lid; or approved equal. Lid shall be water tight, gasketed, self-sealing, with concealed pick-hole.
5. Low Profile Security Manhole Frame and Casting (Solid Lid):
   a. Neenah Foundry R-1689, with Type B lid having four (4) Type "E" countersunk flathead pent socket screws; or approved equal. Lid shall be water tight, gasketed, self-sealing, with concealed pick-hole.
6. Off-Street Castings:
   a. Off street castings shall have bolt down lids. Bolt down castings shall be Neenah 1916-C castings. The casting shall be bolted to the manhole.

2.8 MANHOLE CHIMNEY SEAL

A. Provide an external frame/cone seal meeting requirements of Sections 8.42.3-8.42.5 of the Standard Specifications for Sewer and Water Construction in Wisconsin for all manholes. Provide Type I flexible watertight frame/chimney joint with Cretex internal chimney seals.

2.9 PIPE INSULATION

A. Rigid, closed-cell extruded polystyrene insulation. Insulation shall be suitable for buried insulation.
B. Individual boards shall have dimensions of 8'x4'x2".
C. Dow Styrofoam, or approved equal.

2.10 TRACER WIRE

A. The tracer wire shall be installed on top of all PVC sanitary sewer laterals and taped at 6-foot intervals from the wye at the sewer main to the center of the terrace. A second wire shall be extended from the center of the terrace to the end of the lateral stubbed into the lot. A spool of excess wire shall be provided at the end of the lateral equal to one-half the depth of the lot for use by the building plumber at the time of building connection. The conductor shall be brought to the surface to a test box located directly above the sewer lateral in the center of the terrace between the back of the curb and the front of the sidewalk.
B. Below grade splices are discouraged. If splices are necessary, the splice should be made with a 3M Scotchlok Self-Stripping Connector, or approved equal.
C. A 12-gauge, solid copper, neoprene wrapped, green tracer wire shall be installed on top of all PVC sanitary sewer laterals.
D. The end of the tracer wire at the sewer wye shall be connected to a 2-foot long, 5/8-inch diameter ground rod.
E. Test Access Box: Taylor P200NFG or a Valvco CP Test Mini-box with "SEWER" stamped lid and tracer wire connection holes with stainless steel bolts. Lid shall have standard pentagonal head key.

2.11 MARKER POSTS

A. Point of termination shall be marked with a 6-foot steel fence post with 1 foot of the post below the end of the lateral. A 6-foot 4'x4' treated wood post will also be installed at the end of each lateral with 3 feet of the post being buried below grade. The exposed portion of the post shall be painted green.

2.12 MARKER BALLS

A. Marker balls shall be used to mark location of sewer lateral. Marker balls shall be 4-inch diameter 3M EMS Extended Range 5-foot Ball Marker or approved equal.

PART 3 - EXECUTION

3.1 NOTIFICATION

A. Contractor, prior to excavation work, shall notify all utilities, governmental agencies, or entities, known to, or which can reasonably be assumed to, have above or below ground pipe, conduit cables, structures or similar items within limits of project, to locate and mark location of such items. The Contractor shall expose potential pipe conflicts prior to installation of sewers to allow for any field changes to the design to be made.

3.2 BYPASS PUMPING

A. Unless otherwise noted, all tributary buildings and services will remain occupied during construction. Wastewater will continue to be discharged to the sanitary sewers during construction. Contractor shall provide, operate and maintain all diversion and bypass pumping equipment necessary to carry out the work and allow wastewater to be discharged. Provide all necessary generators or other power source necessary to operate pumps on a continuous basis. Extra pumping and power equipment shall be staged onsite to maintain bypass pumping in the event of failure of the primary bypass pumping equipment. The Contractor is solely responsible for wastewater bypassing.

3.3 BYPASS PLAN

A. Contractor shall provide a wastewater bypass pumping plan indicating the order and schedule for completion of the work and associated bypassing provisions. The plan shall indicate the location of proposed bypassing, discharge locations, and the type and size of pumping equipment to be used. The plan shall describe contingencies to be used in the event of failure of the primary bypass pumps. Contractor's by-passing plan is subject to Owner's approval prior to implementation.

3.4 LAYING PIPE

A. Install all pipe in accordance with ASTM specifications which pertain to the specified type of pipe material and the installation situation.
B. Do not use any pipe or fittings cracked in cutting or handling or otherwise not free from defects.
C. Clean all pipe of any dirt and/or debris both inside and out prior to placing in the trench.
D. Cap all pipe ends to prevent material from entering pipe. Only use caps supplied by the same manufacturer, and of the same type, unless otherwise specified or approved in advance by the Engineer.
E. Make joints in accordance with manufacturer's directions with due care to avoid damaging pipe and/or disturbing previously laid pipe.
F. Cut pipe only according to manufacturer's directions.
G. Lay all sewer pipes to horizontal alignment and grade shown on the plans with bell ends up hill. Establish and maintain horizontal alignment using total station, transit or theodolite. Use pipe laser or level to establish and maintain grade of pipe. Discrepancies from the required horizontal alignment or grade at any location shall not be greater than 0.10 foot or 0.03 foot, respectively.
H. Do not exceed specified trench widths.

3.5 BEDDING/INITIAL COVER

A. Provide 3/4-inch clear stone bedding and initial cover in accordance with the applicable requirements of Section 31 23 16.13 – Trenching.
B. Sanitary sewer and sewer services shall be provided with 6 inches of bedding material and 12 inches of initial cover material (both measured at the bell of the pipe). Crushed stone bedding shall be used for both bedding and initial cover.

3.6 MANHOLES

A. Contractor shall determine the proper location, size, elevation, and orientation of all pipes entering new manholes before ordering. Do not connect abandoned pipes to new manholes. Manholes having improper location and/or orientation of the pipe connections will be rejected. Field repairs or adjustments of connection points are not permitted.
B. Limit the excavation for manholes so as to provide only the necessary amount of space to sufficiently prepare the subgrade, set the base, set the manhole or structure, and lay pipe. Provide a minimum of 1 foot of clearance between structure and trench wall for adequate backfilling and compaction.
C. Where excavation occurs below the bottom elevation of the structure's base, bring the excavation to the required elevation by the use of compacted crushed stone bedding. A minimum of 8 inches of compacted Crushed Stone Bedding shall be placed below manhole base.

D. Set manhole base in accordance with elevation and location as indicated on the plans. Install base plumb and level. Install subsequent pre-cast manhole sections in accordance with shop drawing layout. Provide watertight gaskets between each manhole section.

E. Pour inverts with smooth surface draining to downstream pipe. Where two or more lines meet at an angle, provide curved channel. Slope manhole bench at 2 inches/foot towards flow channel.

F. Manholes shall be provided with between 4 inches and 8 inches of adjusting rings, with the top adjusting ring being 2 inches thick. Provide butyl sealant material between rings. Once rings are in place, tuck point the exterior joint and provide the entire exterior surface of the adjusting ring riser with a coating of mortar.

G. When indicated on the Drawings, the manhole frame shall be set with a Type I frame/chimney joint as specified in the Standard Specifications for Sewer and Water Construction in Wisconsin, latest edition. The frame and adjusting rings shall be sealed with an internal rubber sleeve as detailed in File 12A of the Standard Specifications.

H. Drop manholes shall be constructed in accordance with File No. 19 of the Standard Specifications.

I. At all manholes, 3/4-inch crusher run stone shall be installed from the top of the cone to the top of the casting.

3.7 CASTING INSTALLATION

A. Install casting type as indicated on the plans or in the specifications.

B. Provide butyl sealant material between last adjusting ring and casting base. Adjust casting elevation and slope to match adjacent proposed grades.

3.8 CONNECTIONS TO EXISTING STRUCTURES

A. Make all necessary openings into existing structures or sewers including the reconstruction of existing inverts or benches, as necessary. Patch all openings permanently watertight with concrete brick and mortar, or hydraulic cement and waterstops, or for sanitary sewers, hydraulic cement and flexible watertight boots.

3.9 SEWER LATERALS

A. Connect existing sewer laterals in accordance with all of the requirements of the sewer mains, including bedding, backfill, compaction, and jointing of the pipe. Connect sewer laterals to the sewer main by means of an approved “wye” fitting. Connect the new pipe to the existing lateral material using a no-hub coupling or approved transition fitting. Coupling/fitting shall be selected for the specific pipe material being connected.

B. Based on local municipality requirements, cut-in type saddle wyes are not permitted on existing sanitary sewers where service laterals are to be connected to the sewer.

C. Sewer lateral coordinates will be obtained via GPS by the Owner’s Construction representative during construction.

D. All laterals shall have tracer wires from the main to the end.

3.10 PIPE INSULATION

A. Provide insulation when indicated on the Drawings, or where depth of cover is less than 6 feet. Unless otherwise noted, install 2-inch thick polystyrene boards for insulation over the pipe.

B. Install insulation on compacted initial cover material, 6 inches above the top of the pipe. Stagger joints where more than one layer of insulation is required. Provide insulation with a minimum of 1 foot of initial cover material. Place cover and backfill material in manner that does not damage insulation; replace any damaged insulation.

3.11 LOCATOR TAPE

A. The tracer wire shall be installed on top of all PVC sanitary sewer laterals and taped at 6-foot intervals from the wye at the sewer main to the center of the terrace. A second wire shall be extended from the center of the terrace to the end of the lateral stubbed into the lot. A spool of excess wire shall be provided at the end of the lateral equal to one-half the depth of the lot for use by the building plumber at the time of building connection. The conductor shall be brought to the surface to a test box located directly above the sewer lateral in the center of the terrace between the back of the curb and the front of the sidewalk.

3.12 DEFLECTION TESTING

A. Test all PVC sewer pipe in the presence of the Owner’s Construction Representative by a “go-no-go” deflection test mandrel furnished by the Contractor. Do not perform deflection testing any sooner than 30 days following the installation of the PVC pipe. Pull the mandrel by hand, or hand operated winch so as to avoid any damages to the pipe that may be caused by mechanized pulling equipment.

B. Size the to test the pipeline for a maximum allowable internal deflection of the pipe (in any direction) of not to exceed 5 percent (5%) of the original internal diameter for the pipelines tested, regardless of how long after installation the testing takes place.

C. Deflection testing may be done concurrently with any necessary televising of the sewers. When done concurrently with sewer televising, the mandrel may be pulled by mechanized equipment, provided the mandrel is visible in the television picture during the testing and the operation of the mandrel can be quickly halted before damage to the pipe occurs.

D. Where poor trench soils conditions require the pipe excavation to be undercut and/or over excavated, the Construction Representative reserves the right to require an additional deflection test prior to the expiration of the Contractor's one year performance guarantee.

E. Remove and replace all pipe that fails to pass the five (5) percent vertical deflection testing until the pipe passes the deflection test.

3.13 LEAKAGE TESTING

A. All new sanitary sewer lines shall be leakage tested in accordance with Chapter 3.7.0 of Standard Specifications for Sewer and Water Construction.

B. Air leak testing shall be used unless the ground water surface is greater than 2 feet above the top of the sewer pipe.

3.14 SEWER TELEVISING

A. Upon completion of the sewer construction all new sewers shall be televised to provide a record of the actual conditions inside the newly constructed sewers via closed circuit televising equipment. The City or Owner’s Construction Representative may or may not be present during sewer inspections via this method.

B. Utilize televising equipment with a color camera specially designed and equipped for the conditions of the sewers to be televised, and with a monitor screen. Provide equipment capable of recovering digital tape, video, and pictures for future reference.

C. Transport the camera equipment through the sewers by means of mechanical or hand operated winches, coordinated to provide speed and directional control necessary to fully observe the sewer interior. Provide a light source for the necessary illumination.

D. Provide televising equipment equipped with an on-screen distance meter, capable of registering distances in the sewer from the starting manhole, and accurate to the nearest 0.5-foot station, so as to facilitate in the locating of sewer features and/or defects from the ground surface.

E. Provide televising equipment with an on-screen date and time clock, so as to permit the verification of the date and time of the television inspection.

F. Any video tapes of the sewer inspection shall contain audio notes describing the sewer location, direction of inspection, and a description of any pertinent features observed during the televised inspection (service locations, leaking or faulty joints, debris in the line, offset joints, etc.). In addition, record this information on a written log or record, in a format of the Contractor's choosing.

G. The Contractor shall provide to the Owner’s Construction Representative with two (2) copies of the televising DVD. Electronic video files (MP4 or other format) are also acceptable.

END OF SECTION

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SECTION 33 40 00
STORM SEWER CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes storm sewer pipe and accessories.

B. The following sections contain requirements that relate to this Section:

1. Section 31 23 16.13 - Trenching
2. Section 31 25 00 - Erosion Control

1.2 REFERENCES

A.	ASTM A615-89	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
B.	ASTM C76-90	Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
C.	ASTM D698-91	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-pound (2.5kg) Rammer and 12-inch (304.8-mm) Drop
D.	AASHTO M-198	Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Water tight Gaskets
E.	AASHTO M252	Corrugated HDPE Pipe Underdrain, 3-inch to 10-inch
F.	AWWA C905	PVC Pressure Pipe and Fabricated Fittings, 14 inches through 48 inches for Water Transmission and Distribution
G.	AWWA C906	PE Pressure Pipe and Fittings 4 inches through 63 inches for Water Transmission and Distribution
H.	NRCS 378	Anti-Seep Collar for Discharge Pipe Through Embankment

I. Where reference is made to the "Construction Specifications," it shall be construed to mean the pertinent section of the City of Madison's Standard Construction Specifications, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

J. Where reference is made to the "Standard Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Sewer and Water Construction in Wisconsin," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

K. Where reference is made to the "State Specifications," it shall be construed to mean the pertinent section of the "Standard Specifications for Highway and Structure Construction," current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

L. Where reference is made to the "Geotechnical Report," it shall be construed to mean the geotechnical report in Section 02 32 00.

1.3 REGULATORY AGENCIES

A. City of Madison

B. The Department of Natural Resources (WDNR)

1.4 SUBMITTALS

A. Submit product data under provisions of Division 1.

B. Submit product data for pipe and pipe accessories.

1.5 PROJECT RECORD DOCUMENTS

A. Submit documents under provisions of Division 1.

B. Accurately record location of pipe runs, connections, manhole rim elevations, and invert elevations.

1.6 MEASUREMENT AND PAYMENT

A. Measurement and payment for storm sewer construction and related work specified herein shall be by unit price as shown on the Bid Form. Work shall include all labor, equipment and materials related to storm sewer construction.

1. Lengths of storm sewer construction are from center of structure to center of structure.

PART 2 - PRODUCTS

2.1 STORM SEWER PIPE MATERIALS

A. Reinforced Concrete:
   1. Pipe: Reinforced concrete pipe meeting requirements of ASTM C76 or ASTM C507. Provide Class III unless indicated otherwise in the Specifications or on the Drawings.
   2. Joints:
      a. Circular Pipe: Tongue and groove meeting requirements of ASTM C443.
   3. Joint ties shall be in accordance with Detail Drawings.
   4. All Public Storm Sewer shall be concrete pipe.

B. PVC Pipe:
   1. Conform to ASTM D3034 with solvent weld or elastomeric joints.
   2. Pipe shall be SDR-35, unless otherwise noted. Pipe over 15 inches in diameter shall meet the requirements of ASTM F679-03. Do not mix different manufacturer's products, or fittings.

C. HDPE Solid Wall Pipe:
   1. Conform to ASTM D3350 for PE material with a cell classification of 335434C or better. Pipe shall be SDR 11, unless otherwise noted.
   2. Joints shall be thermal butt fusion in accordance with the manufacturer's recommendation.

D. HDPE Corrugated Wall Pipe:
   1. Corrugated pipe with an integrally formed smooth liner.
   2. Pipes which are between 4-inch diameter and 36-inch diameter shall meet the requirements of AASHTO M252 and M294, Type S.
   3. Pipe and fittings shall be manufactured from virgin PE compounds conforming to the requirements of ASTM D3350, cell class 324420C.
   4. Joints for fittings and pipe shall be soil-tight bell and spigot, provided with rubber gasket. Rubber gasket shall be installed by the pipe manufacturer.

E. HDPE Corrugated Underdrain Pipe:
   1. Corrugated underdrain pipe with perforations.
   2. Pipes which are between 4-inch diameter to 10-inch diameter shall meet the requirements of AASHTO M252, Type CP.
   3. Joints and wyes for pipe shall be soil tight.

1.7 STORM SEWER PRE-CAST MANHOLES AND INLETS

A. Frames, grates, and manhole lids shall be constructed and installed per City's Construction Specifications and are considered incidental to the price of the structure.
   1. Manhole castings shall be Neenah R-1550 with non-rocking lids and Type D grates.
   2. Inlet castings shall be R-3067 with Type L grates at low points and where grades are less than 1 percent. Vane grates shall not be used at low points.

1.8 CONNECT TO EXISTING STORM MANHOLE OR STORM PIPE

A. All work and materials to comply with City's Construction Specifications.

B. Contractor to supply all materials, equipment, labor and supervision necessary to construct the required connections per the contract documents.

1.9 PRE-CAST STORM SEWER PIPE END SECTIONS AND WELDED GRATES

A. Pre-cast Apron end Walls Shall be provided and installed with hinged metal grates in accordance with Section 502 of the State Specifications. Apron end wall shall be provided with cut-off walls to prevent undermining.

B. Apron End Walls shall be tied to a minimum of two pipe segments upstream of the endwall (three joint ties).

1.10 HDPE STORM SEWER PIPE END SECTIONS AND WELDED GRATES

A. HDPE apron endwalls shall be provided and installed with removable/hinged metal grates and cut-off walls to prevent undermining.

B. Apron endwalls shall be securely fastened to the HDPE storm pipes with a fastening system that has been reviewed and approved by Engineer prior to installation.

1.11 BEDDING AND COVER MATERIAL

A. Provide 3/4-inch clear stone bedding and cover material in accordance with the Drawings and Section 31 23 16.13 -Trenching.

B. Granular Backfill material shall conform to the requirements of the City's Standard Specifications. Granular backfill shall be used under public and private pavement/walks and where shown in the plans unless otherwise directed by the City's Construction Representative or Owner's Project Representative based on geotechnical evaluation of native materials.

1.12 CRUSHED STONE

A. Provide crushed stone base in accordance with the drawings and Section 31 23 16.13 - Trenching.

B. Stone trench backfill for storm sewer underdrain shall be 3/4-inch washed in accordance with AASHTO #57.

1.13 ANTI-SEEP COLLAR

A. Provide and install anti-seep collar(s) at the locations indicated on the plan, of type and size noted within the plan details and in compliance with NRCS 378.

1.14 LOCATOR TAPE

A. Detectable metal locator tape shall be specifically manufactured for marking utilities.

B. Tape shall be a minimum of 6 inches wide and shall be marked with "STORM".

1.15 DRAIN BASINS AND INLETS

A. General:

1. PVC surface drainage inlets shall include the drain basin type as indicated on the contract drawing and referenced within the contract specifications. The ductile iron grates for each of these fittings are to be considered an integral part of the surface drainage inlet and shall be furnished by the same manufacturer. The surface drainage inlets shall be as manufactured by Nyloplast a division of Advanced Drainage Systems, Inc., or prior approved equal.

B. Materials:

1. The drain basins required for this contract shall be manufactured from PVC pipe stock, utilizing a thermoforming process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784, Cell Class 12454.
2. The grates and frames furnished for all surface drainage inlets shall be ductile iron for sizes 8, 10, 12, 15, 18, 24, and 30 inches and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for drain basins shall be capable of supporting various wheel loads as specified by Nyloplast. The 12-inch and 15-inch square grates will be hinged to the frame using pins. Ductile iron used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05. Grates and covers shall be provided painted black.
3. Where shown, the basins shall be provided with the sump specified.

1.16 STORM FORCE MAIN PIPE

A. Stormwater force main shall be Polyvinyl Chloride (PVC) meeting the requirements of AWWA C900 or C905 as applicable.

1. Unless otherwise noted, PVC force main pipe shall have a dimension ratio (DR) of 25 or less.
2. Retainer Glands for PVC Pipe:
   a. Wedge action retainer glands designed for use with PVC pipe.
   b. Glands shall be constructed of ductile iron. Restraint shall be provided by a minimum of four (4) wedges which are tightened onto the exterior of the pipe using a threaded, torque limiting mechanism.
   c. Glands shall be tested to provide restraint at 200 psi operating pressure.
   d. Retainer glands shall be MEGA-LUG by EBBA Iron, or approved equal.
3. Main Clamp Hardware:
   a. Corrosion resistant steel hardware specifically fabricated for use in pipe restraint systems.
   b. Astral, or approved equal.

4. Threaded Rod Joint Restraint:
   a. 3/4-inch diameter threaded rod.
   b. Rod shall be constructed of carbon steel having a minimum tensile strength of 30 ksi.
   c. Rod shall be zinc plated.
5. Fittings shall be ductile iron meeting AWWA C151 or C153.26.

1.17 DUCTILE IRON STORM FORCE MAIN

A. Ductile iron force main shall be centrifugally cast, cement mortar lined ductile iron force main meeting the requirements of ANSI/AWWA C151/A21.51 and ANSI/AWWA C104/A21.4.

B. Unless otherwise specified, ductile force main shall be Class 52 as defined by ANSI/AWWA C151/A21.51.

PART 2 - EXECUTION

2.1 HANDLING OF MATERIALS

A. Handle materials with care to avoid damage. Do not dump or drop materials. Remove all damaged or flawed materials from the site.

B. Arrange for suitable sites for material storage.

2.2 LINES AND GRADE

A. Benchmarks and Construction Layout:
   1. Engineer will provide vertical and horizontal control.
   2. Contractor shall provide construction layout.

B. Contractor shall provide all materials, equipment, and labor to maintain line and grade.
   1. The laser beam method is the preferred method for controlling line and grade. Equipment shall be operated in accordance with the manufacturer's instructions. A person who is competent with the operation of the laser equipment shall be present at the jobsite whenever it is being used.
   2. Grade boards may be used. Use straight and even-edged 2X6 boards nailed or clamped to substantial stakes on either side of the trench. Use stout twill line fastened at the center of the alignment, pulled sufficiently tight to remove any noticeable or measurable sag. Measure down from the line to set the alignment of the pipe. Maintain a minimum of three boards at all times.
   3. Banjo strings may be used only when approved by the Engineer.

2.3 JOINTS

A. Construct joints as described herein and in accordance with manufacturer's installation instructions. Provide pipe joint type for soil tight, silt tight, or watertight only silt tight or watertight only watertight joint performance in accordance with the following table. The table applies only to the extent as applicable to the pipe and joint type and the joint performance as shown or specified.

Pipe and Joint Type	Joint Performance		
	Watertight	Silt Tight	Soil Tight
RCP:			
Rubber O-Ring Gasket	X	X	X
Bitumen or Butyl Rubber Sealant			X
HDPE:			
Rubber Gasket:			
Hancor BLUE SEAL	X	X	X
ADS N-12 WT	X	X	X
Hancor Sure-Lok		X	X
ADS N-12 ST		X	X
Corrugated Coupling Bands:			
Hancor Hi-Q			X
ADS N-12			X
PE Wrap			X
PVC:			
Restrained Gasket	X	X	X

2.4 UNSTABLE FOUNDATION

A. Remove undesirable material below the trench bottom, such as organic soils, which cannot support the pipe. Replace the material with crushed stone meeting the requirements of Section 31 23 16.13 for 2-inch crushed stone base material.

B. Crushed stone base material will be paid for at the unit price bid or on the basis of a negotiated price if there is no bid price. Payment for crushed stone base will be made only if the Owner's Project Representative is notified prior to its placement. Payment will not be made for crushed stone base used for dewatering the trench.

2.5 LAYING OF PIPE

A. Lay pipe uniformly to line and grade so that the finished sewer presents a uniform bore. Noticeable variations from true alignment and grade will be sufficient cause for rejection of the work.

B. Commence at the lowest point and proceed to the upper end. Lay pipe with bell-end pointing up-grade.

C. Provide a minimum of 6 inches between the pipe or box wall and the trench wall.

D. Rest each pipe on the full length of its barrel. Place box culvert sections on 6 inches of bedding material.

E. Do not lay the next pipe until the previous pipe is back-filled sufficiently to prevent movement during joining.

F. Keep water out of the pipe. Do not let water rise into or around the pipe until the trench is filled at least 1 foot above the pipe.

G. When work is stopped for any reason, securely plug the end of the pipe.

H. Pipe Jointing: Assemble joints in accordance with the pipe manufacturer's instructions.

2.6 BEDDING AND COVER

A. Use the following bedding sections as indicated on the Drawings.

B. Class C:

1. Provide a minimum of 6 inches of bedding material under the pipe barrel and 4 inches under the bell. Provide crushed stone bedding meeting requirements of Section 31 23 16.13. Spade or shovel-slice the material so that it fills and supports the haunch area and encases the pipe to the limits shown on the Drawing detail. If excavation is carried deeper than 6 inches below the pipe barrel, backfill the excess depth with 1½-inch crushed stone base material meeting requirements of Section 31 23 16.13.
2. After the pipe has been laid and jointed, place cover material by hand or equally careful means around the sides of the pipe and up to a level twelve inches above the pipe. Provide cover material meeting the requirements of Section 31 23 16.13.
3. For pipes 36 inches in diameter or larger, backfill material may be substituted for cover material. If backfill material is used, the bedding material shall extend to the spring line of the pipe.

2.7 SEPARATION FROM WATER MAIN

A. Provide a minimum horizontal separation of 10 feet when constructing parallel to the water main.

B. Vertical Separation

1. When a sewer crosses under a water main, provide a minimum of 12 inches between the bottom of the water main and the top of the sewer.
2. When a sewer crosses over a water main, provide a minimum of 36 inches between the bottom of the sewer and the top of the water main.

C. Excess excavated trench material shall be transported and disposed on site in a location approved by the Construction Coordinator or Engineer. Trench excavation material cannot be cast into piles within the roadway.

2.8 MANHOLES, CATCH BASINS, INLETS, AND JUNCTION BOXES

A. Construct drainage structures in accordance with details shown on Drawings and in accordance with Section 33 40 00, as applicable.

B. Precast Sections:

1. Install precast section with bases in accordance with Sections 33 30 00 and 33 40 00 or as shown on Drawings.
2. Align pipe openings to that of the pipe entering and leaving the manhole, etc. Properly pipe with connections to manholes, etc., as shown on the Drawings.
   a. Construct cast-in-place sections as shown on the Drawings and in accordance with Section 03 30 00 - Cast-in-Place Concrete.
3. Form bottom of excavation clean and smooth to correct elevation.
4. Form and place cast-in-place concrete base pad, with provision for storm sewer pipe to be placed at proper elevation.

5. Form and place cast-in-place concrete walls, sleeved at proper elevation to receive storm sewer pipe in accordance with details shown on Drawings.

C. Invert channels shall be smooth and accurately shaped to a semicircular bottom conforming to the inside of the adjacent sewer section. Shape invert channels and structure bottoms with cement mortar. Changes in size and grade of invert shall be made gradually and evenly. Changes in direction of the sewer entering branch or branches shall have a true curve of as large a radius as the manhole will permit.

3.9 TELEVISE REPORT

A. All new storm sewer installation completed between structures shall be televise once backfilled, and a copy of the television report shall be submitted to the City's Construction Representative and the Engineer.

B. The Contractor is responsible for conducting and reporting the results of testing. The televising of the storm sewer shall be done in the presence of the City's Construction Representative.

3.10 CONDUCTIVITY TESTING

A. Perform continuity testing on all newly installed storm sewer mains in accordance with the City's Construction Standards.

B. The Contractor is responsible for conducting and reporting the results of testing. Conductivity testing shall be done in the presence of the City's Construction Representative.

END OF SECTION