$1,099,380.05

BID OF **Parisi Construction, LLC**

2026

PROPOSAL, CONTRACT, BOND AND SPECIFICATIONS

FOR

Metro Transit Kennedy Road On-Route Bus Charger

CONTRACT NO. 9766

PROJECT NO. 14880

IN

MADISON, DANE COUNTY, WISCONSIN

AWARDED BY THE COMMON COUNCIL
MADISON, WISCONSIN ON May 19, 2026

CITY ENGINEERING DIVISION
1600 EMIL STREET
MADISON, WISCONSIN 53713

https://bidexpress.com/login

METRO TRANSIT KENNEDY ROAD ON-ROUTE BUS CHARGER
CONTRACT NO. 9766

INDEX

This Proposal, and Agreement have
been prepared by:

CITY ENGINEERING DIVISION
CITY OF MADISON
MADISON, DANE COUNTY, WISCONSIN

Christof Spieler, Transportation Director

CS: MC

SECTION A: ADVERTISEMENT FOR BIDS AND INSTRUCTIONS TO BIDDERS

REQUEST FOR BID FOR PUBLIC WORKS CONSTRUCTION
CITY OF MADISON, WISCONSIN

A BEST VALUE CONTRACTING MUNICIPALITY

PROJECT NAME:	METRO TRANSIT KENNEDY ROAD ON-ROUTE BUS CHARGER
CONTRACT NO.:	9766
SBE GOAL	5%
BID BOND	5%
SBE PRE BID MEETING (2:00 P.M.)	APRIL 16, 2023
PREQUALIFICATION APPLICATION DUE (2:00 P.M.)	APRIL 16, 2023
BID SUBMISSION (2:00 P.M.)	APRIL 23, 2026
BID OPEN (2:30 P.M.)	APRIL 23,2026
PUBLISHED IN WSJ	APRIL 9, & 16, 2026

SBE PRE BID MEETING: Pre-Bid Meetings are being held virtually. Advance registration is required. Visit the SBE Meeting web page on Engineering's web site: https://www.cityofmadison.com/engineering/developers-contractors/contractors/how-to-bid-public-works-contracts/small-business.
Questions regarding SBE Program requirements may be directed to Tracy Lomax, Affirmative Action Division. Tracy may be reached at (608) 267-8634, or by email, TLomax@cityofmadison.com.

PREQUALIFICATION APPLICATION: Forms are available on our website, www.cityofmadison.com/engineering/developers-contractors/contractors/how-to-get-prequalified. If not currently prequalified in the categories listed in Section A, an amendment to your Prequalification will need to be submitted prior to the same due date. Postmark is not applicable.

BIDS TO BE SUBMITTED: by hand to 1600 EMIL ST., MADISON, WI 53713 or online at www.bidexpress.com.

Bids may be submitted on line through Bid Express or in person at 1600 Emil St. The bids will be posted on line after the bid opening. If you have any questions, please call Isaac Gabriel at (608) 267-1197, or Kyle Frank at (608) 266-9091.

STANDARD SPECIFICATIONS

The City of Madison's Standard Specifications for Public Works Construction - 2026 Edition, as supplemented and amended from time to time, forms a part of these contract documents as if attached hereto.

These standard specifications are available on the City of Madison Public Works website, www.cityofmadison.com/engineering/developers-contractors/standard-specifications.

The Contractor shall review these Specifications prior to preparation of proposals for the work to be done under this contract, with specific attention to Article 102, "BIDDING REQUIREMENTS AND CONDITIONS" and Article 103, "AWARD AND EXECUTION OF THE CONTRACT." For the convenience of the bidder, below are highlights of three subsections of the specifications.

SECTION 102.1: PRE-QUALIFICATION OF BIDDERS

In accordance with Wisconsin State Statutes 66.0901 (2) and (3), all bidders must submit to the Board of Public Works proof of responsibility on forms furnished by the City. The City requires that all bidders be qualified on a biennial basis.

Bidders must present satisfactory evidence that they have been regularly engaged in the type of work specified herein and they are fully prepared with necessary capital, materials, machinery and supervisory personnel to conduct the work to be contracted for to the satisfaction of the City. All bidders must be pre-qualified by the Board of Public Works for the type of construction on which they are bidding prior to the opening of the bid.

In accordance with Section 39.02(9)(a)l. of the General Ordinances, all bidders shall submit in writing to the Affirmative Action Division Manager of the City of Madison, a Certificate of Compliance or an Affirmative Action Plan at the same time or prior to the submission of the proof of responsibility forms.

The bidder shall be disqualified if the bidder fails to or refuses to, prior to opening of the bid, submit a Certificate of compliance, Affirmative Action Plan or Affirmative Action Data Update, as applicable, as defined by Section 39.02 of the General Ordinances (entitled Affirmative Action) and as required by Section 102.11 of the Standard Specifications.

SECTION 102.4 PROPOSAL

No bid will be accepted that does not contain an adequate or reasonable price for each and every item named in the Schedule of Unit Prices.

A lump sum bid for the work in accordance with the plans and specifications is required. The lump sum bid must be the same as the total amounts bid for the various items and it shall be inserted in the space provided.

All papers bound with or attached to the proposal form are considered a part thereof and must not be detached or altered when the proposal is submitted. The plans, specifications and other documents designated in the proposal form will be considered a part of the proposal whether attached or not.

A proposal submitted by an individual shall be signed by the bidder or by a duly authorized agent. A proposal submitted by a partnership shall be signed by a member/partner or by a duly authorized agent thereof. A proposal submitted by a corporation shall be signed by an authorized officer or duly authorized registered agent of such corporation, and the proposal shall show the name of the State under the laws of which such corporation was chartered. The required signatures shall in all cases appear in the space provided thereof on the proposal.

Each proposal shall be placed, together with the proposal guaranty, in a sealed envelope, so marked as to indicate name of project, the contract number or option to which it applies, and the name and address of the Contractor or submitted electronically through Bid Express (www.bidexpress.com). Proposals will be accepted at the location, the time and the date designated in the advertisement. Proposals received after the time and date designated will be returned to the bidder unopened.

SECTION 102.5: BID DEPOSIT (PROPOSAL GUARANTY)

All bids, sealed or electronic, must be accompanied with a Bid Bond (City of Madison form) equal to at least 5% of the bid or a Certificate of Annual/Biennial Bid Bond or certified check, payable to the City Treasurer. Bid deposit of the successful bidders shall be returned within forty-eight (48) hours following execution of the contract and bond as required.

MINOR DISCREPENCIES

Bidder is responsible for submitting all forms necessary for the City to determine compliance with State and City bidding requirements. Nothwithstanding any language to the contrary contained herein, the City may exercise its discretion to allow bidders to correct or supplement submissions after bid opening, if the minor discrepancy, bid irregularity or omission is insignificant and not one related to price, quality, quantity, time of completion or performance of the contract.

Bidders for this Contract(s) must be Pre-Qualified for at least one of the following type(s) of construction denoted by an ☒

Building Demolition

101 ☐ Asbestos Removal
110 ☐ Building Demolition
120 ☐ House Mover

Street, Utility and Site Construction

201 ☐ Asphalt Paving
205 ☐ Blasting
210 ☐ Boring/Pipe Jacking
215 ☐ Concrete Paving
220 ☐ Con. Sidewalk/Curb & Gutter/Misc. Flat Work
221 ☐ Concrete Bases and Other Concrete Work
222 ☐ Concrete Removal
225 ☐ Dredging
230 ☐ Fencing
235 ☐ Fiber Optic Cable/Conduit Installation
240 ☐ Grading and Earthwork
241 ☐ Horizontal Saw Cutting of Sidewalk
242 ☐ Hydro Excavating
243 ☐ Infrared Seamless Patching
245 ☐ Landscaping, Maintenance
246 ☐ Ecological Restoration (Certification required, See Section III & provide a minimum of 3 references
250 ☐ Landscaping, Site and Street
251 ☐ Parking Ramp Maintenance
252 ☐ Pavement Marking
255 ☐ Pavement Sealcoating and Crack Sealing
260 ☐ Petroleum Above/Below Ground Storage Tank Removal/Installation
262 ☐ Playground Installer
265 ☐ Retaining Walls, Precast Modular Units
270 ☐ Retaining Walls, Reinforced Concrete
275 ☐ Sanitary, Storm Sewer and Water Main Construction
276 ☐ Sawcutting
280 ☐ Sewer Lateral Drain Cleaning/Internal TV Insp.
285 ☐ Sewer Lining
290 ☐ Sewer Pipe Bursting
295 ☐ Soil Borings
300 ☐ Soil Nailing
305 ☐ Storm & Sanitary Sewer Laterals & Water Svc.
310 ☒ Street Construction
315 ☐ Street Lighting
318 ☐ Tennis Court Resurfacing
320 ☐ Traffic Signals
325 ☐ Traffic Signing & Marking
332 ☐ Tree pruning/removal
333 ☐ Tree, pesticide treatment of
335 ☐ Trucking
340 ☐ Utility Transmission Lines including Natural Gas, Electrical & Communications
399 ☐ Other_____

Bridge Construction

501 ☐ Bridge Construction and/or Repair

Building Construction

401 ☐ Floor Covering (including carpet, ceramic tile installation, rubber, VCT
402 ☐ Building Automation Systems
403 ☐ Concrete
404 ☐ Doors and Windows
405 ☐ Electrical - Power, Lighting & Communications
410 ☐ Elevator - Lifts
412 ☐ Fire Suppression
413 ☐ Furnishings - Furniture and Window Treatments
415 ☐ General Building Construction, Equal or Less than $250,000
420 ☒ General Building Construction, $250,000 to $1,500,000
425 ☐ General Building Construction, $1,500,000 to $10,000,000
426 ☐ General Building Construction, over $10,000,000
428 ☐ Glass and/or Glazing
429 ☐ Hazardous Material Removal
430 ☐ Heating, Ventilating and Air Conditioning (HVAC)
433 ☐ Insulation - Thermal
435 ☐ Masonry/Tuck pointing
437 ☐ Metals
440 ☐ Painting and Wallcovering
445 ☐ Plumbing
450 ☐ Pump Repair
455 ☐ Pump Systems
460 ☐ Roofing and Moisture Protection
464 ☐ Tower Crane Operator
461 ☐ Solar Photovoltaic/Hot Water Systems
465 ☐ Soil/Groundwater Remediation
466 ☐ Warning Sirens
470 ☐ Water Supply Elevated Tanks
475 ☐ Water Supply Wells
480 ☐ Wood, Plastics & Composites - Structural & Architectural
499 ☐ Other_____

State of Wisconsin Certifications

1 ☐ Class 5 Blaster - Blasting Operations and Activities 2500 feet and closer to inhabited buildings for quarries, open pits and road cuts.
2 ☐ Class 6 Blaster - Blasting Operations and Activities 2500 feet and closer to inhabited buildings for trenches, site excavations, basements, underwater demolition, underground excavations, or structures 15 feet or less in height.
3 ☐ Class 7 Blaster - Blasting Operations and Activities for structures greater than 15 ' in height, bridges, towers, and any of the objects or purposes listed as “Class 5 Blaster or Class 6 Blaster”.
4 ☐ Petroleum Above/Below Ground Storage Tank Removal and Installation (Attach copies of State Certifications.)
5 ☐ Hazardous Material Removal (Contractor to be certified for asbestos and lead abatement per the Wisconsin Department of Health Services, Asbestos and Lead Section (A&LS).) See the following link for application: www.dhs.wisconsin.gov/Asbestos/Cert. State of Wisconsin Performance of Asbestos Abatement Certificate must be attached.
6 ☐ Certification number as a Certified Arborist or Certified Tree Worker as administered by the International Society of Arboriculture

State of Wisconsin Certifications (continued)

7 ☐ Pesticide application (Certification for Commercial Applicator for Hire with the certification in the category of turf and landscape (3.0) and possess a current license issued by the DATCP)

8 ☐ State of Wisconsin Master Plumbers License.

9 ☐ Pesticide application (Certification for Commercial Applicator in the category of Right-of-Way (6.0) and possess a current license issued by the DATCP)

10 ☐ Other:

SECTION C: SMALL BUSINESS ENTERPRISE

Instructions to Bidders
City of Madison
SBE Program Information

2 Small Business Enterprise (SBE) Program Information

2.1 Policy and Goal

The City of Madison reaffirms its policy of nondiscrimination in the conduct of City business by maintaining a procurement process which remains open to all who have the potential and ability to sell goods and services to the City. It is the policy of the City of Madison to allow Small Business Enterprises (SBE) maximum feasible opportunity to participate in City of Madison contracting. The bidder acknowledges that its bid has been submitted in accordance with the SBE program and is for the public's protection and welfare.

Please refer to the "ADVERTISEMENT FOR BIDS" for the goal for the utilization of SBEs on this project. SBEs may participate as subcontractors, vendors and/or suppliers, which provide a commercially useful function. The dollar value for SBE suppliers or 'materials only' vendors shall be discounted to 60% for purposes of meeting SBE goals.

A bidder which achieves or exceeds the SBE goal will be in compliance with the SBE requirements of this project. In the event that the bidder is unable to achieve the SBE goal, the bidder must demonstrate that a good faith effort to do so was made. Failure to either achieve the goal or demonstrate a good faith effort to do so will be grounds for the bidder being deemed a non-responsible contractor ineligible for award of this contract.

A bidder may count towards its attainment of the SBE goal only those expenditures to SBEs that perform a commercially useful function. For purposes of evaluating a bidder's responsiveness to the attainment of the SBE goal, the contract participation by an SBE is based on the percentage of the total base bid proposed by the Contractor. The total base bid price is inclusive of all addenda.

Work performed by an SBE firm in a particular transaction can be counted toward the goal only if it involves a commercially useful function. That is, in light of industry practices and other relevant considerations, does the SBE firm have a necessary and useful role in the transaction, of a kind for which there is a market outside the context of the SBE Program, or is the firm's role a superfluous step added in an attempt to obtain credit towards goals? If, in the judgment of the Affirmative Action Division, the SBE firm will not perform a commercially useful function in the transaction, no credit towards goals will be awarded.

The question of whether a firm is performing a commercially useful function is completely separate from the question of whether the firm is an eligible SBE. A firm is eligible if it meets the definitional criteria and ownership and control requirements, as set forth in the City of Madison's SBE Program.

If the City of Madison determines that the SBE firm is performing a commercially useful function, then the City of Madison must then decide what that function is. If the commercially useful function is that of an SBE vendor / supplier that regularly transacts business with the respective product, then the City of Madison will count 60% of the value of the product supplied toward SBE goals.

To be counted, the SBE vendor / supplier must be engaged in selling the product in question to the public. This is important in distinguishing an SBE vendor / supplier, which has a regular trade with a variety of customers, from a firm which performs supplier-like functions on an ad hoc basis or for only one or two contractors with whom it has a special relationship.

A supplier of bulk goods may qualify as an eligible SBE vendor / supplier if it either maintains an inventory or owns or operates distribution equipment. With respect to the distribution equipment; e.g., a fleet of trucks, the term "operates" is intended to cover a situation in which the supplier leases the equipment on a regular basis for its entire business. It is not intended to cover a situation in which the firm simply provides drivers for trucks owned or leased by another party; e.g., a prime contractor, or leases such a party's trucks on an ad hoc basis for a specific job.

If the commercially useful function being performed is not that of a qualified SBE vendor / supplier, but rather that of delivery of products, obtaining bonding or insurance, procurement of personnel, acting as a broker or manufacturer's representative in the procurement of supplies, facilities, or materials, etc., only the fees or commissions will apply towards the goal.

For example, a business that simply transfers title of a product from manufacturer to ultimate purchaser; e. g., a sales representative who re-invoices a steel product from the steel company to the Contractor, or a firm that puts a product into a container for delivery would not be considered a qualified SBE vendor / supplier. The Contractor would not receive credit based on a percentage of the cost of the product for working with such firms.

Concerning the use of services that help the Contractor obtain needed supplies, personnel, materials or equipment to perform a contract: only the fee received by the service provider will be counted toward the goal. For example, use of a SBE sales representative or distributor for a steel company, if performing a commercially useful function at all, would entitle the Contractor receiving the steel to count only the fee paid to the representative or distributor toward the goal. This provision would also govern fees for professional and other services obtained expressly and solely to perform work relating to a specific contract.

Concerning transportation or delivery services: if an SBE trucking company picks up a product from a manufacturer or a qualified vendor / supplier and delivers the product to the Contractor, the commercially useful function it is performing is not that of a supplier, but simply that of a transporter of goods. Unless the trucking company is itself the manufacturer or a qualified vendor / supplier in the product, credit cannot be given based on a percentage of the cost of the product. Rather, credit would be allowed for the cost of the transportation service.

The City is aware that the rule's language does not explicitly mention every kind of business that may contribute work on this project. In administering these programs, the City would, on a case-by-case basis, determine the appropriate counting formula to apply in a particular situation.

2.2 Contract Compliance

Questions concerning the SBE Program shall be directed to the Contract Compliance Officer of the City of Madison Department of Civil Rights, Affirmative Action Division, 210 Martin Luther King, Jr. Blvd., Room 523, Madison, WI 53703; telephone (608) 266-4910.

2.3 Certification of SBE by City of Madison

The Affirmative Action Division maintains a directory of SBEs which are currently certified as such by the City of Madison. Contact the Contract Compliance Officer as indicated in Section 2.2 to receive a copy of the SBE Directory or you may access the SBE Directory online at https://www.cityofmadison.com/civil-rights/contract-compliance.

All contractors, subcontractors, vendors and suppliers seeking SBE status must complete and submit the **Targeted Business Certification Application** to the City of Madison Affirmative Action Division by the time and date established for receipt of bids. A copy of the Targeted Business Certification Application is available by contacting the Contract Compliance Officer at the address and telephone indicated in Section 2.2 or you may access the Targeted Business Certification Application online at www.cityofmadison.com/civil-rights/contract-compliance/targeted-business-enterprise-programs/targeted-business-enterprise. Submittal of the Targeted Business Certification Application by the time specified does not guarantee that the applicant will be certified as a SBE eligible to be utilized towards meeting the SBE goal for this project.

2.4 Small Business Enterprise Compliance Report

2.4.1 Good Faith Efforts

Bidders shall take all necessary affirmative steps to assure that SBEs are utilized when possible and that the established SBE goal for this project is achieved. A contractor who self performs a portion of the work, and is pre-qualified to perform that category of work, may subcontract that portion of the work, but shall not be required to do so. When a bidder is unable to achieve the established SBE goal, the bidder must demonstrate that a good faith effort to do so was made. Such a good faith effort should include the following:

2.4.1.1 Attendance at the pre-bid meeting.

2.4.1.2 Using the City of Madison's directory of certified SBEs to identify SBEs from which to solicit bids.

2.4.1.3 Assuring that SBEs are solicited whenever they are potential sources.

2.4.1.4 Referring prospective SBEs to the City of Madison Affirmative Action Division for certification.

2.4.1.5 Dividing total project requirements into smaller tasks and/or quantities, where economically feasible, to permit maximum feasible SBE participation.

2.4.1.6 Establishing delivery schedules, where requirements permit, which will encourage participation by SBEs.

2.4.1.7 Providing SBEs with specific information regarding the work to be performed.

2.4.1.8 Contacting SBEs in advance of the deadline to allow such businesses sufficient time to prepare a bid.

2.4.1.9 Utilizing the bid of a qualified and competent SBE when the bid of such a business is deemed reasonable (i.e. 5% above the lowest bidder), although not necessarily low.

2.4.1.10 Contacting SBEs which submit a bid, to inquire about the details of the bid and confirm that the scope of the work was interpreted as intended.

2.4.1.11 Completion of Cover Page (page C-6), Summary Sheet (page C-7) and SBE Contact Reports (pages C-8 and C9) if applicable.

2.4.2 **Reporting SBE Utilization and Good Faith Efforts**

The Small Business Enterprise Compliance Report is to be submitted by the bidder with the bid: This report is due by the specified bid closing time and date. Bids submitted without a completed SBE Compliance Report as outlined below may be deemed non-responsible and the bidder ineligible for award of this contract. Nothwithstanding any language to the contrary contained herein, the City may exercise its discretion to allow bidders to correct or supplement submissions after bid opening, if the minor discrepancy, bid irregularity or omission is insignificant and not one related to price, quality, quantity, time of completion, performance of the contract, or percentage of SBE utilization.

2.4.2.1 If the Bidder meets or exceeds the goal established for SBE utilization, the Small Business Enterprise Compliance Report shall consist of the following:

2.4.2.1.1 **Cover Page,** Page C-6; and
2.4.2.1.2 **Summary Sheet,** C-7.

2.4.2.2 If the bidder does not meet the goal established for SBE utilization, the Small Business Enterprise Compliance Report shall consist of the following:

2.4.2.2.1 **Cover Page,** Page C-6;
2.4.2.2.2 **Summary Sheet,** C-7; and
2.4.2.2.3 **SBE Contact Report,** C-8 and C-9. (A separate Contact Report must be completed for each applicable SBE which is not utilized.)

2.5 Appeal Procedure

A bidder which does not achieve the established goal and is found non-responsible for failure to demonstrate a good faith effort to achieve such goal and subsequently denied eligibility for award of contract may appeal that decision to the Small Business Enterprises Appeals Committee. All appeals shall be made in writing, and shall be delivered to and received by the City Engineer no later than 4:30 PM on the third business day following the bidder's receipt of the written notification of ineligibility by the Affirmative Action Division Manager. Postmark not acceptable. The notice of appeal shall state the basis for the appeal of the decision of the Affirmative Action Division Manager. The Appeal shall take place in accordance with Madison General Ordinance 33.54.

2.6 SBE Requirements After Award of the Contract

The successful bidder shall identify SBE subcontractors, suppliers and vendors on the subcontractor list in accordance with the specifications. The Contractor shall submit a detailed explanation of any variances between the listing of SBE subcontractors, vendors and/or suppliers on the subcontractor list and the Contractor's SBE Compliance Report for SBE participation.

No change in SBE subcontractors, vendors and/or suppliers from those SBEs indicated in the SBE Compliance Report will be allowed without prior approval from the Engineer and the Affirmative Action Division. The contractor shall submit in writing to the City of Madison Affirmative Action Division a request to change any SBE citing specific reasons which necessitate such a change. The Affirmative Action Division will use a general test of reasonableness in approving or rejecting the contractor's request for change. If the request is approved, the Contractor will make every effort to utilize another SBE if available.

The City will monitor the project to ensure that the actual percentage commitment to SBE firms is carried out.

2.7 SBE Definition and Eligibility Guidelines

A Small Business Enterprise is a business concern awarded certification by the City of Madison. For the purposes of this program a Small Business Enterprise is defined as:

A. An independent business operated under a single management. The business may not be a subsidiary of any other business and the stock or ownership may not be held by any individual or any business operating in the same or a similar field. In determining whether an entity qualifies as a SBE, the City shall consider all factors relevant to being an independent business including, but not limited to, the date the business was established, adequacy of its resources for the work in which it proposes to involve itself, the degree to which financial, equipment leasing and other relationships exist with other ineligible firms in the same or similar lines of work. SBE owner(s) shall enjoy the customary incidents of ownership and shall share in the risks and profits commensurate with their enjoyment interests, as demonstrated by an examination of the substance rather than form or arrangements that may be reflected in its ownership documents.

B. A business that has averaged no more than $4.0 million in annual gross receipts over the prior three year period and the principal owner(s) do not have a personal net worth in excess of $1.32 million.

Firm and/or individuals that submit fraudulent documents/testimony may be barred from doing business with the City and/or forfeit existing contracts.

SBE certification is valid for one (1) year unless revoked.

SECTION D: SPECIAL PROVISIONS

METRO TRANSIT KENNEDY ROAD ON-ROUTE BUS CHARGER
CONTRACT NO. 9766

It is the intent of these Special Provisions to set forth the final contractual intent as to the matter involved and shall prevail over the Standard Specifications and plans whenever in conflict therewith. In order that comparisons between the Special Provisions can be readily made, the numbering system for the Special Provisions is equivalent to that of the Specifications.

Whenever in these Specifications the term “Standard Specifications” appears, it shall be taken to refer to the City of Madison Standard Specifications for Public Works Construction and Supplements thereto.

SECTION 102.11 BEST VALUE CONTRACTING

This Contract shall be considered a Best Value Contract if the Contractor’s bid is equal to or greater than $79,000 for a single trade contract; or equal to or greater than $386,500 for a multi-trade contract pursuant to MGO 33.07(7).

SECTION 104 SCOPE OF WORK

The work under this contract shall include, but is not limited to, construction of foundation for overhead bus charger, a building (restroom and electrical facilities), concrete pavement, HMA pavement, pavement resurfacing, curb and gutter, sidewalk, grading, storm sewer, sanitary sewer, water, electrical, pavement marking, signs and all incidental items necessary to complete the work as shown on the plans and included in the proposal and contract.

Building construction includes foundation, building structure, mechanical components, electrical components, plumbing components and all incidental items and coordination with outside parties necessary to complete the work as shown on the plans and included in the proposal and contract. The Contractor shall view the site prior to bidding to become familiar with the existing conditions. It will be the responsibility of the Contractor to work with the utilities located in the right of way to resolve conflicts during the construction process.

SECTION 104.4 INCREASED OR DECREASED QUANTITIES

Contractor shall note that some bid item quantities may increase or decrease based on what is encountered in the field. If the actual field conditions vary from the plan quantity, no additional compensation shall be given for increasing or decreasing quantities. Any overruns shall be paid for under the appropriate bid item(s) without any penalty or change to the bid price for the associated bid item. The Contractor shall not be reimbursed for any deletions to the contract. No change to the unit bid price will be allowed for changes to the quantities.

SECTION 104.6 DECREASED AND DELETED ITEMS

Proposed work includes preparations for installation by New Flyer of charging equipment as well as electrical service installation by MG&E. The proposed improvements include excavation cut, topsoil, remove concrete sidewalk and drive, clearing, grubbing, terrace seeding, concrete sidewalk & drive, crushed aggregate base course, and various components of the building, charger foundation, and Route B Kennedy site electrical and electrical service.

The City will not compensate the Contractor in the case that all or some of these items are removed from the scope of work.

SECTION 105.12 COOPERATION BY THE CONTRACTOR

Be advised that there shall be multiple mobilizations and/or remobilizations to complete construction operations, for example such items as: erosion control, utility installations, excavation, base course placement, concrete and asphalt work, restoration, pavement marking, and other incidental items related to the staging, building construction, and testing.

Coordination with On-Site Field Staff

The Construction Management team is representing Metro Transit during the construction process as the engineer. The engineer will be on-site during construction activities and will serve as the primary contact.

Construction Management team contact:

Jeff Held
Strand Associates, Inc.
608-251-4846 ext. 1175
Jeff.held@strand.com

Coordination with Utilities

The following utility owners have facilities within the project limits. No relocations are anticipated. Contact utility representative listed on the General Notes sheet to coordinate any potential conflicts.

AT&T Wisconsin - Communications
Cogent - Communications
MG&E - Electric
MG&E - Gas
Spectrum - Communications
Win Technologies – Communications

The following utility companies have facilities within the project area and will have facilities constructed, adjusted or relocated by the Contractor as part of this project:

MG&E - Electric
Contractor to contact MG&E to arrange for site electrical service. Submit power application for Route B Charger building according to the power requirements as shown in the plans. Coordination with MG&E has been completed through the design phase to identify MG&E's preferred locations for the meter socket, CT cabinets, service size, and source of power.

New electrical construction generally takes 10-weeks to 12-weeks, which generally begins 3-weeks after all required documents obtain approval by MG&E. Submit applications as soon as possible to assure electrical service is installed, inspected, and ready for turn-on at the required date. Contact utility for service questions and requirements.

Madison Gas and Electric Company (MG&E)

Contact:	Mark Gauger
Phone:	608-252-1570
Email:	mgauger@mge.com

City of Madison – Sanitary Sewer

Contact:	Mark Moder
Phone:	608-261-9250
Email:	mmoder@cityofmadison.com

City of Madison – Storm Sewer

Contact: Janet Schmidt
Phone: 608-261-9688
Email: jschmidt@cityofmadison.com

City of Madison – Water

Contact: Peter Braselton
Phone: 608-261-9834
Email: pbraselton@madisonwater.org

Coordination with Madison Metropolitan School District

Notify the engineer and Madison Metropolitan School District at least fourteen days prior to construction. Madison Metropolitan School District contact: Jeff Fedler, Madison School District Transportation Coordinator, jfedler@madison.k12.wi.us

Construction Testing Phase

Provide construction support for the 60-day construction testing phase, including providing modifications to previously constructed activities. This work to complete the modifications is incidental to the contract if modifications required are due to contractor or manufacturer deviances from the provided plans and specifications. Additional work identified from operational testing outside of construction work outlined within the plans and specifications, and not due to errors in construction, will be paid for accordingly. Payment shall be agreed upon by the contractor and City of Madison prior to beginning any out of scope work.

SECTION 107.6 DUST PROOFING

The Contractor shall take all necessary steps to control dust arising from operations connected with this contract. When ordered by the Engineer, the Contractor shall dust proof the construction area by using power sweepers and water. Dust proofing shall be incidental with operations connected with this contract.

SECTION 107.7 MAINTENANCE OF TRAFFIC

General

This work includes furnishing, constructing, assembling, hauling, erecting, re-erecting, maintaining, restoring, and removing non-permanent traffic signs, drums, barricades, and similar control devices, including arrow boards, for providing, placing, and maintaining work zones. Maintaining shall include replacing damaged or stolen traffic control devices. Existing traffic control devices such as signs and pavement markings that conflict with the Maintenance of Traffic Control Plan shall be removed or covered as directed by the engineer.

All signing and barricading shall conform to Part VI of the Federal Highway Administration's latest "Manual on Uniform Traffic Control Devices" (MUTCD), the State of Wisconsin Standard Facilities Development Manual (including Chapter 16 – Standard Detail Drawings, Series 15 – R/W, Access Control and Traffic Control) and the City of Madison Standards for sidewalk and bikeway closures.

The contractor shall submit a Traffic Control Plan, including all necessary phases, to Tom Mohr, 608-267-8725, tmohr@cityofmadison.com and Chad Veinot, 608-267-1960, cveinot@cityofmadison.com , prior to

the pre-construction meeting. The Traffic Control Plan shall address all requirements of this section of the special provisions. The successful bidder shall work with the City Traffic Engineering Division to develop an approved Traffic Control Plan. The contractor shall not start construction on this project until the Traffic Engineering Division has approved a traffic control plan and traffic control devices have been installed, in accordance with the approved plan. Request and receive closure approval through the Wisconsin Lane Closure System (WisLCS), https://transportal.cee.wisc.edu/closures a minimum of 7 calendar days prior to the lane closure, partial street closure, or start of each new construction stage or phase along Northport Drive. The contractor shall notify the project engineer of the approval prior to a lane closure, partial street closure, or start of a new construction stage for phase along Northport Drive. Failure of the contractor to obtain approval of a Traffic Control Plan or closure, as specified above, may prevent the contractor from starting work or implementing a lane or street closure and shall be considered a delay of the project, caused by the contractor.

The contractor shall refer to Chapter 6 in the MUTCD to provide adequate signs and taper lengths. The contractor may use drums as a channelizing device to separate traffic from the work zone.

The contractor shall be responsible for installing and maintaining traffic control in accordance with the approved Traffic Control Plan and as directed by the engineer. The traffic control plan may need to be altered as conditions change in the field or as unexpected conditions occur. This shall include relocating existing traffic control or providing additional traffic control. The contractor shall install and maintain any necessary modifications or additions to the traffic control, as directed by the engineer, at no cost to the City. Provide 24 hours-a-day availability of equipment and forces to expeditiously restore lights, signs, or other traffic control devices that are damaged or disturbed. The contractor shall also supply the name and telephone number of the local contact person for traffic control repairs before starting work. The turning of traffic control devices when not in use to obscure the message will not be allowed under this contract.

Do not park or store equipment, vehicles, or construction materials within the clear zone on any roadway carrying traffic during non-working hours except at locations and periods of time approved by the engineer.

Obtain prior approval from the engineer for the location of egress and ingress for construction vehicles to prosecute the work.

The contractor shall conduct a traffic control meeting with the engineer and the City of Madison Traffic engineer prior to the following events. Notification must be given to the engineer 7 business days in advance.

-Initial Traffic Control Set Up

-Each Station Construction

-Closure, Re-Striping, and Opening of Traffic

Removals or covering of conflicting pavement marking and signs shall be performed at no cost to the City, unless specified in the plans.

Traffic Control Changes

Submit any traffic control change request to the engineer at least 72 hours prior to an actual traffic control change. A request does not constitute approval.

Local Street Work Restrictions

Existing trees, street light poles, hydrants and other utility poles are to remain in place during construction unless otherwise noted in the plan. Conduct an on-site visit prior to bidding to determine any special measures required for proper clearance between the trees, hydrants and poles and the paving equipment. Any existing trees within the limits of construction to remain shall be protected according to City of Madison standard specification 107.13.

Maintenance of Access

Contractor shall maintain or provide pedestrian access to adjacent properties, businesses, and bus stops throughout the duration of construction.

The contractor shall allow emergency vehicles access throughout the construction zones at all times.

Pedestrian Movements

The contractor shall conduct operations in a manner that will minimize interference to pedestrian and bicycle movements adjacent to the work site and pedestrian access within the project limits.

The contractor shall always provide and maintain pedestrian walkways within the project limits that provide the following pedestrian movements:

Pedestrian walkways shall be surfaced of existing concrete, asphalt, or temporary pavement and be maintained ADA accessible, and free from mud, sand, and construction debris. Sections of the walkways that are disturbed or removed during construction shall be repaired with temporary pavement or other engineer approved material prior to reopening. Walkway sections shall not be closed overnight. The contractor shall provide temporary pedestrian accommodations for pedestrian paths when not actively working within the existing pedestrian zone. Temporary pedestrian barricades or other engineer approved method shall be installed to guide pedestrian walkways; traffic control barrels shall not be used for pedestrian corridors.

Pedestrian walkways shall have a minimum clear width of 5-feet.

Utility Construction

The contractor shall complete the utility work in a manner that will minimize lane closure durations due to utility work. When not actively working on utilities within the clear zone of traffic along Northport Drive, the excavation trenches shall be backfilled or covered with temporary steel plates.

Adjacent Streets

The contractor shall always conduct their operations in a manner that will cause a minimum of inconvenience to the free flow of vehicle, bicycle, and pedestrian traffic on all adjacent streets. Temporary lane closures and/or halting of traffic within open roadways for delivery of materials or equipment shall require flaggers. All traffic control items and flaggers for any temporary lane closure for delivery of materials shall be included in the bid item “Traffic Control”, under this contract. The materials and equipment used by the contractor shall remain within the boundaries of the project and traffic control limits as approved by the engineer.

Roadway and sidewalk signing shall be in place as detailed on the plans and special provisions and in conformance with the Manual on Uniform Traffic Control Devices (MUTCD), latest edition. Conflicting

signs shall either be covered or removed by the contractor after coordination with the City of Madison Traffic Engineering Division as necessary to avoid confusion. A two-week notice is required to Chad Veinot, 608-267-1960, cveinot@cityofmadison.com to cover or remove traffic signs.

The contractor shall use only City of Madison designated truck routes for material haul roads as detailed in WisDOT standard spec section 618.

Coordination

The contractor shall notify the engineer and the following agencies 48 hours in advance of any changes to traffic operations or closures of streets. Notifications must be given by 4:00 p.m. on Thursday for any such work to be done on the following Monday.

Contacts include:

- City of Madison Traffic Engineering – Chad Veinot, 608-267-1960, cveinot@cityofmadison.com

  Tom Mohr, 608-267-8725, tmohr@cityofmadison.com

- City of Madison Streets Division – Charlie Romines, 608-266-4680, cromines@cityofmadison.com

- City of Madison Metro Transit – Mike Cechvala, 608-261-9283, MCechvala@cityofmadison.com

The contractor shall notify the engineer and the following agencies 48 hours in advance of any changes to traffic operations or closures of streets when construction activities are to take place at or immediately adjacent to owner's facilities. Notifications must be given by 4:00 p.m. on Thursday for any such work to be done on the following Monday

The contractor is directed to the fact that other separate contracts are, or may be, in force that intersect the construction limits of this project. The contractor shall cooperate with other contractors in the phasing and performance of this work so as not to delay, interrupt, or hinder the progress or completion of the work being performed by other contractors. No additional compensation will be allowed for compliance with the above requirements, nor for any delays or inconveniences resulting from activities of other contractors. Should a conflict arise between contractors with respect to the sequence of construction or maintenance of traffic requirements, said conflicts shall be resolved by, or at the direction of, the city traffic engineer.

Holiday and Other Work Restrictions

The work is expected to be completed in 2026. City of Madison events and other public holidays may increase both vehicular and pedestrian traffic to the project area.

The public holidays include:

2026

From noon Friday, May 22nd, 2026 to 6:00 AM Tuesday, May 26th, 2026, for Memorial Day.

From noon Friday, July 3rd, 2026 to 6:00 AM Monday, July 6th, 2026, for Independence Day;

From noon Friday, September 4th, 2026 to 6:00 AM Tuesday, September 8th, 2026, for Labor Day;

From noon Wednesday, November 25th, 2026 to 6:00 AM Monday, November 30th, 2026, for Thanksgiving.

From noon Thursday, December 24th, 2026 to 6:00 AM Monday, December 28th, 2026, for Christmas.

Traffic control and work hours may need to be modified during this time. Contractor shall comply to changes to the work zones during that time.

One lane in each direction shall always be maintained unless otherwise shown on the plans. Some work on side streets may require one direction of the traffic to be detoured. Such detours shall not be allowed for more than 7 days. All detours will need to be coordinated and approved by the City of Madison before implementation.

MEASUREMENT

The work to maintain the traffic through improvement locations for the duration of construction shall be measured as lump sum per bid contract. All work related to traffic control will be included in the pay item "Traffic Control" unless listed separately in the plans.

PAYMENT

This work will be measured and paid for at the contract unit price per lump sum. This shall include compensation for furnishing, delivering, installing, maintenance and removal of all devices and markings, and for all labor, equipment, and incidentals necessary to complete this item of work unless specified separately in the plans.

SECTION 109.2 PROSECUTION OF THE WORK

The contractor may start work as early as **June 8, 2026.** Work may only proceed after the contract is fully signed and the start work letter is received. The contractor shall notify the City Engineer of their anticipated start date a minimum of 3 weeks prior to that date.

All work to allow installation of the switchgear shall be completed by **August 6, 2026.**
All work to allow installation of the overhead pantograph pole (by others) and electrical cabinets shall be completed by **August 25, 2026.**

All work shall be completed to allow operations by **October 20, 2026.**
The contractor shall limit workdays to 7:00 a.m. to 7:00 p.m. No work shall be allowed on Sundays and holidays unless approved by the engineer.

SECTION 108.2 PERMITS

The City of Madison has obtained a City of Madison Erosion Control Permit. The Contractor shall meet the conditions of the permits by properly installing and maintaining the erosion control measures shown on the plans, specified in these Special Provisions, or as directed by the Construction Engineer or his designees. This work will be paid for under the appropriate contract bid items or, if appropriate items are not included in the contract, shall be paid for as Extra Work. A copy of the permit is available at the City of Madison, Engineering Division office.

The City's obtaining this permit is not intended to be exhaustive of all permits that may be required to be obtained by the Contractor for construction of this project. It shall be the responsibility of the Contractor to identify and obtain any other permits needed for construction.

SECTION 109.9 LIQUIDATED DAMAGES

If the contractor fails to complete the work to allow installation of the switchgear prior to 11:59 p.m., August 6, 2026, the City of Madison will assess the contractor **$2,150** in liquidated damages for each day that requirements are not met after 12:01 a.m. August 7, 2026.

If the contractor fails to complete the work to allow installation of the overhead pantograph pole and electrical cabinets prior to 11:59 p.m., August 25, 2026, the City of Madison will assess the contractor **$2,150** in liquidated damages for each day that requirements are not met after 12:01 a.m. August 26, 2026.

If the contractor fails to complete all work to allow full transit service operations, bus charging, and restroom capabilities prior to 11:59 p.m., October 20, 2026, the City of Madison will assess the contractor **$2,150** in liquidated damages for each day that requirements are not met after 12:01 a.m. October 21, 2026.

The contractor shall not restrict traffic during peak hours on streets with a functional classification of collector or arterial unless otherwise specified in the plans or approved by the engineer. The City of Madison shall assess the contractor $1,000 in liquidated damages per occurrence for working during peak hours.

SECTION 301.8(a) COLD WEATHER PROTECTION

Cold weather protection if required for bid items per the standard specs will be incidental to the bid items. No additional payment will be provided for cold weather protection.

SECTION 502.1(f) UTILITY TRENCH PATCHES

Utility trench patches to be constructed using materials and HMA pavement and crushed aggregate base course structure as shown in the plans and in accordance with spec 502.1(f).

BID ITEM 90001 COLORING CONCRETE WISDOT RED

DESCRIPTION

This work describes coloring concrete pavement as shown on the plans.

MATERIALS

Article 405.2 of the WisDOT Standard Specifications.

CONSTRUCTION METHODS

Article 405.3 of the WisDOT Standard Specifications.

METHOD OF MEASUREMENT

This work will be measured per cubic yard and per Section 405.4 of the WisDOT Standard Specifications.

PAYMENT

This work will be paid for at the contract unit price per cubic yard. This shall include compensation for developing mix designs and providing sample panels or test slabs, for furnishing pigments, for special construction procedures required under 405.3; for removing test slabs and restoring the site; and for other cost associated with coloring concrete.

BID ITEM 90002 CONCRETE CURB INTEGRAL 6-INCH

DESCRIPTION

This work describes furnishing and installing concrete curb as shown on the plans.

MATERIALS

Article 501.2 and 601.2 of the WisDOT Standard Specifications.

CONSTRUCTION METHODS

Article 601.3 of the WisDOT Standard Specifications.

METHOD OF MEASUREMENT

This work will be measured per linear foot and per Section 601.4 of the WisDOT Standard Specifications.

PAYMENT

This work will be paid for at the contract unit price per linear foot and per 601.5 of the WisDOT Standard Specifications.

BID ITEM 90003 CONCRETE GUTTER 24-INCH MODIFIED

DESCRIPTION

This work describes furnishing and installing concrete curb and gutter as shown on the plans.

MATERIALS

Article 501.2 and 601.2 of the WisDOT Standard Specifications.

CONSTRUCTION METHODS

Article 601.3 of the WisDOT Standard Specifications.

METHOD OF MEASUREMENT

This work will be measured per linear foot and per Section 601.4 of the WisDOT Standard Specifications.

PAYMENT

This work will be paid for at the contract unit price per linear foot and per 601.5 of the WisDOT Standard Specifications.

BID ITEM 90004 MOUNTABLE CURB HEAD

DESCRIPTION

This work describes furnishing and installing concrete curb and gutter as shown on the plans.

MATERIALS

Article 501.2 and 601.2 of the WisDOT Standard Specifications.

CONSTRUCTION METHODS

Article 601.3 of the WisDOT Standard Specifications.

METHOD OF MEASUREMENT

This work will be measured per linear foot and per Section 601.4 of the WisDOT Standard Specifications.

PAYMENT

This work will be paid for at the contract unit price per linear foot and per 601.5 of the WisDOT Standard Specifications.

BID ITEM 90005 CONCRETE CURB INTEGRAL 12-INCH

DESCRIPTION

This work describes furnishing and installing concrete curb as shown on the plans.

MATERIALS

Article 501.2 and 601.2 of the WisDOT Standard Specifications.

CONSTRUCTION METHODS

Article 601.3 of the WisDOT Standard Specifications.

METHOD OF MEASUREMENT

This work will be measured per linear foot and per Section 601.4 of the WisDOT Standard Specifications.

PAYMENT

This work will be paid for at the contract unit price per linear foot and per 601.5 of the WisDOT Standard Specifications. Tie bars and longitudinal bars are included in the cost of the CONCRETE CURB INTEGRAL 12-INCH.

BID ITEM 90006 POSTS TUBULAR STEEL 2X2-INCH X 14-FT AND PRECAST SIGN POST BASE

DESCRIPTION

This work describes furnishing and installing sign posts and sign post bases as shown on the plans and per City of Madison Standard Detail Drawings 6.42 and 6.43.

MATERIALS

Article 634.2 and 637.2 of the WisDOT Standard Specifications.

CONSTRUCTION METHODS

Article 634.3 and 637.3 of the WisDOT Standard Specifications.

METHOD OF MEASUREMENT

This work will be measured per each individual post assembly, including each section and base, acceptably completed.

PAYMENT

This work will be paid for at the contract unit price per each and per Section 634.5 of the WisDOT Standard Specifications.

BID ITEM 90007 **SIGNS TYPE II REFLECTIVE H**

DESCRIPTION

This work describes furnishing and installing signs as shown on the plans.

MATERIALS

Article 637.2 of the WisDOT Standard Specifications.

CONSTRUCTION METHODS

Article 637.3 of the WisDOT Standard Specifications.

METHOD OF MEASUREMENT

This work will be measured per square foot acceptably completed, measured as the area of sign face for individually mounted signs and the area of the entire base panel for multiple signs mounted as an assembly.

PAYMENT

This work will be paid for at the contract unit price per square foot and per Section 637.5 of the WisDOT Standard Specifications.

BID ITEM 90008 **REMOVING SIGNS TYPE II**

DESCRIPTION

This work describes removing existing signs as shown on the plans.

MATERIALS (VACANT)

CONSTRUCTION METHODS

Article 638.3 of the WisDOT Standard Specifications.

METHOD OF MEASUREMENT

This work will be measured as each individual sign and per Section 638.4 of the WisDOT Standard Specifications.

PAYMENT

This work will be paid for at the contract unit price per each and per Section 638.5 of the WisDOT Standard Specifications.

BID ITEM 90009 **REMOVING SMALL SIGN SUPPORTS**

DESCRIPTION

This work describes removing existing sign supports as shown on the plans.

MATERIALS (VACANT)

CONSTRUCTION METHODS

Article 638.3 of the WisDOT Standard Specifications.

METHOD OF MEASUREMENT

This work will be measured as each individual sign and per Section 638.4 of the WisDOT Standard Specifications.

PAYMENT

This work will be paid for at the contract unit price per each and per Section 638.5 of the WisDOT Standard Specifications.

BID ITEM 90010 **TEMPORARY MARKING REMOVABLE MASK OUT TAPE 6-INCH**

DESCRIPTION

This work describes furnishing and installing temporary pavement marking mask out tape as shown on the plans.

MATERIALS

Article 646.2 of the WisDOT Standard Specifications.

CONSTRUCTION METHODS

Article 643.3 of the WisDOT Standard Specifications.

METHOD OF MEASUREMENT

This work will be measured per linear foot and per Section 643.4.6 of the WisDOT Standard Specifications.

PAYMENT

This work will be paid for at the contract unit price per linear foot and per 643.5.4 of the WisDOT Standard Specifications.

BID ITEM 90011 **PAVEMENT MARKING EPOXY, WORD, BUS**

DESCRIPTION

This work describes furnishing and installing pavement markings as shown on the plans.

MATERIALS

Article 646.2 of the WisDOT Standard Specifications.

CONSTRUCTION METHODS

Article 646.3 of the WisDOT Standard Specifications.

METHOD OF MEASUREMENT

This work will be measured per each acceptably completed and per Section 646.4 of the WisDOT Standard Specifications.

PAYMENT

This work will be paid for at the contract unit price per each and per Section 646.5.1 of the WisDOT Standard Specifications.

BID ITEM 90012 **4-INCH PVC STORM SEWER PIPE**

DESCRIPTION

This work describes furnishing and installing PVC storm sewer pipe as shown in the plans.

MATERIALS

The material shall be per Section 504.2 of the Standard Specifications. The type of PVC pipe shall be the same material as the storm pipe outlet from the building.

CONSTRUCTION METHODS

Construct pipe per Section 504.3 of the Standard Specifications.

METHOD OF MEASUREMENT

This work will be measured per linear foot and per Section 504.4 of the Standard Specifications.

PAYMENT

This work will be paid for at the contract unit price per linear foot and per 504.4 of the Standard Specifications.

BID ITEM 90013 KENNEDY TERMINAL RESTROOM AND ELECTRICAL BUILDING

DESCRIPTION

This special provision describes the construction of buildings as shown in the plans. See drawings and Architectural Special Provisions. Scope includes but is not limited to, the following sections:
012500 Substitution Procedures
013100 Project Management and Coordination
013300 Submittal Procedures
014000 Quality Requirements
016000 Product Requirements
017300 Execution
017700 Closeout Procedures
031000 Concrete Forming and Accessories
032000 Concrete Reinforcing
033000 Cast-In-Place Concrete
042000 Unit Masonry
051200 Structural Steel Framing
053100 Steel Decking
061000 Rough Carpentry
061600 Sheathing
071416 Cold-Fluid Applied Waterproofing
072100 Thermal Insulation
072726 Fluid-Applied Membrane Air Barriers
075423 Thermoplastic-Polyolefin (TPO) Roofing
076200 Sheet Metal Flashing and Trim
078400 Joint Firestopping
079200 Joint Sealants
081113 Hollow Metal Doors and Frames
083113 Access Doors and Frames
087100 Door Hardware
092216 Non-Structural Metal Framing
099123 Interior Painting
099600 High-Performance Coatings
102800 Toilet, Bath, And Laundry Accessories
104416 Fire Extinguishers
230000 Mechanical and Plumbing
230514 HVAC Variable Frequency Drives
230593 HVAC Testing and Balancing
230993 Automatic Control Sequences
260500 Common Work Results for Electrical
260519 Low-Voltage Electrical Power Conductors and Cables
260523 Control-Voltage Electrical Power Cables
260526 Grounding and Bonding for Electrical Systems
260529 Hangers and Supports for Electrical Systems
260533 Raceways and Boxes for Electrical Systems
260544 Sleeves and Sleeve Seals for Electrical Raceways and Cabling
260553 Identification for Electrical Systems
260572 Overcurrent Protective Device Short-Circuit Study
260573 Overcurrent Protective Device Coordination Study

260574 Overcurrent Protective Device Arc-Flash Study
260800 Commissioning of Electrical Systems
260923 Lighting Control Devices
262200 Low-Voltage Transformers
262416 Panelboards
262726 Wiring Devices
262813 Fuses
262816 Enclosed Switches and Circuit Breakers
262913 Enclosed Controllers
264313 Surge Protection for Low-Voltage Electrical Power Circuits
265119 Led Interior Lighting
265219 Emergency and Exit Lighting
265600 Exterior Lighting
321613.19 Docking Guide Strip

MATERIALS (VACANT)

CONSTRUCTION METHODS (VACANT)

METHOD OF MEASUREMENT

The City of Madison will measure each building completed in accordance to the contract and accepted, as a single complete unit of work.

PAYMENT

This work will be paid for at the contract unit price per each.

Payment is full compensation for all materials, labor and incidentals for constructing the building, including Architectural elements, Structural elements, 800-amp Electrical system, Mechanical system, and Plumbing system in accordance with the Kennedy Terminal Restroom and Electrical Building drawings and as set forth in these specifications. Sanitary sewer, water lateral, and storm sewer included up to five feet from building exterior. Site Electrical and Electrical Service not included in payment of the Kennedy Terminal Restroom and Electrical Building bid item. Sanitary sewer, water lateral, and storm sewer outside of five feet from building exterior not included in payment of the Kennedy Terminal Restroom and Electrical Building bid item. This payment also includes all testing, verification, and functional performance demonstrations required to confirm proper operation of the Electrical, Mechanical, and Plumbing systems as specified, including coordination of all third-party testing where applicable.

BID ITEM 90014 CHARGER FOUNDATION

DESCRIPTION

This special provision describes the construction of the foundation to be used for overhead 450 kW chargers at the Kennedy Terminal as shown in the plans. See drawings and Architectural Special Provisions. Scope includes but is not limited to, the following sections:

012500 Substitution Procedures
013100 Project Management and Coordination
013300 Submittal Procedures
014000 Quality Requirements

016000 Product Requirements
017300 Execution
017700 Closeout Procedures
031000 Concrete Forming and Accessories
032000 Concrete Reinforcing
033000 Cast-In-Place Concrete

MATERIALS (VACANT)

CONSTRUCTION METHODS (VACANT)

METHOD OF MEASUREMENT

The City of Madison will measure foundation completed in accordance to the contract and accepted, as a single complete unit of work.

PAYMENT

This work will be paid for at the contract unit price per each.

Payment is full compensation for all materials, labor and incidentals for constructing the foundation, in accordance with the drawings and as set forth in these specifications.

BID ITEM 90015 ROUTE B KENNEDY SITE ELECTRICAL

DESCRIPTION

This work consists of furnishing and installing the underground site electrical, including but not limited to the power and communication feeds from the Route B Charger Building for the Bus Chargers and Power Cabinets, future BRT Station, handholes, conduit raceway and fittings, conductors and cables, trench and backfill, and circuit wiring connections in accordance with the NEC, contract drawings and specifications, and manufacturer's recommended installation requirements. Work includes all equipment, labor, and materials required for site preparation and any other incidental work relating to a finished and complete in place installation. The Bus Charging equipment, Route B Charger Building, future Platform Shelter electrical work and site Utility Electrical Service work not included in payment of the Route B Kennedy Site Electrical bid item.

Scope of work to be performed as specified herein and includes, but is not limited to, the pertinent provisions of the following sections, specific Articles in the City of Madison Standard Specifications for Public Works Construction and Architectural Special Provisions:

Part I	General Conditions
Part II	Earthwork and Miscellaneous Construction
Part VIII	Standard Detail Drawings
601	General Requirements
602	Underground Distribution Systems
606	Installation of Metered or Unmetered Electric Service
607	Electrical Utility Access Structures, Electrical Handholes and Box-outs
260500	Common Work Results for Electrical
260519	Low-Voltage Electrical Power Conductors and Cables
260523	Control-Voltage Electrical Power Cables
260526	Grounding and Bonding for Electrical Systems
260529	Hangers and Supports for Electrical Systems
260533	Raceways and Boxes for Electrical Systems
260544	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
260553	Identification for Electrical Systems

MATERIALS

Refer to material and product sections in the above specifications for requirements.

CONSTRUCTION METHODS

Refer to construction and execution sections in the above specifications for requirements.

Provide cabling, raceway, and connections to Route B Kennedy site equipment from the Electrical Building and Restroom as shown in the contract. Perform site electrical work in accordance with the above specification's execution sections, NEC requirements, and applicable local electrical codes.

METHOD OF MEASUREMENT

The City of Madison will confirm Route B Kennedy Site Electrical completed in accordance to the contract and accepted. This work will be measured and paid for at the contract unit price per lump sum.

PAYMENT

Payment is full compensation for all materials, labor and incidentals for installing the site electrical work, including but not limited to the site Overhead Bus Charger electrical feed and connections, handholes, raceway, conductors and cables, circuit wiring connections, and fittings in accordance with the drawings and as set forth in this Special Provision for a finished and complete installation. The Bus Charging equipment, Route B Charger building electrical work, future Platform Shelter electrical work, and Utility Electrical Service not included in payment of the Route B Kennedy Site Electrical bid item.

BID ITEM 90016 ROUTE B KENNEDY ELECTRICAL SERVICE

DESCRIPTIONThis work consists of furnishing and installing the site utility power service with the amperage capacity as shown on the plans, including but not limited to meter socket, free-standing CT metering cabinet and concrete foundation pad, conduit raceway and fittings, conductors and secondary cables, grounding electrodes, trench and backfill, and cable connections in accordance with the NEC, contract drawings and City of Madison Standard Specifications, and local utility installation requirements. Work includes all equipment, labor, and materials required for site preparation and any other incidental work relating to a finished and complete in place installation. Include any charges by the local utility

company for permanent service. Payments made to the local utility for power service to be reimbursed for the actual costs incurred.

Scope of work to be performed as specified herein and includes, but is not limited to, the pertinent provisions of the following sections, specific Articles in the City of Madison Standard Specifications for Public Works Construction and Architectural Special Provisions:

Part I	General Conditions
Part II	Earthwork and Miscellaneous Construction
Part VIII	Standard Detail Drawings
601	General Requirements
602	Underground Distribution Systems
606	Installation of Metered or Unmetered Electric Service
607	Electrical Utility Access Structures, Electrical Handholes and Box-outs
033000	Cast-In-Place Concrete
260500	Common Work Results for Electrical
260519	Low-Voltage Electrical Power Conductors and Cables
260523	Control-Voltage Electrical Power Cables
260526	Grounding and Bonding for Electrical Systems
260529	Hangers and Supports for Electrical Systems
260533	Raceways and Boxes for Electrical Systems
260544	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
260553	Identification for Electrical Systems

MATERIALS

Furnish an approved electrical service with an amperage capacity as shown on the plans having a meter socket, free-standing CT metering cabinet and concrete foundation pad, grounding electrodes and connections, conduit and fittings, conduit supports, secondary service conductors, handholes, and necessary equipment required by the WSEC and the utility (MG&E) for a underground service connection. Furnish a utility approved CT metering cabinet with meter socket and equipment foundation pad. The meter socket and CT cabinet shall include all equipment requirements as shown in the MG&E Electrical Contractors' Handbook for service termination in a single-metered commercial customer. Install an approved meter seal after the meter socket is energized. Meter furnished by the utility.

CONSTRUCTION METHODS

Contractor to contact MG&E to arrange for site electrical service. Submit power application for Route B Charger building according to the power requirements as shown in the plans. Coordination with MG&E has been completed through the design phase to identify MG&E's preferred locations for the meter socket, CT cabinets, service size, and source of power. Provide cabling, raceway, system grounding and connections to provide an AC power service to the Route B Charger building main distribution panel from the service bus located within the CT cabinet. Mount utility approved meter socket to exterior of free-standing CT cabinet as shown on the plans. Perform electrical service work in accordance with the local utility requirements, NEC, and applicable local electrical codes.

New electrical construction generally takes 10-weeks to 12-weeks, which generally begins 3-weeks after all required documents obtain approval by MG&E. Submit applications as soon as possible to assure electrical service is installed, inspected, and ready for turn-on at the required date. Contact utility for service questions and requirements.

Madison Gas and Electric Company (MGE).

Contact:	Mark Gauger
Phone:	608-252-1570
Email:	mgauger@mge.com

METHOD OF MEASUREMENT

The City of Madison will confirm Electrical Service completed in accordance to the contract and accepted. This work will be measured and paid for at the contract unit price per lump sum.

PAYMENT

Payment is full compensation for all materials, labor and incidentals for installing the Electrical Service, including but not limited to, the meter socket, CT metering cabinet, conduit raceway and fittings, conduit supports, secondary service cables, equipment foundation pad, handholes, conductors and cables, grounding electrodes, connections, trench and backfill in accordance with the drawings, local utility requirements, and as set forth in this Special Provision for a finished and complete installation. Include charges by local utility company for permanent service as needed.

BID ITEM 90017 DOCKING GUIDE STRIP

DESCRIPTION

This special provision describes furnishing and installing a docking guide strip onto the station platform as indicated in the plans. See drawings and Architectural Special Provisions. Scope includes but is not limited to, the following sections:

012500 Substitution Procedures
013100 Project Management and Coordination
013300 Submittal Procedures
014000 Quality Requirements
016000 Product Requirements
017300 Execution
017700 Closeout Procedures
321613.19 Docking Guide Strip

MATERIALS (VACANT)

CONSTRUCTION METHODS

Location and limits of docking guide strip installation to be approved by the engineer.

METHOD OF MEASUREMENT

The City of Madison will measure docking guide strip by the linear foot, acceptably completed.

PAYMENT

This work will be paid for at the contract unit price per linear foot.

Payment is full compensation for procurement and installation of docking guide strip, backer boards and anchorage as set forth in these specifications.

BID ITEM 90018 **PREFABRICATED SHELTER**

DESCRIPTION

This special provision describes furnishing and installing a fully functioning customizable, American made outdoor shelter.

MATERIALS

Furnish all prefabricated shelter components—including structural posts, roof panels, wall panels, fasteners, brackets, glazing materials, and all incidental items required to complete the shelter installation. Obtain approval from the engineer prior to furnishing any components. Submission of a submittal does not constitute approval.

Aluminum structure with straight I beams:

- Rear wall, open front, side walls
- Powder coat finish (RAL TBD)
- Three way split wall glazing:
- White acrylic upper and lower panels
- Clear tempered safety glass center panel with polished edges
- Stainless steel glass clamps
- Sloped flat roof with welded double blade rafters
- 16 mm structured polycarbonate roof glazing
- Shelter size: 8 ft long (two 4-ft segments)
- Location: Between bus front and middle doors; behind charger; open toward street
- Pedestrian circulation: Maintain ADA paths around shelter; allow movement between shelter and charger
- Concrete requirements: Minimum 6-inch slab, continuous paving around shelter
- Grading: Adjust to provide level pad and ADA slopes
- Foundation: Bolt-down, no special foundation required

CONSTRUCTION METHODS

As applicable, install per manufacturer's instructions.

Examination

A. Verify field conditions and foundation readiness before installation.
B. Notify Engineer of any conditions detrimental to proper installation.

Installation

Install shelter components in strict accordance with manufacturer's instructions and approved shop drawings. Confirm all edges, joints, caps, and panel connections are secure and properly sealed.

Coordinate installation of lighting, solar panels, and routing of concealed wiring where applicable. Clean exposed surfaces of debris and construction residue and protect finished components from damage until final acceptance.

METHOD OF MEASUREMENT

The City of Madison will measure each prefabricated shelter completed in accordance to the contract and accepted, as a single complete unit of work.

PAYMENT

This work will be paid for at the contract unit price per each.

Payment is full compensation for the prefabricated shelter shall be made at the contract unit price for a complete shelter installation, which price shall include furnishing all materials, components, hardware, finishes, labor, equipment, and incidentals necessary to provide a fully installed and functional shelter as specified.

BID ITEM 90019 KENNEDY TERMINAL FENCING

DESCRIPTION

This special provision describes furnishing and installing a fully functioning fence, including all work, materials, labor, equipment, and supervision necessary, matching the style and dimensions including height and picket interspace of the existing fence at the Kennedy Terminal building.

MATERIALS

Furnish all fence components including posts, post caps, rails, fasteners, brackets, rails, pickets, and all incidental items required to complete a fence installation. Receive approval from the engineer prior to furnishing. A submittal does not constitute approval.

The top of the pickets are to be flat, with caps.

Fence Components

- Pickets: 1.00" square, 16 G.A.
- Rails: 1.75" square, 14 G.A.
- Tubing fence pickets, rails, and posts shall be manufactured from coil steel with a yield strength of 50,000 psi.
- Steel shall be pregalvanized to meet ASTM A 653/A653M-22 with a minimum zinc coating weight of .90 oz/sq. ft. (G-90), hot-dip galvanized.
- Fence pickets: 1" square x 16 G.A. tubing.
- Rails: 1.75" square, 14 G.A.
- Post spacing: 8' on center nominal with 2 1/2" square posts.
- Rubber grommets to seal all picket-to-rail intersections.
- Picket holes in rails spaced 4.98" on center.
- Picket retaining rods: 0.125" diameter galvanized steel.
- Coating: Thermoset polyester, capable of withstanding 500 hours of salt spray testing to ASTM B117 without creep.

Picket Interspaces

Standard 4".

Fence Height

6'-0" including a 4" clearance between the bottom of the pickets and the soil.

Fence Posts

2 1/2" square, 12 G.A., minimum 8'-6" long.

Color

Black for pickets, rails, metal posts, and hardware.

Conform to ASTM A 653/A653M-22 – Steel Sheet Zinc Coated (Galvanized by the Hot Dip Process) and ASTM B117 – Salt Spray Testing.

The fencing contractor shall determine the exact dimensions for length of fencing under this contract.

Fabrication

- Pre-cut pickets, rails, and posts to specified lengths.
- Pre-punch and pre-drill rails.
- Insert grommets into rail holes; insert pickets through grommets.
- Insert retaining rods into rails through picket holes.
- Cap posts.
- Panels must support a 600 lb load at midspan without permanent deformation.

Concrete

Conform to section 501 of the WisDOT Standard Specifications for concrete, except the engineer may waive the requirements for proportioning by weight, and may allow alternate mixers or mixing methods.

CONSTRUCTION METHODS

As applicable, install per manufacturer's instructions.

Construct concrete footings as shown in the plans. Locate the concrete footing to allow centering of the posts. Excavate holes in firm ground for the footings to the neat dimensions and place concrete directly in the excavation. Remove rock or other obstructions encountered in the excavation to the required depth. If unstable soils or other areas prevent making footing excavation to neat dimensions, use forms. Keep the form in place until the concrete cures for at least 24 hours. After removing the form, backfill the footing with suitable material. Ensure the backfill material has the correct moisture content for compacting and place and compact in layers.

Set fence posts in concrete footings as shown in the plans.

Insert rail ends into horizontal rails and fasten in place to the posts using panel brackets and bolt-on hardware supplied by the manufacturer.

Attach ends of fence to existing or proposed pilasters using panel brackets and bolt-on hardware supplied by the manufacturer.

METHOD OF MEASUREMENT

The City of Madison will measure Kennedy Terminal building Fencing by the linear foot, acceptably completed, measured from edge to edge of existing or proposed pilaster at ends of fence.

BASIS OF PAYMENT

Payment is full compensation for furnishing and installing the fencing including excavation, base course, concrete footings, posts, post caps, rails, fasteners, brackets, backfill, and all incidentals necessary to complete the work.

BID ITEM 90020 KENNEDY TERMINAL BOLLARDS

DESCRIPTION

This special provision describes furnishing and installing a fully functioning pipe bollard, including all work, materials, labor, equipment, and supervision necessary. Install bollards at locations shown on the plans. Work includes excavation, concrete footing, embedded reinforcement, galvanized pipe, concrete fill, surface treatments, and restoration of adjacent surfaces.

MATERIALS

Provide all materials necessary to complete a pipe bollard installation, including galvanized steel pipe, concrete, reinforcement, coatings, and incidental items. Engineer approval is required before furnishing materials; submittal does not constitute approval.

Pipe Bollard Components

- Steel Pipe: 6" diameter standard galvanized steel pipe, filled with concrete.
- Galvanization: Conform to ASTM A123 for pipe galvanizing.
- Cap: Concrete cap shaped as shown in the plan detail.
- Concrete Fill: Conform to WisDOT Standard Specifications Section 501 for concrete.
- Coating: Apply two coats of safety paint to match adjacent fence paint unless noted otherwise.

Reinforcement

- (2) #4 circular ties placed as shown in the plans.

Footing

- Concrete footing constructed with neat excavation or forms.
- Minimum footing depth: 4'-0" below finished grade.

- Minimum diameter: 1'-6" (or per plan).
- Concrete: Conform to Section 501 of WisDOT Standard Specifications.

Paving Interface

- Provide sloped concrete base at surface transition per details.
- Restore all paving disturbed during installation.

Fabrication

- Cut pipe to required length to achieve 4'-0" above finished grade.
- Install reinforcement ties inside footing area.
- Fill pipe with concrete after setting.
- Form and finish concrete cap.
- Apply required safety coating after installation and curing.

CONSTRUCTION METHODS

Install bollards per manufacturer's recommendations and plan details.

Excavate holes to required neat dimensions. Remove rock and other obstructions to achieve full depth. If unstable soils prevent neat excavation, use forms. Place concrete directly into the excavation or formwork.

Center the bollard within the footing. Confirm bollard is plumb during concrete placement and curing.

Allow concrete to cure for a minimum of 24 hours before placing final coatings or backfill. Backfill with suitable material, placed and compacted in layers with appropriate moisture content.

Restore adjacent paving or concrete base to match existing conditions.

METHOD OF MEASUREMENT

The City will measure pipe bollards per each individually, acceptably completed and installed in accordance with the plans and this special provision.

BASIS OF PAYMENT

Payment is full compensation for furnishing and installing pipe bollards, including excavation, concrete footing, reinforcing ties, galvanized pipe, concrete fill, caps, coatings, backfill, surface restoration, and all incidental items necessary to complete the installation.

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Fadi El Musa Gonzalez, P.E.
Andrew J. Zwieg, P.E.

Financial Manager
Steven B. Danner-Rivers

April 17, 2026

NOTICE OF ADDENDUM
ADDENDUM 1
CONTRACT NO. 9766
METRO TRANSIT KENNEDY ROAD ON-ROUTE BUS CHARGER – 2026

Revise and amend the contract document(s) for the above project as stated in this addendum, otherwise, the original document shall remain in effect.

Summary of modifications includes:

- Inclusion of architectural special provision
- Enhanced information per contractor requests

PROPOSAL:

ADD: SECTION 105.1 AUTHORITY OF THE ENGINEER AFTER SECTION 104.6 DECREASED AND DELETED ITEMS

City of Madison Building Inspection may act as a duly authorized representative of the Engineer on this contract, and they will have the right to inspect any elements of the work as may be deemed necessary by the Engineer.

ADD: SECTION 105.5 INSPECTION OF WORK AFTER SECTION 105.1 AUTHORITY OF THE ENGINEER

The Contractor shall coordinate with the Engineer and City Building Inspection a minimum of 7 days in advance of starting the work and provide a schedule to all City representatives at that time. A plan will then be developed by the City containing an inspection schedule and primary contacts for completing this inspection.

APPEND THE FOLLOWING TO *SECTION D: SPECIAL PROVISIONS*:

ARCHITECTURAL SPECIAL PROVISIONS

City of Madison

Kennedy Terminal

Final PS&E

ISSUE DATE:
February 24, 2026

ARCHITECTURAL SPECIAL PROVISIONS, TABLE OF CONTENTS

DIVISION 09 – FINISHES

DIVISION 10 – SPECIALTIES

DIVISIONS 11 – 22

Not Applicable

DIVISION 23 – HEATING, VENTIALATING, AND AIR CONDITIONING

DIVISIONS 24 – 25

Not Applicable

DIVISION 26 – ELECTRICAL

DIVISION 32

END TABLE OF CONTENTS

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:
1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.2 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents.
1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required to meet other Project requirements but may offer advantage to Contractor or Owner.

1.3 ACTION SUBMITTALS

A. Substitution Requests: Submit documentation identifying product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Substitution Request Form: Use form that is part of web-based Project management software or acceptable to Architect.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.

f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within five days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 10 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
   b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.4 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.5 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.6 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
   1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect

will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
b. Substitution request is fully documented and properly submitted.
c. Requested substitution will not adversely affect Contractor's construction schedule.
d. Requested substitution has received necessary approvals of authorities having jurisdiction.
e. Requested substitution is compatible with other portions of the Work.
f. Requested substitution has been coordinated with other portions of the Work.
g. Requested substitution provides specified warranty.
h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
b. Requested substitution does not require extensive revisions to the Contract Documents.
c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
d. Substitution request is fully documented and properly submitted.
e. Requested substitution will not adversely affect Contractor's construction schedule.
f. Requested substitution has received necessary approvals of authorities having jurisdiction.
g. Requested substitution is compatible with other portions of the Work.
h. Requested substitution has been coordinated with other portions of the Work.
i. Requested substitution provides specified warranty.
j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
   1. General coordination procedures.
   2. Coordination drawings.
   3. RFIs.
   4. Digital project management procedures.
   5. Web-based Project management software package.
   6. Project meetings.

B. Related Requirements:
   1. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
   2. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.

1.2 DEFINITIONS

A. RFI: Request for Information. Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.3 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
   1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, cellular telephone numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1.4 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

1.5 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
2. Owner name.
3. Owner's Project number.
4. Name of Architect.
5. Architect's Project number.
6. Date.
7. Name of Contractor.
8. RFI number, numbered sequentially.
9. RFI subject.
10. Specification Section number and title and related paragraphs, as appropriate.
11. Drawing number and detail references, as appropriate.
12. Field dimensions and conditions, as appropriate.
13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
14. Contractor's signature.

15. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.
1. Attachments shall be electronic files in PDF format.

D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow four days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
a. Requests for approval of submittals.
b. Requests for approval of substitutions.
c. Requests for approval of Contractor's means and methods.
d. Requests for coordination information already indicated in the Contract Documents.
e. Requests for adjustments in the Contract Time or the Contract Sum.
f. Requests for interpretation of Architect's actions on submittals.
g. Incomplete RFIs or inaccurately prepared RFIs.
2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Software log with not less than the following:
1. Project name.
2. Name and address of Contractor.
3. Name and address of Architect.
4. RFI number, including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date Architect's response was received.
8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within three days if Contractor disagrees with response.

1.6 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Web-Based Project Management Software Package: Provide, administer, and use web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion.
1. Web-based Project management software includes, at a minimum, the following features:
a. Compilation of Project data, including Contractor, subcontractors, Architect, Architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.

b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
c. Document workflow planning, allowing customization of workflow between project entities.
d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
e. Track status of each Project communication in real time, and log time and date when responses are provided.
f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
g. Processing and tracking of payment applications.
h. Processing and tracking of contract modifications.
i. Creating and distributing meeting minutes.
j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
k. Management of construction progress photographs.
l. Mobile device compatibility, including smartphones and tablets.

2. Provide up to seven Project management software user licenses for use of Owner, Architect, and Architect's consultants.
3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.

B. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:
1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.7 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times a minimum of four days prior to meeting. Provide meeting location or virtual meeting weblinks.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Progress Meetings: Conduct progress meetings at weekly intervals.
1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these

meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
   a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
      1) Review schedule for next period.
   b. Review present and future needs of each entity present, including the following:
      1) Interface requirements.
      2) Sequence of operations.
      3) Status of submittals.
      4) Deliveries.
      5) Off-site fabrication.
      6) Access.
      7) Site use.
      8) Temporary facilities and controls.
      9) Progress cleaning.
      10) Quality and work standards.
      11) Status of correction of deficient items.
      12) Field observations.
      13) Status of RFIs.
      14) Status of Proposal Requests.
      15) Pending changes.
      16) Status of Change Orders.
      17) Pending claims and disputes.
      18) Documentation of information for payment requests.
3. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
   a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Submittal schedule requirements.
   2. Administrative and procedural requirements for submittals.

B. Related Requirements:
   1. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
   2. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.3 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.
   1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
   2. Initial Submittal Schedule: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
   3. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.
      a. Submit revised submittal schedule as required to reflect changes in current status and timing for submittals.
   4. Format: Arrange the following information in a tabular format:
      a. Scheduled date for first submittal.

b. Specification Section number and title.
c. Submittal Category: Action; informational.
d. Name of subcontractor.
e. Description of the Work covered.
f. Scheduled date for Architect's final release or approval.
g. Scheduled dates for purchasing.
h. Scheduled date of fabrication.
i. Scheduled dates for installation.
j. Activity or event number.

1.4 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:
1. Project name.
2. Date.
3. Name of Architect.
4. Name of Contractor.
5. Name of firm or entity that prepared submittal.
6. Names of subcontractor, manufacturer, and supplier.
7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
8. Category and type of submittal.
9. Submittal purpose and description.
10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
11. Drawing number and detail references, as appropriate.
12. Indication of full or partial submittal.
13. Location(s) where product is to be installed, as appropriate.
14. Other necessary identification.
15. Remarks.
16. Signature of transmitter.

B. Options: Identify options requiring selection by Architect.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. Paper Submittals:
1. Paper Submittals are permitted for physical samples only.
2. Place a permanent label or title block on each submittal item for identification; include name of firm or entity that prepared submittal.
3. Provide a space approximately 6 by 8 inches (150 by 200 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
4. Action Submittals: Submit three paper copies of each submittal unless otherwise indicated. Architect will return two copies.

5. Transmittal for Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using transmittal form as approved by Architect.

E. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

F. Submittals Utilizing Web-Based Project Software: Prepare submittals as PDF files or other format indicated by Project management software.

1.5 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.
a. If web-based project management software is not used:
b. Email: Prepare submittals as PDF package and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect. Architect will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
2. Paper: Prepare submittals in paper form and deliver to Architect.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.

a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 10 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 15 days for review of each resubmittal.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
   1. Note date and content of previous submittal.
   2. Note date and content of revision in label or title block, and clearly indicate extent of revision.
   3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

1.6 SUBMITTAL REQUIREMENTS

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
   1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
   2. Mark each copy of each submittal to show which products and options are applicable.
   3. Include the following information, as applicable:
      a. Manufacturer's catalog cuts.
      b. Manufacturer's product specifications.
      c. Standard color charts.
      d. Statement of compliance with specified referenced standards.
      e. Testing by recognized testing agency.
      f. Application of testing agency labels and seals.
      g. Notation of coordination requirements.
      h. Availability and delivery time information.
   4. For equipment, include the following in addition to the above, as applicable:
      a. Wiring diagrams that show factory-installed wiring.
      b. Printed performance curves.
      c. Operational range diagrams.
      d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
   5. Submit Product Data before Shop Drawings, and before or concurrently with Samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
   1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
      a. Identification of products.
      b. Schedules.
      c. Compliance with specified standards.
      d. Notation of coordination requirements.
      e. Notation of dimensions established by field measurement.
      f. Relationship and attachment to adjoining construction clearly indicated.
      g. Seal and signature of professional engineer if specified.

C. Samples: Submit Samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.
   1. Transmit Samples that contain multiple, related components, such as accessories together in one submittal package.
   2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
      a. Project name and submittal number.
      b. Generic description of Sample.
      c. Product name and name of manufacturer.
      d. Sample source.
      e. Number and title of applicable Specification Section.
      f. Specification paragraph number and generic name of each item.
   3. Samples shall be submitted in both digitally and physical submittals as follows:
      a. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics and identification information for record.
      b. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
      c. Paper Transmittal: Include paper transmittal, including complete submittal information indicated.
   4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
      a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
      b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
   5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units, showing the full range of colors, textures, and patterns available.
      a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
   6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
      a. Number of Samples: Submit three sets of Samples. Architect will retain one Sample sets; remainder will be returned.
         1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
         2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
   1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
   2. Manufacturer and product name, and model number if applicable.
   3. Number and name of room or space.
   4. Location within room or space.

E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

G. Certificates:
   1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
   2. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
   3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
   4. Material Certificates: Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
   5. Product Certificates: Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.
   6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:
   1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
   2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
   3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
   4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed

before installation of product, for compliance with performance requirements in the Contract Documents.

5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
   a. Name of evaluation organization.
   b. Date of evaluation.
   c. Time period when report is in effect.
   d. Product and manufacturers' names.
   e. Description of product.
   f. Test procedures and results.
   g. Limitations of use.

1.7 DELEGATED DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
   1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.8 CONTRACTOR'S REVIEW

A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp or indication in web-based Project management software. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
   1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ARCHITECT'S REVIEW

A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required.
   1. Digital Submittals: Architect will indicate, via markup on each submittal, the appropriate action, as follows:
      a. Conforms As Is: Where submittals are marked "Conforms As Is," that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
      b. Conforms As Noted: When submittals are marked "Confirms As Noted," that part of the Work covered by the submittal may proceed provided it complies with both the Architect's notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
      c. When submittal is marked "Does Not Conform;" or "Revise and Resubmit," do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise and prepare a new submittal in accordance with the Architect's notations; resubmit without delay. Repeat if necessary to obtain a different action mark. Do not permit submittals marked as indicated above to be used at the Project site, or elsewhere where construction is in progress.
   2. Paper Submittals: Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:
      a. Conforms As Is: Where submittals are marked "Conforms As Is," that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
      b. Conforms As Noted: When submittals are marked "Confirms As Noted," that part of the Work covered by the submittal may proceed provided it complies with both the Architect's notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
      c. When submittal is marked "Does Not Conform;" or "Revise and Resubmit," do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise and prepare a new submittal in accordance with the Architect's notations; resubmit without delay. Repeat if necessary to obtain a different action mark. Do not permit submittals marked as indicated above to be used at the Project site, or elsewhere where construction is in progress.

B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Architect will discard submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
   2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
   3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.2 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
   1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.

E. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency

qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).

G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."

H. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

I. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

1.3 DELEGATED DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.4 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Contractor's quality-control personnel.

B. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

C. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

E. Reports: Prepare and submit certified written reports and documents as specified.

F. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.6 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
   1. Name, address, telephone number, and email address of technical representative making report.
   2. Statement on condition of substrates and their acceptability for installation of product.
   3. Statement that products at Project site comply with requirements.
   4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
   5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
   6. Statement of whether conditions, products, and installation will affect warranty.
   7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
   1. Name, address, telephone number, and email address of factory-authorized service representative making report.
   2. Statement that equipment complies with requirements.
   3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
   4. Statement of whether conditions, products, and installation will affect warranty.
   5. Other required items indicated in individual Specification Sections.

1.7 QUALITY ASSURANCE

A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
   1. Requirements of authorities having jurisdiction supersede requirements for specialists.

G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following Contractor's responsibilities, including the following:
   1. Provide test specimens representative of proposed products and construction.
   2. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
   3. Provide sizes and configurations of test assemblies to adequately demonstrate capability of products to comply with performance requirements.
   4. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.

1.8 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
   1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
   2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
   1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.

2. Engage a qualified testing agency to perform quality-control services.
   a. Contractor will not employ same entity engaged by Owner, unless agreed to in writing by Owner.
3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.

6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.
1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
2. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's and authorities' having jurisdiction reference during normal working hours.
1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
   1. Construction layout.
   2. Installation of the Work.
   3. Cutting and patching.
   4. Progress cleaning.
   5. Starting and adjusting.
   6. Protection of installed construction.
   7. Correction of the Work.

1.2 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.3 QUALITY ASSURANCE

A. Professional Engineer Qualifications: Refer to Section 014000 "Quality Requirements."

B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
   1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
   2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
   3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
   4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction 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.

C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to 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 provide a match acceptable to Architect for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.

C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
   1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
   1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
   2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
   1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.

2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
2. List of detrimental conditions, including substrates.
3. List of unacceptable installation tolerances.
4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect in accordance with requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Architect promptly.

B. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

C. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

D. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 INSTALLATION

A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
   1. Make vertical work plumb, and make horizontal work level.
   2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
   3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.

F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.

G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Architect. Fit exposed connections together to form hairline joints.

3.5 CUTTING AND PATCHING

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

C. Protection: Protect in-place construction 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.

D. 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 neatly to minimum 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 and 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 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.

E. 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 practicable, as judged by Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.
   1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
   2. Exposed Finishes: 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.
      a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
      b. Restore damaged pipe covering to its original condition.

F. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.6 PROGRESS CLEANING

A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
   1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
   2. Remove waste materials at the end of each day.
   3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
      a. Use containers intended for holding waste materials of type to be stored.
   4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with City's waste disposal requirements.

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.8 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.

C. Comply with manufacturer's written instructions for temperature and relative humidity.

3.9 CORRECTION OF THE WORK

A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.
   1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.

C. Restore permanent facilities used during construction to their specified condition.

D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
   1. Substantial Completion procedures.
   2. Final completion procedures.
   3. Warranties.
   4. Final cleaning.

1.2 DEFINITIONS

A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for the Architect's use prior to Architect's inspection, to determine if the Work is substantially complete.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cleaning agent.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items required by other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
   1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   2. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   3. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.
      a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Architect's signature for receipt of submittals.
   4. Submit testing, adjusting, and balancing records.
   5. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
   1. Complete startup and testing of systems and equipment.
   2. Perform preventive maintenance on equipment used prior to Substantial Completion.
   3. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
   4. Terminate and remove temporary facilities from Project site, along with construction tools and similar elements.
   5. Complete final cleaning requirements.
   6. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
   1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Results of completed inspection will form the basis of requirements for Final Completion.

1.7 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:
   1. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

2. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
2. Include the following information at the top of each page:
   a. Project name.
   b. Date.
   c. Name of Architect.
   d. Name of Contractor.
   e. Page number.
3. Submit list of incomplete items in one of the following formats:
   a. MS Excel Electronic File: Architect will return annotated file.
   b. Web-Based Project Software Upload: Utilize software feature for creating and updating list of incomplete items (punch list).

1.9 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
1. Submit on digital media acceptable to Architect or by uploading to web-based project software site.

C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
    a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
    b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
    d. Remove tools, construction equipment, machinery, and surplus material from Project site.
    e. Remove snow and ice to provide safe access.
    f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces.
    g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    h. Clean transparent materials, including glass. Remove glazing compounds and other noticeable, vision-obscuring materials.
    i. Remove labels that are not permanent.
    j. Wipe surfaces of electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
    k. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
    l. Clean strainers.
    m. Leave Project clean and ready for occupancy.

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations required by Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 017700

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Form-facing material for cast-in-place concrete.
2. Shoring, bracing, and anchoring.

1.2 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. Form-release agent.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores 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.

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.

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 RELATED MATERIALS

A. Chamfer Strips: Wood, metal, PVC, or rubber strips, ¾-inch by ¾-inch.

B. 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.

C. 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.

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. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

D. 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.

E. Do not use rust-stained form-facing material.

F. 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.

G. 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.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

J. Form openings, chases, offsets, sinkages, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

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.

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.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.
3. Mechanical splice couplers.

B. Shop Drawings: Comply with ACI SP-66:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, and supports for concrete reinforcement.

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. 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.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615, Grade 60, deformed.

B. Epoxy-Coated Reinforcing Bars:

1. Steel Bars: ASTM A615, Grade 60, deformed bars.
2. Epoxy Coating: ASTM A775 with less than 2 percent damaged coating in each 12-inch bar length.

C. Plain-Steel Welded-Wire Reinforcement: ASTM A1064, plain, fabricated from as-drawn steel wire into flat sheets.

2.2 REINFORCEMENT ACCESSORIES

A. 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 support 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.

B. Mechanical Splice Couplers: ACI 318 Type 1, same material as reinforcing bar being spliced.

C. Steel Tie Wire: ASTM A1064, annealed steel, not less than 0.0508 inch in diameter.

2.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. 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. Stagger splices in accordance with ACI 318.
2. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.

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.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

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.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. 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.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
3. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.

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, and other pozzolans; materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 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. Curing 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. 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.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Bonding agents.
5. Adhesives.
6. Joint-filler strips.

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. Preconstruction Test Reports: For each mix design.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.6 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.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 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 single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I, gray.
2. Fly Ash: ASTM C618, Class C or F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.

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.

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.

F. Water and Water Used to Make Ice: ASTM C94/C94M, potable.

2.3 CURING MATERIALS

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, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

F. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

2.4 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.

B. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

2.5 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: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Total of Fly Ash or Other Pozzolans, and Slag Cement: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing, or plasticizing 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.

2.6 CONCRETE MIXTURES

A. Class A: Normal-weight concrete used for footings, foundation walls, and platforms.

1. Exposure Class: ACI 318 F3.
2. Minimum Compressive Strength: 4000 psi at 28 days.
3. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery.

B. Class B: Normal-weight concrete used for interior slabs-on-ground.

1. Exposure Class: ACI 318 F0.
2. Minimum Compressive Strength: 4000 psi at 28 days.
3. Air Content: Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94, 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 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.
3. Unless otherwise indicated on Drawings, locate vertical joints in walls near corners, and in concealed locations where possible.
4. Use a bonding agent 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 foundation walls 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. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement and embedded items is complete and that required inspections are completed.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. 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.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. 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. Deposit concrete to avoid segregation.
2. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
3. 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.

E. Deposit and consolidate concrete for slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete 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 bleed water appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.6 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.

B. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.7 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 bleed water 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.

D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

3.8 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.

3.9 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.
2. If forms remain during curing period, moist cure after loosening forms.
3. 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 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.

3.10 TOLERANCES

A. Conform to ACI 117.

3.11 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 more than 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 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.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will 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.
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, ASTM C39, 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 seven days and 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. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172 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:

   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 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:

   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:
   a. Cast, initial cure, and field cure four standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C39/C39M.
   a. Test one field-cured specimen 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. 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 is less than 90 percent of specified compressive strength.
8. 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.
9. 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 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.

10. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
11. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.13 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.

END OF SECTION 033000

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Concrete masonry units.
2. Face brick.
3. Stone trim units.
4. Lintels.
5. Mortar and grout materials.
6. Steel reinforcing bars.
7. Masonry joint reinforcement.
8. Ties and anchors.
9. Embedded flashing.
10. Accessories.
11. Mortar and grout mixes.

B. Products Installed but not Furnished under This Section:
1. Steel shelf angles for supporting unit masonry.
2. Cavity wall insulation.

C. Related Requirements:
1. Section 072100 "Thermal Insulation" for cavity wall insulation.

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. Stone Trim Units: Show sizes, profiles, and locations of each stone trim unit required.
3. Reinforcing Steel: Indicate bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315R. Indicate elevations of reinforced walls.
4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:
   1. Face brick, in the form of small-scale units.
   2. Colored mortar.
   3. Weep/cavity vents.

D. Samples for Verification: For each type and color of the following:
   1. Face brick.
   2. Colored mortar. Make Samples using same sand and mortar ingredients to be used on Project.
   3. Weep/cavity vents.
   4. Cavity drainage material.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type of the following:
   1. Masonry units.
      a. Include data on material properties.
      b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
      c. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
      d. For exposed brick, include test report for efflorescence according to ASTM C67.
   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. Qualification Statements: For testing agency.

C. 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.

D. 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.

E. 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.

B. Concrete masonry design must follow the recommendations of the National Concrete Masonry Association contained in the publication, TEK Manual for Concrete Masonry Design and Construction.

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 multiwythe 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. Obtain exposed masonry units and cementitious mortar components from single source.

B. 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 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
   1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 602.
   2. Determine net-area compressive strength of masonry by testing masonry prisms in accordance with ASTM C1314.

2.3 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 and will be within 20 ft. (6 m) vertically and horizontally of a walking surface.

2.4 CONCRETE MASONRY UNITS

A. 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 at door frames unless otherwise indicated.

B. CMUs: ASTM C90, normal weight.
   1. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less than nominal dimensions.

2.5 LINTELS

A. 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.

B. Offset Angle Supports: Steel plate brackets anchored to structure. Component and anchor size and spacing engineered by manufacturer.

2.6 BRICK:

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
   2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
   3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
   4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Face Brick: Facing brick complying with ASTM C216.
   1. Grade: SW
   2. Type: FBX.
   3. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3350 psi .
   4. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C67.
   5. Efflorescence: Provide brick that has been tested according to ASTM C67and is rated "not effloresced."

6. Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm) long.
7. Application: Use where brick is exposed unless otherwise indicated.
8. Color and Texture: As selected by Architect.

2.7 STONE TRIM UNITS:

A. Limestone: ASTM C568, Classification III High Density.

B. Provide stone units accurately shaped, with exposed faces dressed true, and with beds and joints at right angles to faces.
1. Comply with recommendations in ILI's "Indiana Limestone Handbook."

2.8 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. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

E. 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.

F. Aggregate for Grout: ASTM C404.

G. Water: Potable.

2.9 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M, 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: Hot-dip 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. Wire Size for Veneer Ties: 0.148-inch (3.77-mm) diameter.
6. Spacing of Cross Rods: Not more than 16 inches (406 mm) o.c.
7. Provide in lengths of not less than 10 ft. (3 m), with prefabricated corner and tee units.

2.10 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. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
2. Stainless Steel Wire: ASTM A580/A580M, Type 304.
3. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
4. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
5. Stainless Steel Bars for Stone Trim: ASTM A276 or ASTM A666, Type 304.

C. Partition Top Anchors: As indicated on Drawings.

D. Adjustable Masonry-Veneer Anchors:
1. General: Provide anchors that allow vertical adjustment but resist a 100 lbf (445 N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch (1.6 mm).
2. Fabricate wire ties from 0.187-inch- (4.76-mm-) diameter, stainless steel wire unless otherwise indicated.
3. Masonry-Veneer Anchors, Thermally-Broken Veneer tie for CMU construction: Anchors to include washer at face of insulation and air barrier, and design to decrease thermal transfer through the rigid insulation.
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Heckmann Building Products
2) Hohmann & Barnard, Inc.
3) Wire-Bond.

2.11 EMBEDDED FLASHING

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 316, 0.016 inch (0.40 mm) thick.
2. Fabricate continuous flashings in sections 96 inches (2438 mm) long minimum, but not exceeding 12 ft. (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with sawtooth ribs at 3-inch (76-mm) intervals along length of flashing to provide an integral mortar bond.
4. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
5. Solder metal items at corners.

B. Flexible Flashing: Use one of the following unless otherwise indicated:
1. Stainless Steel Fabric Flashing: Composite, flashing product consisting of 2-mil (0.05-mm) of Type 304 stainless steel sheet, bonded to a layer of polymeric fabric, to produce an overall thickness of 40-mil (1.0-mm).
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hohmann & Barnard, Inc.
      2) Wire-Bond.
2. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of 2 mil (0.05 mm) of Type 304 stainless steel sheet, bonded to a layer of polymeric fabric with a permanent, clear adhesive.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hohmann & Barnard, Inc.
      2) Wire-Bond.
   b. Applications: Use 10-mil- (0.25-mm-) thick flashing at windows, doors, and small wall penetrations; not at base of walls. Use 40-mil- (1.0-mm-) thick flashing at base of walls.
3. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 40 mil (1.0 mm).
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Advanced Building Products Inc.
      2) GCP Applied Technologies Inc.
      3) Heckmann Building Products, Inc.
      4) Hohmann & Barnard, Inc.
      5) W. R. Meadows, Inc.
      6) Wire-Bond.
   b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
4. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 40 mil (1.0 mm).
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) GCP Applied Technologies Inc.
      2) Wire-Bond.

b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

C. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

E. Termination Bars for Flexible Flashing: Stainless steel bars 1/8 inch by 1 inch (3.2 mm by 25 mm).

2.12 ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane, or PVC.

B. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

C. Weep/Cavity Vents: Use one of the following unless otherwise indicated:
1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3.2 mm) less than depth of outer wythe, in color selected from manufacturer's standard.
2. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch (3.2 mm) less than depth of outer wythe; in color selected from manufacturer's standard.

D. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Mortar Deflector: Strips, full depth of cavity and 16 inches (406 mm) high, with dovetail-shaped notches or dimpled surface that prevent clogging with mortar droppings.

E. Masonry Veneer Thermal Break: Provide cellular glass structural insulating blocks (SIB) beneath masonry veneer as shown.
1. High-compressive strength, not less than 304 psi.
2. Equal to Owens Corning FOAMGLAS PERINSUL SIB.
3. Thickness: Refer to Drawings.

F. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.13 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.
   3. Add cold-weather admixture 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.
   1. Basis-of-Design for Exterior Mortar: Westbrook Type S Mortar Premix
      a. Single component product, consisting of Type S Masonry Cement (ASTM C-91) and finely graded Mason Sand (ASTM C-144), scientifically blended to a uniform mixture. Meets and exceeds the requirements of ASTM C-387 and ASTM C-270, Type S.
      b. Colors: To be selected by Architect from manufacturer's full range.

C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
   1. For exterior masonry, use Type S.
   2. For interior nonload-bearing partitions, use 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, Table 1 or paragraph 4.2.1.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
   3. Provide grout with a slump of 8 to 11 inches (203 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. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

D. 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.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

F. F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/200 sq. cm) per minute when tested per ASTM C67. Allow units to absorb water so they are damp but not wet at time of laying.

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.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.6 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

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). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 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 bond pattern indicated on Drawings; do not use units with less-than-nominal 4-inch (102-mm) horizontal face dimensions at corners or jambs.

C. 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, and remove loose masonry units and mortar.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

E. 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.

F. Fill cores in hollow CMUs with grout 24 inches (610 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

G. Build non-load bearing interior partitions full height of story to underside of roof structure above unless otherwise indicated.
1. Install compressible filler in joint between top of partition and underside of structure above.

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 grouted masonry, including starting course on footings.
   3. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
   4. 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. Set stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
   1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
   2. Wet joint surfaces thoroughly before applying mortar.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Cut joints flush where indicated to receive waterproofing or air barriers unless otherwise indicated.

3.6 CAVITY WALLS

A. Bond wythes of cavity walls together using bonding system indicated on Drawings.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (305 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as indicated.
   1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.7 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. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.8 ANCHORING FACE BRICK:

A. Anchor face brick to CMU backup with masonry-veneer anchors to comply with the following requirements:
1. Fasten screw-attached anchors to CMU backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Embed tie sections in masonry joints.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than 16 inches (458 mm) o.c. vertically and 16 inches (610 mm) o.c. horizontally, with not less than 1 anchor for each 1.77 sq. ft. (0.2 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 8 inches (203 mm), around perimeter.

3.9 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 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.

3.10 LINTELS

A. Install steel lintels where indicated.

B. Provide masonry lintels where indicated and where openings of more than 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.

3.11 FLASHING, WEEP HOLES, AND CAVITY VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:
   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

C. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.

D. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
   1. Use specified weep/cavity vent products to form weep holes.
   2. Space weep holes 24 inches (610 mm) o.c. unless otherwise indicated.

E. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than 2 inches (51 mm), to maintain drainage.
   1. Fill cavities full height by placing pea gravel in cavities as masonry is laid, so that at any point, masonry does not extend more than 24 inches (610 mm) above top of pea gravel.

F. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Accessories" Article.

G. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.

3.12 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).

3.13 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.

B. Inspections: Special inspections in accordance with Level 2 in TMS 402.
1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.

E. Clay Masonry Unit Test: For each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.

F. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.

H. Grout Test (Compressive Strength): For each mix provided, in accordance with ASTM C1019.

3.14 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. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. 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. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
6. Where required by manufacturer. clean masonry with a proprietary acidic masonry cleaner applied according to manufacturer's written instructions.

END OF SECTION 042000

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel materials.
2. Shrinkage-resistant grout.

1.2 COORDINATION

A. 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.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Structural steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Threaded rods.
4. Forged-steel hardware.
5. 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.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Mill test reports for structural steel materials, including chemical and physical properties.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).

B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1.

1.6 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. Clean and relubricate bolts and nuts that become dry or rusty before use.
2. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125, 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.
2. ANSI/AISC 360.
3. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

2.2 STRUCTURAL STEEL MATERIALS

A. W-Shapes: ASTM A992.

B. Channels, Angles: ASTM A36.

C. Plate and Bar: ASTM A36.

D. Cold-Formed Hollow Structural Sections: ASTM A500, Grade B structural tubing.

E. Steel Pipe: ASTM A53, Type E or Type S, Grade B.

F. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength Bolts, Nuts, and Washers: ASTM F3125, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436, Type 1, hardened carbon-steel washers; all 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 carbon steel.
3. Washers: ASTM F436, Type 1, hardened carbon steel.
4. Finish: Plain.

2.5 SHRINKAGE-RESISTANT GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 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. Fabricate beams with rolling camber up.
2. Identify high-strength structural steel in accordance with ASTM A6 and maintain markings until structural steel framing has been erected.
3. Mark and match-mark materials for field assembly.

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.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. 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.

2.7 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 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of masonry bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

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. 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. Bearing Plates: Clean 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. 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.
3. 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.

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

D. 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 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.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:

1. Verify structural steel materials.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Bolted Connections: Inspect 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.

END OF SECTION 051200

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof deck.

1.2 ACTION SUBMITTALS

A. Product Data:

1. 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. Certificates:

1. Product Certificates: For each type of steel deck.

B. Test and Evaluation Reports:

1. Product Test Reports: For tests performed by a qualified testing agency, indicating that power-actuated mechanical fasteners comply with requirements.
2. Research Reports: For steel deck, from ICC-ES showing compliance with the building code.

1.4 DELIVERY, STORAGE, AND HANDLING

A. 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.

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. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:

1. Galvanized-Steel Sheet: ASTM A653, Structural Steel (SS), Grade 33 zinc coating.
2. Deck Profile: As indicated.
3. Profile Depth: As indicated.
4. Design Uncoated-Steel Thickness: As indicated.
5. Span Condition: As indicated.
6. Side Laps: Overlapped.

2.3 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.

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. End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

G. 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.

H. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch wide flanges and level recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

I. Galvanizing Repair Paint: ASTM A780.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install deck panels and accessories in accordance with SDI RD; manufacturer's written instructions; and requirements in this Section.

B. Locate deck bundles to prevent overloading of supporting members.

C. Place deck panels on supporting framing and adjust to final position with ends accurately aligned and bearing on supporting framing before being permanently fastened. Do not stretch or contract side-lap interlocks.

D. Place deck panels flat and square and fasten to supporting framing without warp or deflection.

E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

H. Locate mechanical fasteners and install in accordance with deck manufacturer's written instructions.

3.2 INSTALLATION OF ROOF DECK

A. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels as shown on Drawings.

B. End Bearing: Install deck ends over supporting framing with a minimum end bearing of 1-1/2 inches.

C. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches apart with at least one fastener at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.

D. Miscellaneous Roof Deck Accessories: Install finish strips, end closures, and reinforcing channels in accordance with deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.

E. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.

3.3 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780 and manufacturer's written instructions.

END OF SECTION 053100

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wood products.
   2. Wood-preservative-treated lumber.

B. Related Requirements:
   1. Section 061600 "Sheathing" for sheathing, subflooring, and underlayment.

1.2 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) size or greater but less than 5 inches nominal (114 mm actual) size in least dimension.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:
   1. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS

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. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
   3. Dress lumber, S4S, unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1, Use categories as follows:
   1. UC3A (Commodity Specification A): Coated sawn products in exterior construction not in contact with ground but exposed to all weather cycles including intermittent wetting. Include the following items:
      a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   2. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   3. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

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.

2.3 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   1. Blocking.
   2. Nailers.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

C. Roofing Nailers: Structural- or No. 2-grade lumber or better; kiln-dried Douglas fir, southern pine, or wood having similar decay-resistant properties.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

2.4 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 (38 mm) 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 or ASTM F2329.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.

C. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

E. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
   1. Use inorganic boron for items that are continuously protected from liquid water.
   2. Use copper naphthenate for items not continuously protected from liquid water.

G. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

H. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. Table 2304.10.1, "Fastening Schedule," in ICC's International Building Code (IBC).
   2. ICC-ES evaluation report for fastener.

I. Securely attach roofing nailers to substrates by anchoring and fastening to withstand bending, shear, or other stresses imparted by Project wind loads and fastener-resistance loads as designed in accordance with ASCE/SEI 7.

J. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILERS

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach wood roofing nailers securely to substrate to resist the designed outward and upward wind loads indicated on Drawings and in accordance with ANSI/SPRI ED-1, Tables A6 and A7.

END OF SECTION 061000

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Parapet sheathing.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. Parapet sheathing.

B. Product Data Submittals: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

C. Shop Drawings:
   1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
   2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PARAPET SHEATHING

A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Certainteed; SAINT-GOBAIN.
      b. Continental Building Products Inc.
      c. Gold Bond Building Products, LLC provided by National Gypsum Company.
      d. USG Corporation.
   2. Type and Thickness: Type X, 5/8 inch (15.9 mm) thick.

2.2 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. For parapet sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
   1. For steel framing less than 0.0329 inch (0.835 mm) thick, use screws that comply with ASTM C1002.
   2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, use screws that comply with ASTM C954.

2.3 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
   1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches (50 mm) wide, 10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m), of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. Table 2304.10.1, "Fastening Schedule," in the ICC's International Building Code.
   2. ICC-ES evaluation report for fastener.

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate parapet sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 INSTALLATION OF GYPSUM SHEATHING

A. Comply with GA-253 and with manufacturer's written instructions.
   1. Fasten gypsum sheathing to cold-formed metal framing with screws.
   2. Install panels with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
   3. Install panels with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Seal sheathing joints in accordance with sheathing manufacturer's written instructions.

END OF SECTION 061600

SECTION 071416 - COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Polyurethane waterproofing.
   2. Insulation drainage panels.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review waterproofing requirements including, but not limited to, the following:
      a. Surface preparation specified in other Sections.
      b. Minimum curing period.
      c. Forecasted weather conditions.
      d. Special details and sheet flashings.
      e. Repairs.
      f. Field quality control.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
   2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings:
   1. Indicate locations and extent of waterproofing.
   2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer.
   1. Do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.
   2. Do not apply waterproofing in snow, rain, fog or mist, or when such weather conditions are imminent during application and curing period.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.7 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain waterproofing materials from single source and from single manufacturer.

2.2 POLYURETHANE WATERPROOFING

A. Single-Component, Modified Polyurethane Waterproofing: ASTM C836/C836M and coal-tar free.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CETCO is a subsidiary of Minerals Technologies Inc.
      b. Carlisle Coatings & Waterproofing Inc.
      c. MAPEI Corporation.
      d. Master Builders Solutions.
      e. Neogard; Hempel Group.
      f. Tremco Incorporated.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials recommended in writing by waterproofing manufacturer for intended use and compatible with one another and with waterproofing.

1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Primer: Manufacturer's standard primer, sealer, or surface conditioner; factory-formulated.

C. Sheet Flashing: 50-mil- (1.3-mm-) minimum, nonstaining, uncured sheet neoprene.
1. Adhesive: Manufacturer's recommended contact adhesive.

D. Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.

E. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing; as specified in Section 079200 "Joint Sealants"; and as recommended by manufacturer for substrate andjoint conditions.
1. Backer Rod: Closed-cell polyethylene foam.

2.4 INSULATION DRAINAGE PANELS

A. Unfaced, Wall-Insulation Drainage Panels, Type IV: Extruded-polystyrene board insulation in accordance with ASTM C578, 25 psi (173 kPa) minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. DiversiFoam Products.
b. Insulfoam; Carlisle Construction Materials Company.
c. Owens Corning.
d. The Dow Chemical Company.

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 concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates in accordance with manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.
   1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate in accordance with ASTM D4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces in accordance with ASTM D4258.

E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

3.3 PREPARATION AT TERMINATIONS, PENETRATIONS, AND CORNERS

A. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners in accordance with waterproofing manufacturer's written instructions and to recommendations in ASTM C1471/C1471M.

B. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

3.4 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrate in accordance with waterproofing manufacturer's written instructions and to recommendations in ASTM C1471/C1471M. Before coating surfaces, remove dust and dirt from joints and cracks in accordance with ASTM D4258.
   1. Comply with ASTM C1193 for joint-sealant installation.
   2. Apply bond breaker on sealant surface, beneath preparation strip.
   3. Prime substrate along each side of joint and apply a single thickness of preparation strip at least 6 inches (150 mm) wide along each side of joint. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat.

B. Install sheet flashing and bond to deck and wall substrates where required in accordance with waterproofing manufacturer's written instructions.
   1. Extend sheet flashings for 4 inches (100 mm) onto perpendicular surfaces and items penetrating substrate.

3.5 INSTALLATION OF WATERPROOFING

A. Apply waterproofing in accordance with manufacturer's written instructions and to recommendations in ASTM C1471/C1471M.

B. Start installing waterproofing in presence of manufacturer's technical representative.

C. Apply primer over prepared substrate unless otherwise instructed in writing by waterproofing manufacturer.

D. Unreinforced Waterproofing Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.
   1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases and pinholes, with a dry film thickness of 90 mils (2.25 mm).
   2. Apply waterproofing to prepared wall terminations and vertical surfaces.
   3. Verify manufacturer's recommended wet film thickness of waterproofing every 100 sq. ft. (9.3 sq. m).

E. Cure waterproofing, taking care to prevent contamination and damage during application and curing.

3.6 INSTALLATION OF INSULATION DRAINAGE PANELS

A. Install drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

B. On vertical surfaces, set insulation drainage panels in adhesive or tape applied in accordance with manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components and to furnish daily reports to Architect.

B. Prepare test and inspection reports.

3.8 PROTECTION

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

END OF SECTION 071416

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cavity wall rigid insulation.
   2. Closed-cell spray polyurethane foam insulation.

B. Related Requirements:
   1. Section 071416 "Cold Fluid-Applied Waterproofing" for insulated drainage panels.
   2. Section 075423 "Thermoplastic-Polyolefin (TPO) Roofing" for insulation specified as part of roofing construction.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. Cavity wall rigid insulation.
   2. Closed-cell spray polyurethane foam 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. For spray insulation, indicate initial installed thickness, settled thickness, settled R-value, installed density, and coverage area.
   2. Sign, date, and post the certification in a conspicuous location on Project site.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Research Reports: For foam-plastic insulation, from ICC-ES.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:
   1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
   3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

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 Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

C. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

D. Thermal-Resistance Value (R-Value): R-value as indicated on Drawings in accordance with ASTM C518.

2.2 CAVITY WALL RIGID INSULATION

A. Subject to compliance with the requirements, provide one of the following rigid insulation boards in the exterior cavity wall.

B. Graphite-Polystyrene Foam-Plastic Board, Type I: ASTM C578, Type I, 10-psi (69-kPa) minimum compressive strength; 4-perm (230-ng/Pa x s x sq. m) maximum vapor permeance at 1-inch (25.4-mm) thickness per ASTM E96/E96M.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide BASF; Neopor GPS. or a comparable product by one of the following:
      a. Atlas Molded Products, a division of Atlas Roofing Corporation.
      b. Insulfoam; Carlisle Construction Materials Company.

C. Mineral-Wool Board Insulation, Types IA and IB, Unfaced: ASTM C612, Types IA and IB; passing ASTM E136 for combustion characteristics.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Johns Manville; a Berkshire Hathaway company; JM CladStone Water & Fire Block or a comparable product by one of the following:
      a. Owens Corning.
      b. ROCKWOOL.
   2. Nominal Density: 6 lb/cu. ft. (96 kg/cu. m).

2.3 CLOSED-CELL SPRAY POLYURETHANE FOAM INSULATION

A. Closed-Cell Spray Polyurethane Foam: ASTM C1029, Type II, minimum density of 2.0 lb/cu. ft. and minimum aged R-value at 1-inch (25.4-mm) thickness of 7.0 deg F x h x sq. ft./Btu at 75 deg F.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Johns Manville; a Berkshire Hathaway company; JM Corbond III or a comparable product by one of the following:
      a. Carlisle Spray Foam Insulation.
      b. Gaco; a brand of Firestone Building Products.
      c. Henry Company.

d. Master Builders Solutions.

2. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 450 or less.
3. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

B. Primer: Material recommended by insulation manufacturer where required for adhesion of insulation to substrates.

2.4 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
   1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.
   2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.

B. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

2.5 ACCESSORIES

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 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

B. Priming: Prime substrates where recommended by insulation manufacturer. Apply primer to comply with insulation manufacturer's written instructions. Confine primers to areas to be insulated; do not allow spillage or migration onto adjoining surfaces.

3.2 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.

3.3 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches (610 mm) 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 and specified in Section 042000 "Unit Masonry."

B. Mineral-Wool Board Insulation: Install insulation fasteners 4 inches (100 mm) from each corner of board insulation, at center of board, and as recommended by manufacturer.
   1. Fit courses of insulation between masonry wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
   2. Press units firmly against inside substrates.

C. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
   1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vapor permeable air barriers.

1.2 DEFINITIONS

A. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.

B. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

C. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.4 ACTION SUBMITTALS

A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; dry film thickness; and tested physical and performance properties of products.

B. Shop Drawings: For air-barrier assemblies.
   1. Show locations and extent of air-barrier materials, accessories, and assemblies specific to Project conditions.
   2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
   3. Include details of interfaces with other materials that form part of air barrier.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by Installer, who work on Project.

B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.

C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
   1. Installer to be licensed by ABAA in accordance with ABAA's Quality Assurance Program and to employ ABAA-certified installers and supervisors on Project.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove and replace liquid materials that cannot be applied within their stated shelf life.

B. Protect stored materials from direct sunlight.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.
   1. Protect substrates from environmental conditions that affect air-barrier performance.
   2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain primary air-barrier materials and air-barrier accessories from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction to be capable of performing as a continuous air barrier. Air-barrier assemblies to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, 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. (0.2 L/s x sq. m of surface area at 75 Pa), 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. (0.02 L/s x sq. m of surface area at 75 Pa) pressure difference; ASTM E2178.

D. Adhesion to Substrate: Minimum 30 lbf/sq. in. (207 kPa) when tested in accordance with ASTM D4541.

E. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

F. UV Resistance: Can be exposed to sunlight for 90 days in accordance with manufacturer's written instructions.

2.3 AIR BARRIERS, VAPOR PERMEABLE

A. Vapor-Permeable Air Barrier, Synthetic Polymer Type: Synthetic polymer membrane with an installed dry film thickness according to manufacturer's written instructions, over smooth, void-free substrates.
   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. Carlisle Coatings & Waterproofing Inc.
      b. GE Construction Sealants; Momentive Performance Materials Inc.
      c. GCP Applied Technologies Inc.
      d. Henry Company.
      e. Master Builders Solutions.
      f. PROSOCO, Inc.
      g. Soprema, Inc.
      h. Sto Corp.
      i. The Dow Chemical Company.
      j. Tremco Incorporated.

B. Vapor Permeance: Minimum 5 perms (290 ng/Pa x s x sq. m); ASTM E96/E96M, Procedure A, Desiccant Method.

2.4 ACCESSORY MATERIALS

A. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

B. Primer: Liquid primer recommended for substrate by air-barrier material manufacturer.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, 0.0187 inch (0.5 mm) thick, and Series 300 stainless steel fasteners.

D. Preformed Silicone Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.

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 substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
   2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.
   3. Verify that substrates are visibly dry and free of moisture.
   4. Verify that masonry joints are flush and completely filled with mortar.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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 grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. 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.

G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

H. Bridge 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.

3.3 INSTALLATION OF ACCESSORIES

A. Install accessory 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 (75 mm) 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, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

C. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.

D. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

E. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

F. Seal top of through-wall flashings to air barrier with an additional 6-inch- (150-mm-) wide, transition strip.

G. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

H. 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 (150 mm) beyond repaired areas in strip direction.

3.4 INSTALLATION OF PRIMARY AIR-BARRIER MATERIAL

A. Apply air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier in accordance with air-barrier manufacturer's written instructions and details. Apply air-barrier material within manufacturer's recommended application temperature ranges.
   1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
   2. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
   3. Where multiple prime coats are needed to achieve required bond, allow adequate drying time between coats.

B. Do not cover air barrier until it has been tested and inspected by testing agency.

C. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.5 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Air-barrier dry film thickness.
3. Continuous structural support of air-barrier system has been provided.
4. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
5. Site conditions for application temperature and dryness of substrates have been maintained.
6. Maximum exposure time of materials to UV deterioration has not been exceeded.
7. Surfaces have been primed, if applicable.
8. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
9. Termination mastic has been applied on cut edges.
10. Strips and transition strips have been firmly adhered to substrate.
11. Compatible materials have been used.
12. Transitions at changes in direction and structural support at gaps have been provided.
13. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
14. All penetrations have been sealed.

D. Tests: As determined by testing agency from among the following tests:
1. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate in accordance with ASTM E783 or ASTM E2357.
2. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate in accordance with ASTM D4541 for each 600 sq. ft. (56 sq. m) of installed air barrier or part thereof.

E. 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.

F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

G. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.
   1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials in accordance with air-barrier manufacturer's written instructions.
   2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

C. Remove masking materials after installation.

END OF SECTION 072726

SECTION 075423 - THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Thermoplastic polyolefin (TPO) roofing system.
2. Accessory roofing materials.
3. Substrate board.
4. Roof insulation.
5. Insulation accessories.

B. Related Requirements:
1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Roofing Conference: Conduct conference at Project site.
1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data:
   1. Thermoplastic polyolefin (TPO) roofing system.
   2. Accessory roofing materials.
   3. Substrate board.
   4. Roof insulation.
   5. Insulation accessories.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
   1. Layout and thickness of insulation.
   2. Base flashings and membrane termination details.
   3. Flashing details at penetrations.
   4. Tapered insulation layout, thickness, and slopes.
   5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
   6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. 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 compliance 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.

C. Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

D. Evaluation Reports: For components of roofing system, from ICC-ES.

E. Field Test Reports:
   1. Concrete internal relative humidity test reports.
   2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

F. Field quality-control reports.

G. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.

B. Installer Qualifications: 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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.10 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. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, substrate board, and other components of roofing system.
   2. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.
   1. Accelerated Weathering: Roof to withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
   2. Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

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.

2.2 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING SYSTEM

A. TPO Sheet: ASTM D6878/D6878M, internally fabric- or scrim-reinforced, TPO sheet.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Johns Manville; a Berkshire Hathaway company; JM TPO or a comparable product by one of the following:
      a. Firestone Building Products.
      b. GAF.
   2. Source Limitations: Obtain components for roofing system from roof membrane manufacturer or manufacturers approved by roof membrane manufacturer.
   3. Thickness: 80 mils (2.0 mm), nominal.
   4. Exposed Face Color: White.

2.3 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: Manufacturer's standard unreinforced TPO sheet flashing, 80 mils (2.0 mm) thick, minimum, of same color as TPO sheet.

C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

D. Bonding Adhesive: Manufacturer's standard.

E. Slip Sheet: Manufacturer's standard, of thickness required for application.

F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.

H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.
   1. Provide type, thickness, and brand as required by membrane manufacturer for specified warranty.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.5 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by TPO roof membrane manufacturer, approved for use in FM Approvals' RoofNav listed roof assemblies.

B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Johns Manville; a Berkshire Hathaway company; ENRGY 3 or a comparable product by one of the following:
      a. Firestone Building Products.
      b. GAF.
   2. Compressive Strength: 20 psi (138 kPa).

C. Tapered Insulation: Provide factory-tapered insulation boards.
   1. Material: Match roof insulation.
   2. Minimum Thickness: 1/4 inch (6.35 mm).
   3. Slope:
      a. Roof Field: 1/4 inch per foot (1:48) unless otherwise indicated on Drawings.
      b. Saddles and Crickets: 1/2 inch per foot (1:24) unless otherwise indicated on Drawings.

2.6 INSULATION ACCESSORIES AND COVER BOARD

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.

B. Fasteners: Factory-coated steel fasteners with 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.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate.

D. Cover Board: Provide type, thickness, and brand as required by membrane manufacturer for specified warranty.
   1. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.
   2. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.
   3. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.
   4. Surface: Primed.

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 roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
   2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.3 INSTALLATION OF ROOFING, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav listed roof 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.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches (610 mm) 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 to top flanges of steel deck according to recommendations in FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29.
   5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.
   6. Loosely lay substrate board over roof deck.

3.5 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 roof insulation manufacturer's written instructions for installing roof insulation.

3.6 INSTALLATION OF ADHERED ROOF MEMBRANE

A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.

C. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.

3.7 INSTALLATION OF BASE FLASHING

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to 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 seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.8 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.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.9 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 according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075423

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Low-slope roof sheet metal fabrications.
   2. Copings.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
   2. Section 042000 "Unit Masonry" for materials and installation of manufactured sheet metal through-wall flashing and trim integral with masonry.
   3. Section 075423 "Thermoplastic-Polyolefin (TPO) Roofing" for materials and installation of sheet metal flashing and trim integral with roofing.

1.2 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
   3. Review requirements for insurance and certificates if applicable.
   4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For sheet metal flashing and trim.
   1. Include plans, elevations, sections, and attachment details.
   2. Include identification of material, thickness, weight, and finish for each item and location in Project.
   3. Include details for forming, including profiles, shapes, seams, and dimensions.
   4. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
   5. Include details of termination points and assemblies.
   6. Include details of special conditions.

7. Include details of connections to adjoining work.
8. Detail formed flashing and trim at scale of not less than 3 inches per 12 inches (1:5).

B. Samples for Verification: For each type of exposed finish.
1. Sheet Metal Flashing: 12 inches (300 mm) long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Product Certificates: For each type of roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved.

C. Product Test Reports: For each product, for tests performed by a qualified testing agency.

D. Evaluation Reports: For roof edge flashing, from an agency acceptable to authority having jurisdiction showing compliance with ANSI/SPRI/FM 4435/ES-1.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

B. Special warranty.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
1. For roof edge flashings 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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.9 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 that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-90. 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 to prevent 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: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 (Z275) coating designation or aluminum-zinc alloy-coated steel sheet

in accordance with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation, Grade 40 (Grade 275); prepainted by coil-coating process to comply with ASTM A755/A755M.

1. Surface: Smooth, flat.
2. Exposed Coil-Coated Finish:
   a. 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.
3. Color: Match RAL 9011 Graphite Black.
4. 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 (0.013 mm).

2.3 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, 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.
   2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
   3. 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.

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.

D. 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.

2.4 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 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) 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 (25 mm) 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 of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

F. Do not use graphite pencils to mark metal surfaces.

2.5 COPINGS

A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding 12 feet (3.6 m), concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.
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. ATAS International, Inc.
b. Berridge Manufacturing Company.
c. Metal-Era, Inc.
d. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.
2. Metallic-Coated Steel Sheet Coping Caps: Zinc-coated (galvanized) steel, nominal 0.028-inch (0.71-mm) thickness.
a. Surface: Smooth, flat finish.
b. Finish: Two-coat fluoropolymer.
3. Corners: Factory mitered and continuously welded.

2.6 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long sections. Furnish with 6-inch- (150-mm-) wide, joint cover plates. Shop fabricate interior and exterior corners.
   1. Joint Style: Butted with expansion space and 6-inch- (150-mm-) wide, concealed backup plate.
   2. Fabricate from one of the following materials:
      a. Galvanized Steel: 0.028 inch (0.71 mm) thick.
      b. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, 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 sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, 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, 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 joint.
   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 (300 mm) o.c.
   6. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
   7. Do not field cut sheet metal flashing and trim by torch.
   8. 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.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
   1. Space movement joints at maximum of 10 feet (3 m) with no joints within 24 inches (600 mm) of corner or intersection.
   2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) 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.

3.3 INSTALLATION OF COPINGS

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.4 INSTALLATION OF ROOF FLASHINGS

A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, 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.

3.5 INSTALLATION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.6 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.

3.7 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. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. 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 076200

SECTION 078443 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Joints in or between fire-resistance-rated construction, and wall/floor intersections.

1.2 ACTION SUBMITTALS

A. Product Data: Joint firestopping.

B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

1.4 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:
   1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
   2. Test per 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."

2.3 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: 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, breakdown, 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 per ASTM E1966 or UL 2079.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hilti, Inc.
      b. Owens Corning, Thermafiber.
      c. ROCKWOOL.

d. Specified Technologies, Inc.

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. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

2.4 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 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, 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: Before installing joint firestopping systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions.

B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install joint firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

3.4 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections in accordance with ASTM E2393.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.5 CLEANING AND PROTECTION

A. 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 078443

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nonstaining silicone joint sealants.
   2. Urethane joint sealants.
   3. Mildew-resistant joint sealants.
   4. Latex joint sealants.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. Joint sealants.
   2. Joint-sealant backing materials.

B. Samples for Initial Selection: 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. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.
   3. Joint-sealant formulation.
   4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
   1. Joint-sealant location and designation.
   2. Manufacturer and product name.
   3. Type of substrate material.
   4. Proposed test.
   5. Number of samples required.

B. Preconstruction Laboratory Test Reports: For each joint sealant and substrate material to be tested from sealant manufacturer, indicating the following:
   1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

C. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

D. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.

E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Manufacturers' special warranties.

B. 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 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
   3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with masonry substrates.
   4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
   5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.

7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
5. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.
   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
6. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.8 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.9 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 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer for each sealant type.

2.2 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.

2.3 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. Pecora Corporation.
      c. Sika Corporation - Building Components.
      d. The Dow Chemical Company.
      e. Tremco Incorporated.

2.4 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. Bostik; Arkema.

b. Master Builders Solutions.
c. Pecora Corporation.
d. Sherwin-Williams Company (The).
e. Sika Corporation - Building Components.
f. 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.
b. Pecora Corporation.
c. Sherwin-Williams Company (The).

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, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, 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. Pecora Corporation.
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. Pecora Corporation.
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) or type 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 EXAMINATION

A. Examine joints indicated to receive 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 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.
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. 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.

3.3 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 according to 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.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
   1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
      a. Extent of Testing: Test completed and cured sealant joints as follows:
         1) Perform 10 tests for the first 1000 ft. (300 m) of joint length for each kind of sealant and joint substrate.
         2) Perform one test for each 1000 ft. (300 m) of joint length thereafter or one test per each floor per elevation.
      b. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.
         1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
      c. Inspect tested joints and report on the following:
         1) Whether sealants filled joint cavities and are free of voids.
         2) Whether sealant dimensions and configurations comply with specified requirements.
         3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
      d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
      e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
   2. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

C. Prepare test and inspection reports.

3.5 CLEANING

A. 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.

3.6 PROTECTION

A. 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.

3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Locations:
      a. Construction joints in cast-in-place concrete.
      b. Control and expansion joints in unit masonry.
      c. Joints between metal panels.
      d. Joints between different materials listed above.
      e. Perimeter joints between materials listed above and frames of doors.
   2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.

B. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
   1. Joint Locations:
      a. Isolation joints in cast-in-place concrete slabs.
   2. Joint Sealant: Urethane, S, P, 25, T, NT.

C. Joint-Sealant Application: 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. Vertical joints on exposed surfaces of unit masonry walls.
   2. Joint Sealant: Urethane, S, NS, 25, NT.

D. Joint-Sealant Application: 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.
   2. Joint Sealant: Acrylic latex.

E. Joint-Sealant Application: 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.
   2. Joint Sealant: Silicone, mildew resistant, S, NS, 25, NT.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Exterior standard steel doors and frames.

B. Related Requirements:
   1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.3 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, core descriptions, and finishes.

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.
   4. Locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
   7. Details of anchorages, joints, field splices, and connections.
   8. Details of accessories.

C. Samples for Initial Selection: For hollow-metal doors and frames with factory-applied color finishes.

D. Samples for Verification:

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 127 mm).

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.
   1. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
   2. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Field quality control reports.

1.6 QUALITY ASSURANCE

A. 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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
   1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Energy Efficient Exterior Openings: Comply with minimum thermal ratings, based on ASTM C1363. Openings to be fabricated and tested as fully operable, thermal insulating door and frame assemblies.
   1. Thermal Performance (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM C1363 and meet or exceed the following requirements:
      a. Door Assembly Operable U-Factor and R-Value Ratings: U-Factor 0.395, R-Value 2.53, including insulated door, thermal-break frame and threshold.

2. Air Infiltration (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM E283 to meet or exceed the following requirements:
   a. Rate of leakage of the door assembly shall not exceed 0.25 cfm per square foot of static differential air pressure of 1.567 psf (equivalent to 25 mph wind velocity).

2.2 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. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.
   1. Doors:
      a. Thickness: 1-3/4 inches (44.5 mm).
      b. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A60 (ZF180) coating.
      c. Edge Construction: Model 1, Full Flush.
      d. Edge Bevel: Bevel lock and hinge edges 1/8 inch in 2 inches (3.2 mm in 51 mm).
      e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
      f. 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.
      g. Core: Foamed in place polyurethane and steel reinforced core with no stiffener face welds.
   2. Frames:
      a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A60 (ZF180) coating.
      b. Construction: Full profile welded.
      c. Thermal Break Frames: Subject to the same compliance standards and requirements as standard hollow metal frames. Tested for thermal performance in accordance with NFRC 102, and resistance to air infiltration in accordance with NFRC 400. provide thermally broken frame profiles available for use in masonry construction. Fabricate with 1/16” positive thermal break and integral weatherstripping.
   3. Exposed Finish: Factory.

2.3 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 (610 mm) of frame height above 7 feet (2.1 m).
   3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) 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 (51-mm) height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) 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.

2.4 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

C. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.

D. 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.

E. 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.

2.5 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 (19 mm) 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. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

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, 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.

2.6 STEEL FINISHES

A. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with ANSI/SDI A250.3.
   1. Color and Gloss: As selected by Architect from manufacturer's full range.

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. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. 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. 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.
   3. Solidly pack mineral-fiber insulation inside frames.
   4. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
      a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
      b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
      c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
      d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. 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.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:
   1. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.

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 door assembly indicating compliance with each item listed in NFPA 80.

3.4 REPAIR

A. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

B. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Access doors and frames.

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.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Exposed Flanges:
   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. Babcock-Davis.
      b. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
      c. Karp Associates, Inc.
      d. Milcor; Hart & Cooley, Inc.
      e. Nystrom, Inc.
   2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
   3. Optional Features: Masonry anchors for frames in masonry walls.
   4. Locations: Wall and ceiling.
   5. Door Size: As indicated on Drawings.
   6. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gage, factory primed.
   7. Frame Material: Same material, thickness, and finish as door.
   8. Latch and Lock: Latch bolt, key operated.

2.2 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

C. Frame Anchors: Same material as door face.

D. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.3 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. 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.

C. 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.

D. 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.

2.4 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. 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.

D. 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. Confirm compatibility with specified topcoats in Section 099123 “Interior Painting.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates 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

A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

SECTION 087100 – DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Commercial door hardware.
2. Cylinders for doors specified in other Sections.
3. Electrified door hardware.

1.2 SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Include details of electrified door hardware and wiring diagrams.

C. Samples: For each exposed finish.

D. Door Hardware Schedule: Organized into door hardware sets, using DHI vertical format, indicating type, style, function, size, label, hand, manufacturer, fasteners, location, and finish of each door hardware item. Include description of each electrified door hardware function, including sequence of operation.

E. Keying Schedule: Detail Owner's final keying instructions for locks.

F. Product certificates.

1.3 QUALITY ASSURANCE

A. Supplier Qualifications: Person who is or employs a qualified DHI Architectural Hardware Consultant.

B. Source Limitations: Obtain electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that are listed to perform electrical modifications, by a testing and inspecting agency acceptable to authorities having jurisdiction, are acceptable.

C. Keying Conference: Conduct conference at Project site. Incorporate keying conference decisions into final keying schedule.

D. Pre-Installation Conference: Conduct conference at Project site.

E. Keys: Deliver keys to Owner by registered mail.

F. Templates: Obtain and distribute templates for doors, frames, and other work specified to be factory prepared for installing door hardware.

G. Standards: Comply with BHMA A156 series standards, Grade 1.

H. Certified Products: Provide door hardware that is listed in BHMA directory of certified products.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fails in materials or workmanship within warranty period from date of Substantial Completion.

1. Warranty Period for Manual Closers: 10 years.
2. Warranty Period for Exit Devices: 3 years.
3. Warranty Period for Locks: 7 years.
4. All other hardware one year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Product: Subject to compliance with requirements, provide the product named for each door hardware item indicated in Door Hardware Sets.

B. Basis-of-Design Product: Product named for each door hardware item indicated in Door Hardware Sets establishes the basis of design. Provide either the named product or a comparable product by one of the manufacturers specified for each type of hardware item.

C. Manufacturers Used in the specification:

Products	**Manufacture Specified**	**Acceptable Equals**
Continuous Hinges	Ives	Roton, Select
Locksets	Schlage L9000 SI-204004-26D-41	Sargent, Best Simplex Deadlatch
Card Readers/Keypads	Electronics DL2700	No Substitutions
Exit Devices	Von Duprin 99 Series	Precision, Detex
Closers	LCN 4040XP	Sargent 281 CR 8200
Overhead Stops	Glynn Johnson	Rixson, ABH
Push/Pulls, Stops	Ives	Hager, Rockwood
Flushbolts	Ives	Hager, Rockwood
Thresholds/Seals	Zero	NGP, Pemko
Key Cabinet	Lund	Telkee
Cylinders	Yale	No Substitutions

2.2 DOOR HARDWARE

A. Scheduled Door Hardware: Provide door hardware according to Door Hardware Sets at the end of Part 3. Manufacturers' names are abbreviated.

2.3 HINGES

A. General: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

B. Hinge Base Metal: Unless otherwise indicated, provide the following:

1. Exterior Hinges: Stainless steel, with stainless-steel pin.
2. Interior Hinges: Steel, with steel pin.
3. Hinges for Fire-Rated Assemblies: Steel, with steel pin.

C. Non-removable Pins: Provide set screw in hinge barrel that prevents removal of pin while door is closed; for out-swinging exterior doors.

D. Screws: Phillips flat-head screws; screw heads finished to match surface of hinges.

E. Metal Doors and Frames: Machine screws (drilled and tapped holes).

2.4 MECHANICAL LOCKS AND LATCHES

A. Mortise Locks:

1. Locks shall be ANSI A156.13, Grade 1 mortise locksets, Manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
2. Locks to have a standard 2-3/4” backset with a full 3/4" throw stainless steel mechanical anti-friction latch bolt. Deadbolt shall be a full 1” throw, constructed of stainless steel.
3. Lever trim shall be cast or forged in the design specified, with 2-1/8” diameter roses. Levers to be thru-bolted to assure proper alignment. Trim shall be applied by threaded bushing “no exposed screws”.

B. Cylindrical Locks:

1. Locks shall be ANSI A156.2, Series 4000 Grade 1 UL Listed for 3-hour doors. Manufactured from heavy gauge cold rolled steel mechanisms that are corrosion treated for normal conditions.
2. Locks to have standard 2-3/4” backset with a full 1/2" reversible dead latch. Thru-bolted mounting post for positive interlock to the door with concealed mounting screws.
3. Lever trim shall be pressure cast zinc to match finishes. The design specified, with 3-7/16” diameter roses. Trim shall be applied by “no exposed screws”.

2.5 BOLTS

Shall have forged bronze faceplate with extruded brass lever wrought brass guide and strike. Flush bolts for hollow metal doors shall be extension rod type door up to 7’6” in height shall have 12” steel or brass rods, manual flush bolts for doors over 7’6” in height shall be increased by 6” for each additional 6” of door height. Wood doors shall have corner-wrap type. Provide dust proof strikes for all bottom bolts.

2.6 EXIT DEVICES

A. Panic Exit Devices: Listed and labeled for panic protection, based on testing according to UL 305.

B. Fire Exit Devices: Complying with NFPA 80 that are listed and labeled for fire and panic protection, based on testing according to UL 305 and NFPA 252.

C. All lever design shall match mortise or cylindrical lock lever designs.

D. All devices to incorporate a security dead-latching feature. Provide roller strikes for all rim and surface mounted vertical rod devices, ASA strikes for mortise devices, and manufacturer’s standard strikes for concealed vertical rod devices.

E. Removable Mullions: BHMA A156.3.

1. Fire-Exit Removable Mullions: Complying with NFPA 80 that are listed and labeled for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions shall be used only with exit devices for which they have been tested.

F. Carry-Open Bars: Provide carry-open bars for inactive leaves of pairs of doors, unless automatic or self-latching bolts are used.

2.7 CLOSERS

A. Surface-Mounted Closers:

B. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped. Hydraulic regulation shall be by tamper-proof, non-critical valves. Closers shall have separate adjustment for latch speed, general speed, and back check.

C. All closers will not be seen on the public side or hallway side of the door. The appropriate drop plate or mounting plates will be provided as conditions and special templating dictates.

2.8 PROTECTIVE TRIM UNITS

A. Protective Trim Units: Sized 2” inches less than door width on push side and 1” inch less than door width on pull side, by height scheduled or indicated. Fasten with exposed machine or self-tapping screws.

2.9 STOPS AND HOLDERS

A. Stops and Holders: Provide floor stops for doors, unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic. Where floor or wall stops are not appropriate, provide overhead holders.

B. Silencers for Door Frames: Neoprene or rubber; fabricated for drilled-in application to frame.

2.10 DOOR GASKETING AND THRESHOLDS

A. Door Gasketing: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide non-corrosive fasteners for exterior applications and elsewhere as indicated.

2.11 CYLINDERS, KEYING, AND STRIKES

A. Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

B. Keying System: Factory-registered keying system; grand master key system.

2.12 FABRICATION

A. Base Metals: Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18 for finishes. Do not furnish manufacturer's standard materials if different from specified standard.

B. Fasteners: Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated. Provide steel machine or wood screws or steel through bolts for fire-rated applications.

C. Spacers or Sex Bolts: For through bolting of hollow metal doors.

D. Finishes: Comply with BHMA A156.18. As shown in hardware sets.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine doors and frames for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

B. Steel Door and Frame Preparation: Comply with DHI A115 series. Drill and tap doors and frames for surface-applied hardware according to SDI 107.

C. Wood Door Preparation: Comply with DHI A115-W series.

D. Mounting Heights: Comply with the following requirements, unless otherwise indicated:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

E. Adjust and reinforce attachment substrates as necessary for proper installation and operation. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

1. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

F. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with accessibility requirements.

1. Door Closers: Adjust sweep period so that from an open position of 70 degrees, the door will take at least three seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.

3.2 FIELD QUALITY CONTROL

A. Inspections: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

3.3 DOOR HARDWARE SETS:

79551 X-48266 Version 1

HARDWARE GROUP NO. 01

FOR USE ON DOOR #(S):
101

PROVIDE EACH OPENING WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112XY	628	IVE
1	EA	ELECTRONIC LOCK	SI-204004-26D-41	L1076	SIMPLEX
1	EA	I C CORE	AS REQUIRED	626	YAL
1	EA	SURFACE CLOSER	4040XP SCUSH SRI	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A-223	A	ZER

OPERATION: DOOR CLOSED AND SECURED. VALID CODE ALLOWS ENTRY. FREE EGRESS AT ALL TIMES.

HARDWARE GROUP NO. 02

FOR USE ON DOOR #(S):
103

PROVIDE EACH OPENING WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112XY	628	IVE
1	EA	STOREROOM LOCK	L9080L 17A	626	SCH
1	EA	HOUSING AS REQUIRED	CYL HOUSING	626	YAL
1	EA	I C CORE	AS REQUIRED	626	YAL
1	EA	SURFACE CLOSER	4040XP SCUSH SRI	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A-223	A	ZER

HARDWARE GROUP NO. 03

FOR USE ON DOOR #(S):
102

PROVIDE EACH OPENING WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112XY	628	IVE
1	EA	FIRE EXIT HARDWARE	99-L-NL-F-17	626	VON
1	EA	HOUSING AS REQUIRED	CYL HOUSING	626	YAL
1	EA	I C CORE	AS REQUIRED	626	YAL
1	EA	SURFACE CLOSER	4040XP SCUSH SRI	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A-223	A	ZER

END OF SECTION

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Suspension systems for interior ceilings and soffits.
   2. Grid suspension systems for gypsum board ceilings.

B. Related Requirements:
   1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; and roof rafters and ceiling joists.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation Reports: For embossed, high-strength steel studs and tracks and, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

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.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Notify manufacturer of damaged materials received prior to installation.

B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Design framing systems in accordance with AISI S220, "North American Specification for the Design of Cold-Formed Steel Framing - Nonstructural Members," unless otherwise indicated.

B. Design Loads: As indicated on architectural Drawings or 5 lbf/sq. ft. (239 Pa) minimum as required by the IBC.

2.2 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

B. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

C. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.

D. Furring Channels (Furring Members):
1. Cold-Rolled Channels: 0.0538-inch (1.367-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
2. Steel Studs and Tracks: ASTM C645.
   a. Minimum Base-Steel Thickness: 0.0179 inch (0.455 mm).
   b. Depth: As indicated on Drawings.
3. Embossed, High-Strength Steel Studs and Tracks: ASTM C645.
   a. Minimum Base-Steel Thickness: 0.0147 inch (0.373 mm).
   b. Depth: As indicated on Drawings.

E. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

2.3 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.
   1. 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.

3.4 INSTALLING CEILING 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. Do not attach hangers to steel roof deck.
5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
6. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes surface preparation, priming, and finish painting for surfaces indicated.

B. Related Requirements:
   1. Section 099600 "High-Performance Coatings" for coatings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.
   1. Include preparation requirements and application instructions.
   2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
   1. Submit Samples on rigid backing, 8 inches (200 mm) square.
   2. Apply coats on Samples in steps to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. 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.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.4 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND TYPES

A. General:
1. Use only one manufacturer's products within a paint system. Do not intermix or thin one product line with another.
2. Provide pure, nonfading color pigments of the type and quality to suit substrates and service indicated.

B. Materials and Manufacturers:
1. To establish quality and type of paint required, specific paint materials are listed in Paint Schedule in Part 3 of this Section. Equal paint materials of the other listed acceptable manufacturers may be substituted for materials listed but colors must match colors listed.
2. Acceptable Manufacturers: Manufacturers capable of providing acceptable special coating materials and are capable of matching selected colors and finish include the following:
   a. Benjamin Moore & Co.
   b. Sherwin-Williams (S-W).
   c. ICI Paints, Inc.
   d. PPG Paints
   e. Pratt and Lambert

C. Paint Coordination:
1. Provide finish coats compatible with prime coats used. Review other Sections of these Specifications for compatibility of total coatings system.
2. Upon request from other trades, furnish information on characteristics of proposed finish materials to ensure compatible prime coats.
3. Provide barrier coats over incompatible primers or remove and re-prime as required to provide a proper paint system.
4. Notify Architect in writing of any anticipated problems using specified coating systems with surfaces shop-primed by others.

D. 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.
3. Products shall be of same manufacturer for each coat in a coating system.

E. VOC Content: 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:
1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 100 g/L.
5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.

7. Pretreatment Wash Primers: 420 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

2.2 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
   1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
   2. Testing agency will perform tests for compliance with product requirements.
   3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Masonry (Clay and CMUs): 12 percent.
   2. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. 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.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

3.3 INSTALLATION

A. Apply paints according to manufacturer's written instructions.
1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. 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.

3.4 FIELD QUALITY CONTROL

A. Dry-Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.
1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
   1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
   2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
   3. Allow empty paint cans to dry before disposal.
   4. Collect waste paint by type and deliver to recycling or collection facility.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. 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.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. Gypsum Board Ceilings - Flat, Low-Odor/Low VOC:
   1. Primer: 1 coat S-W ProMar 200 Zero VOC Latex Primer
   2. Finish: 2-3 coats S-W ProMar 200 Zero VOC Latex Flat

B. Concrete Masonry Units, Interior - Low-Odor/Low VOC:
   1. Primer: 1 coat S-W Pro Industrial Heavy Duty Block Filler.
   2. Finish: 2 coats S-W Pro Industrial, Pre-Catalyzed, Water-Based Epoxy, Eg-Shel.

C. Steel Access Doors and Frames:
   1. Primer: Factory primed; confirm primer compatibility with topcoat
   2. Finish: 2 coats S-W Pro Industrial, Pre-Catalyzed, Water-Based Epoxy, Eg-Shel

END OF SECTION 099123

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of high-performance coating systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.
   1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
   2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product indicated.

C. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.
   1. Submit Samples on rigid backing, 8 inches (200 mm) square.
   2. Apply coats on Samples in steps to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.4 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product listed in the Part 3 Coating Schedule or comparable product by one of the following:
   1. Steel Coatings:
      a. International Protective Coatings.
      b. PPG Paints; PPG Industries, Inc.
      c. Sherwin-Williams Company (The).
      d. Tnemec Company, Inc.
   2. Anti-Graffiti Coatings:
      a. Rainguard Pro.
      b. Sika Limited.
      c. Sherwin Williams
      d. Prosoco

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. 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.
   3. Products shall be of same manufacturer for each coat in a coating system.

2.3 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:
   1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
   2. Testing agency will perform tests for compliance with product requirements.
   3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

D. 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 in "MPI Architectural Painting Specification Manual" applicable to substrates and coating 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.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

G. Aluminum Substrates: Remove loose surface oxidation.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
   1. Use applicators and techniques suited for coating and substrate indicated.
   2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
   3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
   4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
   1. Contractor shall touch up and restore coated surfaces damaged by testing.
   2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 HIGH-PERFORMANCE COATING SCHEDULE

A. Masonry Substrates, Vertical Surfaces, Anti-Graffiti Coating:
   1. Surface Preparation: Surfaces shall be clean and dry with no oils, dirt, debris, or minerals such as efflorescence, lime and calcium
   2. Finish: 2 coats VandlGuard Non-Sacrificial Coating

B. Galvanized-Structural Steel Substrates:
   1. Pigmented Polyurethane over Epoxy Primer System:
      a. Surface Preparation: In accordance with manufacturer's written instructions.
      b. Shop-Applied Prime Coat: 1 coat Sherwin Williams Macropoxy 646.
      c. Finish: 2 coats Sherwin Williams Acrolon 218HS.

C. Exposed Construction at Ceilings including Steel Deck and Structural Steel:
   1. Surface Preparation: All surfaces must be smooth and clean.
   2. Finish: 2 coats S-W ProIndustrial Acrylic Dryfall

END OF SECTION 099600

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Public-use washroom accessories.
   2. Hand dryers
   3. Underlavatory guards.
   4. Portable Emergency Eye Wash

1.2 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
   3. Include electrical characteristics.

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. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
   1. Identify locations using room designations indicated.
   2. Identify accessories using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

1.6 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. Failures include, but are not limited to, visible silver spoilage defects.
   2. 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: Five 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: Provide fasteners to comply with the following requirements:
   1. Grab Bars: Installed units are able to resist 250 lbf (1112 N) concentrated load applied in any direction and at any point.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Source Limitations: Obtain each type of public-use washroom accessory from single source from single manufacturer.

B. Toilet Tissue (Roll) Dispenser:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Tork 565828 3-Roll Bath Tissue Dispenser or a comparable product by one of the following:
      a. AJW Architectural Products.
      b. ASI-American Specialties, Inc.
      c. Bradley Corporation.
      d. Brey-Krause Manufacturing Co.
      e. Tubular Specialties Manufacturing, Inc.
   2. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
   3. Mounting: Surface mounted.
   4. Operation: Noncontrol delivery with theft-resistant spindle.
   5. Capacity: Designed for 5-inch- (127-mm-) diameter tissue rolls.
   6. Material and Finish: ABS plastic, black.

C. Automatic Soap Dispenser:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide GOJO TFX Dispenser Model 2740-12 or comparable product by one of the following:
      a. AJW Architectural Products.
      b. ASI-American Specialties, Inc.
      c. Bradley Corporation.

2. Description: Automatic dispenser with sensor to detect presence of hands; battery powered; designed for dispensing soap in lather form.
3. Mounting: Wall mounted.
4. Capacity: 1200 ml.
5. Materials: White plastic.
6. Refill Indicator: Sight window.

D. Grab Bar:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc; B-6806 or a comparable product by one of the following:
   a. AJW Architectural Products.
   b. ASI-American Specialties, Inc.
   c. Bradley Corporation.
   d. Brey-Krause Manufacturing Co.
   e. Tubular Specialties Manufacturing, Inc.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
   a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin).
4. Outside Diameter: 1-1/2 inches (38 mm).
5. Configuration and Length: As indicated on Drawings.

E. Sanitary-Napkin and Tampon Vendor:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc; B-47069C or a comparable product by one of the following:
   a. AJW Architectural Products.
   b. ASI-American Specialties, Inc.
   c. Bradley Corporation.
   d. Tubular Specialties Manufacturing, Inc.
2. Mounting: Surface mounted.
3. Capacity: 30 tampons, 20 napkins.
4. Operation: No coin (free).
5. Exposed Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
6. Lockset: Tumbler type with separate lock and key for coin box.

F. Sanitary-Napkin Disposal Unit:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc; B-270 or a comparable product by one of the following:
   a. AJW Architectural Products.
   b. ASI-American Specialties, Inc.
   c. Bradley Corporation.
   d. Brey-Krause Manufacturing Co.
   e. Tubular Specialties Manufacturing, Inc.
2. Mounting: Surface mounted.
3. Door or Cover: Self-closing, disposal-opening cover.
4. Receptacle: Removable.
5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

G. Seat-Cover Dispenser:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc; B-4221 or a comparable product by one of the following:
   a. AJW Architectural Products.

b. ASI-American Specialties, Inc.
c. Bradley Corporation.
d. Brey-Krause Manufacturing Co.
e. Tubular Specialties Manufacturing, Inc.

2. Mounting: Surface mounted.
3. Minimum Capacity: 250 seat covers.
4. Exposed Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
5. Lockset: Tumbler type.

H. Mirror Unit:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc; B-290 Welded-Frame Mirror or a comparable product by one of the following:
   a. AJW Architectural Products.
   b. ASI-American Specialties, Inc.
   c. Bradley Corporation.
   d. Brey-Krause Manufacturing Co.
   e. Tubular Specialties Manufacturing, Inc.
2. Frame: Stainless steel angle, 0.05 inch (1.3 mm) thick.
   a. Corners: Welded and ground smooth.
3. Size: As indicated on Drawings.
4. Hangers: Manufacturer's standard rigid, tamper and theft resistant.

I. Hook:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc; B-6827 or a comparable product by one of the following:
   a. AJW Architectural Products.
   b. ASI-American Specialties, Inc.
   c. Bradley Corporation.
   d. Brey-Krause Manufacturing Co.
   e. Tubular Specialties Manufacturing, Inc.
2. Description: Combination hat and coat hook.
3. Mounting: Concealed.
4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

2.3 HAND DRYERS

A. Source Limitations: Obtain hand dryers from single source from single manufacturer.

B. High-Speed Air Dryer:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Excel Dryer Inc., XLERATOR XL-BW or a comparable product by one of the following:
   a. AJW Architectural Products.
   b. ASI-American Specialties, Inc.
   c. Bobrick Washroom Equipment, Inc.
   d. Bradley Corporation.
   e. Mitsubishi Electric US, Inc.
   f. World Dryer Corporation.
2. Description: High-speed, warm-air hand dryer for rapid hand drying.
3. Mounting: Surface mounted.

4. Operation: Infrared-sensor activated with timed power cut-off switch.
   a. Average Dry Time: 8 seconds.
   b. Automatic Shut Off: At 60 seconds.
5. Maximum Sound Level: 75 dB.
6. Cover Material and Finish: Steel, with white finish.
7. Electrical Requirements: 115 V, 12 A, 1450 W, minimum.

2.4 UNDERLAVATORY GUARDS

A. Underlavatory Guard:
   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. Buckaroos, Inc.
      b. Plumberex Specialty Products, Inc.
      c. Truebro; IPS Corporation.
   2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
   3. Material and Finish: Antimicrobial, molded plastic, white.

2.5 PORTABLE EMERGENCY EYE WASH

A. Self-Contained Eyewash Unit:
   1. Equal to Bradly Corporation Model S19-921 On-Site Gravity-Fed Eyewash.
   2. Flushes eyes for 15 minutes at a minimum of 0.4 gallons/minute by using only 7 gallons of water.
   3. Tank: 12-inches x 22-inches x 9-inches, made of translucent white high-density polyethylene; 7-gallon capacity.
   4. Pedestal: 13-1/2 inches x 22-inches x 18-1/2 inches, made of opaque yellow polypropylene, with black polypropylene pull-down arm.
   5. Wall Bracket: Stainless steel
   6. Exceeds American National Standard Z358.1 Specifications.
   7. Includes universal identification sign and inspection tag

2.6 MATERIALS

A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch- (0.8-mm-) minimum nominal thickness unless otherwise indicated.

B. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch- (0.9-mm-) minimum nominal thickness.

C. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.

D. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).

E. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.7 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. 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.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

END OF SECTION 102800

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 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. Failures include, but are not limited to, the following:
      a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
      b. Faulty operation of valves or release levers.
   2. 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.
   1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
   1. Source Limitations: Obtain fire extinguishers and accessories, from single source from single manufacturer.
   2. Valves: Nickel-plated, polished-brass body.
   3. Handles and Levers: Stainless steel.
   4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb (4.5-kg) nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.
   1. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
   1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
   1. Mounting Height: Top of fire extinguisher to be at 42 inches (1067 mm) above finished floor.

END OF SECTION 104416

SECTION 23 00 00 – MECHANICAL AND PLUMBING

PART 1 GENERAL

1.01 SUMMARY

This Section includes the following:

1. Heating, ventilating, and air conditioning (HVAC) equipment.
2. Plumbing equipment.
3. Definitions for the manner and method by which controls function.
4. Ductwork and piping insulation.

1.02 REFERENCES

A. Wisconsin Administrative Code (2018):

1. Chapter 363 – Energy Conservation.
2. Chapter 364 – Heating, Ventilating, and Air Conditioning.
3. Chapter 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing.
4. Madison, Wisconsin – Code of Ordinances / Chapter 18 – Plumbing Code.

1.03 SUBMITTALS

A. Submit to the Engineer for review and approval complete construction drawings, shop details, installation drawings, catalog data, manufacturer's literature, etc. Complete submittals required include, but are not limited to, waste and vent piping, water piping, water closets, lavatories, tankless water heaters, hose bibbs, wall hydrants, floor drains, electric wall heaters, exhaust ventilators, miniature split systems, toilet accessories and other pertinent items.

B. Product Data
   1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
   2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.

C. Show Drawings:
   1. Riser diagrams showing control network layout, communication protocol, and wire types.
   2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed including adjustable range of control. Show the location of control elements in the system.
   3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals. Clearly identify factory and field wiring requirements.
   4. Control panel mounted devices including door mounted control elements.

1.04 DEFINITIONS

A. Control Sequences: Manner and method by which automatic temperature controls function. Requirements for each type of operation are described in this section.
B. Normal Mode: Mode or position-controlled device assumes without power.
C. Automatic Mode: Mode or position-controlled device assumed when under control of automatic system of controls.
D. Manual Mode: Mode or position-controlled device assumes when under manual control. Unless otherwise specified, manual mode implied and affects only device for which manual mode or position identified.
E. Analog Output: proportional Output Signal (zero – to 10-V dc, 4 to 20 mA)
F. BAS: Building Automation System
G. Binary Output: On/Off output signal or contact closure
H. Digital Output: Data output that must be interpreted digitally

1.05 QUALITY ASSURANCE

A. Manufacturer's Quality System:

1. The control must be UL tested and certified.
2. Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.
3. Interpret specific reference in these specifications to any article, device, product, material, fixture, form or type of construction, etc., by name, make or catalog number as establishing a standard of quality. Do not construe specific references as limiting competition. Use any article, device, product or material, fixtures, form, or type of construction, which in the judgment of the architect is equal to that named in the special provisions or shown on the plans.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide all plumbing fixtures, piping and accessories as outlined in this section meeting ASME A112.119.3.
B. Provide all heating and ventilation equipment, wiring, and accessories as outlined within this section.
C. Provide all products and workmanship of the highest commercial or industrial quality available. Lesser quality products, such as "economy grade", will not be acceptable. The engineer will reject any product or work that is inferior in his/her judgment.

2.02 WASTE, STORM WATER AND VENT PIPING

A. Waste, Storm and vent piping shall be ABS or PVC type DWW plastic.

2.03 WATER PIPING

A. Copper tubing Type L, hard drawn. Provide a gate or ball valve at the inlet end of the water line. Size water lines to provide proper flushing action based on a nominal water pressure of 40 psi.
B. Provide a main shut-off valve and water meter at the water service entrance.
C. Provide a water hammer arrestor, to be installed on water line.
D. Buried water piping to be type K soft copper.

2.04 WATER CLOSETS (WC-1)

A. Ceramic, ADA compliant, wall hung, elongated bowl, with siphon or blowout jet action. Provide back spud for concealed 1.6 gpf flush valve connection. Kohler Kingston K-4323, or approved equal.

2.05 LAVATORIES (L-1)

A. Ceramic, wall mount, ADA compliant, with backsplash and carrier. Kohler Chesapeake K-1728, or approved equal.

B. Lavatory valves to be pneumatically operated pushbutton valve. Valve to be non-hold open type with a vandal resistant pushbutton requiring less than 5 lbs pressure to activate.

2.06 ELECTRIC WATER HEATER (TWH-1)

A. A.O. Smith model EJC-6 or approved equal. Unit shall be compact electric, glass lined storage type with a 6-gal nominal tank single 1.65 kW element (120V), delivering 8 gph recovery at 90°F rise and not less than 98 percent thermal efficiency. Furnish factory installed adjustable thermostat with manual reset high-limit, CSA/ASME T&P Relief Valve, CoreGard Aluminum anode, heat-trap nipples, non- CFC foam insulation rated R-8, provide 3/4 “NPT side water connection. Maximum dimensions 14 ¼ inch diameter × 15 ¼ inch height. Supply with 6-year limited warranty.

2.07 HOSE BIBB (HB-1)

A. Hose bibb to be provided in janitor’s closet/storage room and on the south exterior wall.
B. °/‹-inch brass body, nickel plated, Teflon packing, vacuum breaker with °/ -inch male hose thread.
C. Manufacturers
    1. Woodford Model 26
    2. NIBCO, Inc
    3. Or Equal

2.08 FLOOR DRAINS (FD-1)

A. PVC or ABS body with height adjustment, 4 inches outlet and polished nickel-bronze grate. Zurn Model EZ1 or approved equal.

2.09 TRAP PRIMER (TP-1)

A. Trap primer shall be Precision Plumbing product Model PR-500 “Prime-Rite’ or approval

equal. Unit shall be an automatic, pressure-drop activated valve, fabricated from lead-free 693 brass, ASEE 1018 and UPC listed, NSF-372 certified and capable of priming up to two floor drains. Primer shall connect to a cold-water line 20-80 psi operating range and open when a ≥ 3 psi drop occurs, delivering charge of potable water to the trap to maintain its seal. Provide 1/2-inch FNTP inlet and outlet, stainless steel mesh strainer, EPDM O- ring, and factory-set internals requiring no field adjustment.

2.10 ELECTRICWALL HEATER (EWH-1)

A. The Wall Heater shall be Berko Model FRA4824F or approved equal, recessed mounted, forced fan, delivering 5 kW at 208 V and an integral thermostat adjustable 40-90°F. Provide non- glowing nickel chromium steel sheath element. Five blade aluminum fan, fan-delay relay, manual reset thermal cut- out, double pole on/off disconnect and single pole thermostat. Factory wiring shall be housed in heavy gauge galvanized black box with louvered front cover. Install a minimum of 8 inches above finished floor and wire per NEC standards.

2.11 ELECTRIC UNIT HEATER (EUH-1,2)

A. Unit Heater shall be Berko Model HUHAA320 or approved equal, vertical forced fan type, rated 3 kW at 208 V, 1-Phase, 14.5A, delivering 350 CFM with a 27°F temperature rise, cabinet finished bronze powder coated, for mounting bottom of unit no less than 7 ft above finished floor. Heater shall employ draw through airflow across aluminum finned copper clad steel sheath element, individually adjustable discharge louvers, automatic reset capillary thermal cut-out and line voltage controls. Furnished universal wall/ceiling mounting bracket and install per manufacturers clearances and ASHRAE 90.1 requirements.

2.12 EXHAUST VENTILATORS (EF-1,2)

A. Exhaust Ventilator for Restroom shall be Fantech Model PRO 80 or approved equal; ceiling mounted HVI & ENERGY STAR certified. Capable of exhausting min 80 CFM at 0.10 in. w.g. with maximum sound level of 33 decibels. Unit shall employ a high efficiency capacitor start motor for continuous duty. Provide a low-profile rust proof steel housing with integral backdraft damper, permanently lubricated, polymeric low-profile grille.

B. Exhaust Ventilator for Janitors/Storage shall be Fantech model FG 6 inline centrifugal duct fan or approved equal; Fan housing shall be leak tight 22 ga galvanized steel with black powder coat finish and include factory mounting bracket; impeller shall be backward curved, rated 120 V,1-Phase with permanently sealed ball bearings and automatic reset thermal overload. Unit shall be speed controllable and have an operable air stream of 140°F

2.13 AIR REGISTARS AND GRILLES OPENING (SG-1,2,3 EG-1)

A. Provide steel return grille, Titus 350R or approved equal; fixed 35-degree deflection, ¾ inch blade spacing. Neck mounted OBD for balancing. White baked enamel finish. Size grilles as scheduled to deliver the design airflow and pressure drop. Orient blades parallel to long dimensions as indicated to obtain specified throw and spread. Construct from minimum 22-ga steel.

B. Provide double deflection steel supply grille, Titus 300R or approved equal; ¾ inch blade spacing with independently adjustable louvers. White baked enamel finish. Size grilles as scheduled to deliver the design airflow and pressure drop. Orient blades parallel to long dimensions as indicated to obtain specified throw and spread. Construct from minimum 22-ga steel.

2.16 SUPPLY FAN (SF-1)

A. A Greenheck Model SQ-9-M1 square inline centrifugal fan, direct drive backwards inclined wheel or approved equal. Heavy gauge galvanized steel housing with flanged duct connects and removable access panel; factors finish to manufactures standard coating. Provide 0.5 HP inverter duty motor suitable for VFD service and furnish VFD. Scheduled performance at standard air: 1500 CFM at 1.102 in. w.g ESP approximately 2,391 RPM; Sound (AMAC): 68 dB outlet. Include mounting angles/hangers, vibration isolations and access provisions as required for a code compliant weather tight installation. Reference dimensions, electrical and AMCA 210/ASHRAE 51 air performance and AMCA 300 sound rating.

2.16 LOUVERS (L-1,2,3,4,5,6)

A. Ruskin Model stationary sight proof wall louver, inverted chevron blades or approved equal. Extruded aluminum construction 2in frame depth with 60° vertical blades, Frame and blades 6063-T5 with integral caulk groove. Factory finish to AAMA 2604 backed enamel color selected by architect. Provide sill flashing, mullion covers, and mounting angles as required for wall construction to maintain weathertight installation. Reference shop drawings indicating dimensions and AMCA certified performance data.

2.17 CONTROL DAMPERS (CD-1,2,3,4,5)

A. Dampers shall be model CD50 by Ruskin or approved equal. CD50 dampers shall be extruded aluminum airfoil blade type, suitable for low to medium pressure HVAC systems. Fram shall be 2 in deep, 6063-T5 extruded aluminum with mechanically fastened corner braces. Leakage shall not exceed 6 cfm/ft^2 at 1 in.wg. Dampers shall be AMCA certified for air performance and leakage and labeled accordingly

2.18 THERMALLY INSULATED CONTROL DAMPERS (CD-6)

A. Where thermally broken construction is required, provide Ruskin CDT50 thermally insulated air control dampers or approved equal. Dampers shall be constructed with thermally broken frames and blades to minimize heat transfer across the damper. Frame shall be 2 in deep, thermally broken extruded aluminum and blades shall be thermally insulated airfoil profile. Blade shafts shall be stainless steel with thermal isolators and bearings shall be high temperature, corrosion resistant type. Leakage shall not exceed 6 cfm/ft^2 at 1in.wg. The CDT50 Shall be AMCA livened for air and leakage performance and rated for use in both cold and hot climates.

2.19 INSULATION ACCESSORIES

A. Ductwork Insulation Accessories: Provide staples, wires, bands, wire netting, stud pins, and metal cover tape, anchors, corner angles, and similar accessories as recommended by insulation manufacturer for application indicated.

2.20 VAPOR BARRIER AND JACKETING MATERIALS

A. JK1, Kraft Paper Faced Vapor Barrier Material: FS HH B 100B, Type I, all service type aluminum foil and fiberglass yarn reinforced kraft paper. Manville Type AP, or equal.

1. Maximum water vapor permeability, ASTM E96/E96M, 0.02 perms.
2. Minimum tensile strength, ASTM D828, 40 lbs/in. width.
3. Minimum Mullen burst pressure, ASTM D774/D774M, 70 psi.

2.21 FIBERGLASS INSULATION MATERIALS

A. Manufacturers:

1. Certainteed Corporation.
2. Schuller International, Inc
3. Knauf Fiberglass Corporation.
4. Owns Corning Fiberglass Corporation.
5. Or equal.

B. Fiberglass Pipe Insulation (Roof Drain Piping): ASTM C547, high temperature, preformed, fibrous glass with jacket type specified, 1” minimum thickness, and class for service temperatures indicated.

1. Class 1: To 450°F, maximum k = 0.27 Btu in./hr sq ft F at 100°F.

C. Fiberglass Pipe Fitting Insulation: ASTM C547, high temperature, preformed, fibrous glass with matching premoulded PVC fittings, 1” minimum thickness.

D. Rigid Fiberglass Ductwork Insulation: ASTM C612, high temperature, rigid fibrous glass board with 2” minimum thickness, and class for service temperatures indicated.

1. FGD 1 (Nonload Bearing): ASTM C612, Class 1; ASTM C547, ASTM C553, ASTM C592, and ASTM C612, Form A, Class 1, average density 1.5 pcf, maximum k = 0.24 Btu in./hr sq ft °F, to 400°F.

2. FGD 2 (Load Bearing): ASTM C612, Class 2; ASTM C547, ASTM C553, ASTM C592, and ASTM C612, Form A, Class 2, average density 3.0 pcf, maximum k = 0.23 Btu in./hr sq ft °F, to 400°F.

E. Rigid Fiberglass Equipment Insulation: ASTM C612, high temperature, rigid fibrous glass board, minimum thickness 2 in., and class for service temperature indicated.

1. FGE 1 (Nonload Bearing): ASTM C612, Class 1; ASTM C547, ASTM C553, ASTM C592, and ASTM C612, Form A, Class 1, average density 1.5 pcf, maximum k = 0.24 Btu in./hr sq ft °F at 75°F, to 400°F.

2. FGE 2 (Load Bearing): ASTM C612, Class 2; ASTM C547, ASTM C553, ASTM C592, and ASTM C612, Form A, Class 2, average density 3.0 pcf, maximum k = 0.23 Btu in./hr sq ft °F at 75°F, to 400°F.

2.22 DUCTWORK

A. Provide a complete system of supply, return and outside air duct work fabricated and installed in accordance with the latest SMACNA HVAC Duct Construction Standards- Metal & Flexible and all sections of the IMC, NFPA 90A, ASHRAE 62.1 and ASHRAE 90.

1. Pressure and Leakage

   a. Design all supply and mixed air ducts for 2 in.wg.0 pressure class, sealed to SMACNA Seal Class A; all return and relief ducts for 1 in.wg, Seal Class.

   b. Leak Test a minimum of 10% of the highest-pressure sections; allowable leakage ≤ 4 cfm/100 ft² of duct surface at the test pressure.

2. Materials and Joints

   a. Galvanized Steel, G90 coating 26 ga to 12 in. width, 24 ga to 30 in, 22 ga above 30 in. Use 304SS or aluminum in corrosive area.

   b. Transverse joints: SMACNA TDC/TDF profile or companion- angle flange with gasketed connection; longitudinal seams Pittsburgh-lock or grooved snap lock.

   c. Flexible duct (UL-181, Class 1) permitted only at diffuser drop, max 5ft length, stretch tight, R-6 insulation, internally supported.

   d. Provide mechanically fastened joints throughout the entire duct system, sealing every seam, opening, and penetration to ensure a continuous air- and water-tight assembly.

   e. Design, fabricate, and support all ductwork to withstand all applicable loads—including internal pressure, vibration, thermal expansion, wind, snow, ice, and other environmental forces—supplementing with any additional structural support required for stability.

3. Fittings & Accessories

   a. Provide radius elbows with double-wall turning vanes for throat r < 1.5 W.

   b. Furnish duct access doors (minimum 18 × 18 in.) for coils, smoke detectors, fire/smoke
   dampers, and any device requiring service.

4. Supports & Vibration Isolation

   a. Strap or trapeze supports per SMACNA Table A-1: max 10 ft spacing for ≤ 24 in. ducts and 7 ft for larger sizes; provide additional mid-span hangers for flexible connectors.

   b. Install canvas/neoprene flexible connectors at the air handler at penetrations to prevent vibration transmission. Install canvas/neoprene flexible connectors at the air handler at penetrations to prevent vibration transmission.

5. Insulation &Acoustic Treatment

a. Supply ducts: external foil-scrim fiberglass wrap, R-6 (2 in.) in conditioned spaces, R-8 (2½ in.) in unconditioned spaces; vapor-seal all seams.

b. Return/relief ducts: external R-4 (1½ in.) wrap in conditioned spaces.

c. First 10 ft downstream of the supply fan and any ductwork above occupied spaces shall receive a 1-in. dual-density liner (Max NRC 0.75) with antimicrobial coating for noise attenuation.

6. Identification

Label all mains, branches, fire/smoke dampers, and accessories with 1-in. vinyl letters and directional arrows; provide colored tape bands every 20 ft (blue = supply, green = return, yellow = outside air).

PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturers. Install units' level, plumb, and firmly anchored in locations and at heights indicated.

B. Install all equipment in strict compliance with applicable laws and the latest rules and regulations of all municipal and other public agencies having jurisdiction over this work.

C. Complete the utility service connections to provide a fully functional restroom facility.

D. Install water hammer arrester on water line.

E. Install heating and ventilating equipment, wiring and accessories to comply with manufacturer's written instructions.

F. Install electrical components to comply with manufacturer's written instructions.

3.02 CLEANING

A. Adjust accessories for unencumbered, smooth operation.

B. Replace damaged or defective items.

C. Remove temporary labels and protective coatings.

D. Clean and polish exposed surfaces.

3.03 WARRANTY

A. For all items of work to be performed under this article, guarantee each item against defects in material and workmanship for a period equal to the standard warranty period of the manufacturer or the industry, whichever is longer. Commencement of the warranty period begins after final acceptance of the work. In the event of a legitimate claim, replace or repair the defective item, in whole or in part, as necessary, to restore the item to its original intended state.

3.04 PIPING

A. Exposed Piping: Locate insulation and cover seams in least visible locations.

B. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, up to 3’ from the pump seal water connection.

1. Provide standard jackets with or without vapor barrier, factory applied or field applied.

2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.

3. Finish with glass cloth and vapor barrier adhesive.

4. PVC fitting covers may be used.

5. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

6. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

7. Provide formed insulation segments capable of being removed for service and reinstalled without damage to the segments or vapor barrier sealing tapes for valves, pipe flanges, unions, and valve flanges.

C. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07840 for penetrations of assemblies with fire resistance rating greater than one hour.

D. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all- purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

E. Insulate piping and equipment less than 8 foot above finished floors in locations accessible to personnel contact so that temperatures of exposed surfaces do not exceed 180 degrees F.

END OF SECTION

SECTION 23 05 14 - HVAC VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

A. Description

This section includes variable frequency drive and associated line reactor requirements for HVAC equipment.

B. Related Work Specified Elsewhere

1. Supply Fan (SF-1): 23000.

C. Submittals

1. Submit shop drawings in accordance with the General Conditions and Section 013300.
2. 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.

D. Operation and Maintenance Data

1. AII operations and maintenance data shaft comply with the submission and content requirements specified under General Conditions.

E. Equipment Startup and Agency Training

1. 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.

F. Warranty

1. 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.

PART 2 MATERIALS

A. Products

1. Manufacturers:
   a. Danfoss
   b. Or approved equivalent.

B. Design and Construction

1. The unit shall be variable torque, modular design for control of the motors as specified in Section 230513 and rated at the motor full load nameplate amps.
2. The unit shall be U.L. listed, solid state, microprocessor-based with a pulse width modulated (PWM) output wave form.
3. The VFD shall employ a full wave bridge rectifier and capacitors to minimize the ripple of the rectified voltage tomaintain near constant DC voltage. Insulated gate bipolar transistors (IGBT's) shall be employed as the output switching device.
4. 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.
5. Control circuitry shall be plug-in, plug-out modular basis with a corrosion resistant coating on printed circuit boards.
6. Units to be suitable for an operating environment from 0°C to 40°C temperature and humidity up to 90% non-condensing.
7. 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.
8. The unit enclosure shall be NEMA 12 as required for the application minimum and all components shall be fully factory assembled and tested prior to leaving the manufacturing facility.
9. Include the following operating and monitoring devices mounted on the front cover:
    a. Operating mode selector switch marked "hand-off-auto".
    b. Manual speed adjustment via keypad, mounted on the door.

C. Performance Requirements

1. Units shall be suitable for input power of electrical system as scheduled on the drawings 10%, 3 phase, 60 Hertz nominal.
2. 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.
3. 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.
4. Additional performance capabilities to include the following:
    a. Ride through a momentary power outage of 15 cycles.
    b. Start into a rotating load without damage to drive components or motor.
    c. Capable of automatic restart into a rotating load after a preset, adjustable time delay following a power outage.
    d. Input power factor: Min 0.95 throughout the speed range.
    e. Minimum efficiency: 95% at 100% speed, 85% at 50% speed.

D. Control Features

1. 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.

2. Include the following additional control features:

   a. Hand-Off-Automatic (HOA) selector switch to select local or remote start/stop and speed control.

   b. Local speed control at the VFD.

   c. 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.

   d. Adjustable minimum and maximum speed settings for manual modes of operation.

   e. Field adjustment of minimum and maximum output frequency.

   f. Two (2) sets of programmable form “C” contacts for remote indication of variable frequency

   g. drive condition. Note: default programming to be set for “Drive Run & Fault”.

   h. Illuminated display keypad.

   i. External Fault indicator.

   j. One (1) input for a N.O. dry contact type input for a 2-wire remote start/stop.

   k. 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 the VFD operation when external fault is present.

   l. 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.

   m. PID control loop capable of VFD control from an external device connected to a VFD analog input.

3. The VFD controller shall convert VFD information into the BACnet MSTP 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:

   a. Fault condition.

   b. Speed.

   c. Amperage.

   d. Frequency.

   e. Voltage.

E. Protection Features

1. 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:

   a. Activation of any safety device.

   b. Instantaneous overcurrent and/or over voltage of output.

c. Power line overvoltage and undervoltage protection.

d. Phase loss.

e. Single and three phase short circuiting.

f. Ground faults.

g. Control circuit malfunction.

h. Overtemperature.

i. Output current over limit.

2. Provide the following additional protective features:

a. Input transient overvoltage protection up to 3000 volts per ANSI 37.90A.

b. 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.

c. Fusing for the control circuit transformer.

d. Grounded control chassis.

F. Diagnostics

1. Provide an English character display (no error codes) with indicators for the following:

a. Phase loss.

b. Ground fault.

c. Overcurrent.

d. Overvoltage.

e. Undervoltage.

f. Over temperature.

g. Overload.

h. DC bus status.

G. Quality Assurance Tests

1. Use a factory heat stress test to verify proper operation of all functions and components under full load.

2. Field performance test of variable frequency drives to determine compliance with this specification will be performed at the Owner'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.

3. Variable frequency drive manufacturer or designated representative to perform a field test of each drive for the following items:

a. Provide general inspection to verify proper installation.

b. Demonstrate drive reaction to simulated power interruptions of two seconds and sixty seconds.

H. AC Input Line Reactors

1. When needed to comply with the requirement for 5% equivalent impedance, furnish and

factory install AC input line reactors.

2. 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.

3. 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

A. Variable Frequency Drives

1. Install where indicated on drawings and in accordance with approved submittals and manufacturer's published recommendations. Installation to be by the Division 23 Mechanical contractor.

2. Input power wiring shall be installed in a separate conduit and output power 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. If provided, do not mount output line filter above the drive.

3. Feed input power to the VFD from the load side of the HVAC equipment control panel

4. disconnect switch and motors per HVAC unit manufacturer’s recommendations.

5. The VFD may be mounted in or attached to the HVAC unit mounted control panel as an alternative to the remote wall mounting if:

   a. Approved by the HVAC unit manufacturer.

   b. Adequate room is available.

   c. Adequate ventilation is available or is made available to prevent overheating of the VFD and unit mounted control panel.

6. Power wiring shall be furnished and installed by the Division 26 contractor.

7. Control signal for drive will be provided under Division 23.

8. Division 23 Contractor will furnish and install the required temperature control wiring in conduit and in accordance with Division 26 requirements.

B. Agency Training

1. 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

SECTION 23 09 93 - AUTOMATIC CONTROL

SEQUENCES PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide control sequences for HVAC systems, subsystems, and equipment as indicated and in compliance with Contract Documents.

1.02 DEFINITIONS:

A. Control Sequences: Manner and method by which automatic temperature controls function. Requirements for each type of operation are described in this section

B. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA)

C. BAS: Building automation system

D. DDC: Direct Digital Control

E. Binary Output: On/off output signal or contact closure

F. Digital Output: Data output that must be interpreted digitally

G. Manual Mode: Mode or position-controlled device assumes when under manual control. Unless otherwise specified, manual mode implied and affects only device for which manual mode or position identified

H. Normal Mode: Mode or position-controlled device assumes without power

I. Automatic Mode: Mode or position-controlled device assumes when under control of automatic system of controls

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data:

1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.
3. A BAS/DDC point list for each controlled system identifying all input points, output points, proof points, alarm points, adjustable setpoints, and operator workstation indication points required to ex- ecute and monitor the sequences specified herein.

C. Shop Drawings:

1. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed including adjustable range of control. Show the location of control elements in the system.
3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals. Clearly identify factory and field wiring requirements.
4. Control panel mounted devices including door mounted control elements.
5. Sequence diagrams or control schematics showing the relationship between field devices, interlocks, safety devices, BAS/DDC points, and final control elements for each system identified in this Section.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 REFERENCE PRODUCTS

A. Supply Fan Unit Reference Section 23 00 00.

B. Unit Heater Reference Section 23 00 00.

C. Dampers Reference Section 23 00 00.

D. Exhaust Fans Reference Section 23 00 00.

E. Louvers Reference Section 23 00 00.

F. Provide BAS/DDC control devices, field controllers, sensors, actuators, relays, and interface devices com- patible with the project building automation system and suitable for the control sequences indicated in this Section.

PART 3 - EXECUTION

3.01 GENERAL DDC REQUIREMENTS

A. DDC control for the systems described in this Section. BAS/DDC shall function as the primary

automatic control platform and shall coordinate the sequences, interlocks, monitoring, and alarm reporting described herein.

B. Hard-wired safety devices, smoke detection devices, thermal cutouts, and manufacturer-required protective controls shall remain primary and shall take precedence over BAS/DDC commands. BAS/DDC shall mon- itor available alarm and status points associated with such safety devices.

C. Unless specifically noted otherwise, provide BAS/DDC capability to indicate command status, run/proof status, available fault or trip status, adjustable setpoints, and space or duct temperature associated with each controlled sequence.

D. Where hand-off-auto switches, local selector switches, or balancing-only speed controls are furnished, BAS/DDC shall monitor their status where available and shall coordinate automatic operation when devices are in the automatic position.

E. Provide operator workstation graphics and trend-capable points for the major control variables identified in each sequence, including temperatures, commands, status points, alarms, and damper or VFD outputs as applicable.

3.02 SUPPLY FAN UNIT

A. Units Served:

1. SF-1: 1,500 CFM square inline centrifugal supply fan, direct drive backward-inline wheel, serving ventilation air distribution.

B. General:

1. Provide a return-air smoke detector per local code requirements for Supply Fan SF-1, close any out- door-air damper OR run respective fans with respective dampers open, as preferred by the Authority Having Jurisdiction, when a duct smoke condition is detected, and broadcast an alarm upon smoke detection.
2. Supply Air Damper and Exhaust Air Damper work in unison.
3. Provide BAS/DDC control to monitor and control SF-1, VFD speed command, electrical room tem- perature, smoke detector status, and the outdoor-air and exhaust-air dampers associated with this sequence.
4. The DCC controller shall coordinate the automatic mode sequence and provide operator workstation indication and alarm reporting for the control points identified below.

C. Manual Mode: On

1. SF-1 supply fan: energized.
2. Outdoor Air Damper (CD-5): Open.
3. Exhaust Air Damper (CD-6): Open.

D. Manual Mode: Off

1. SF-1 supply fan: de-energized.
2. Outdoor Air Damper (CD-5): Closed.
3. Exhaust Air Damper (CD-6): Closed.

E. Automatic Mode: On

1. Energize SF-1 supply fan and operate continuously with outdoor air damper in the minimum position.
2. Modulate VFD speed to maintain duct static pressure setpoint or maintain commanded airflow.
3. When the electrical room temperature rises above the adjustable high-temperature enable setpoint of 85°F (adjustable), the supply fan (SF-1) shall operate and provide outdoor-air cooling by opening/modulating the outdoor air damper as required. The supply fan shall be VFD-controlled and modulated to maintain room temperature, operating between a minimum airflow of 450 CFM and a maximum airflow of 1500 CFM. As room temperature increases, fan speed shall increase up to 1500 CFM as required; as room temperature decreases, fan speed shall be reduced accordingly, but the fan shall not shut down and shall maintain a minimum airflow of 450 CFM. When the room temperature falls below the adjustable low-temperature setpoint of 75°F, the fan shall remain in operation at the minimum 450 CFM setting, and the outdoor/exhaust air damper shall return to its minimum position.

F. DDC Control Requirements:

1. Input Device

a. Electrical room space temperature sensor; transference: DDC controller.
b. Duct static pressure sensor or airflow transmitter, as applicable to the selected control sequence; transference: DDC controller.
c. SF-1 fan status/proof and VFD run status/fault status; transference: DDC controller.
d. Duct smoke detector alarm status; transference: DDC controller.
e. Damper position or end-switch status and HOA status where provided; transference: DDC controller.

2. Output Device:

a. Binary enable command to SF-1/VFD.
b. Analog speed command to the VFD to modulate between minimum and maximum operating airflow.
c. Analog or open/close command to Outdoor Air Damper CD-5 and Exhaust Air Damper CD- 6, operating in unison.

3. Operator Workstation Indications:

a. DDC system graphic.
b. SF-1 command status and run status.
c. Electrical room temperature.
d. High-temperature enable setpoint and low-temperature setpoint.
e. Duct static pressure setpoint or commanded airflow, as applicable.
f. VFD speed command/status and available fault indication.
g. Outdoor Air Damper CD-5 command/position.
h. Exhaust Air Damper CD-6 command/position.
i. Duct smoke detector alarm status.

4. Alarms:

a. Duct smoke detection.

b. Fan failure to start or prove when commanded.
c. VFD fault or trip

3.03 INTERLOCKED EXHAUST (Restroom 102)

A. Units Served:

1. Exhaust Fan EF-2
2. Outdoor Air Damper CD-3
3. Electric Wall Heater EWH-1

B. General

1. Interlock Outdoor Air Damper CD-3 to be open when Exhaust Fan EF-2 is running (closed when Exhaust Fan EF-2 is not running).
2. Fan speed control is for balancing purposes only and should not be located where occupants can adjust.
3. Interlock Exhaust Fan EF-2 with light switch to be running when lights are on (not running when lights are off).
4. Provide BAS/DDC control to monitor light switch status, Exhaust Fan EF-2 status, Outdoor Air Damper CD-3 command/position, Restroom 102 space temperature, and Electric Wall Heater EWH-1 enable/status as available. BAS/DDC shall coordinate the automatic sequence described herein.

C. Manual Mode: Off

1. Exhaust Fan EF-2: Not Running
2. Outdoor Air Damper CD-3: Closed
3. Electric Wall Heater EWH-1: Off

D. Manual Mode: On

1. Exhaust Fan EF-2: Running
2. Outdoor Air Damper CD-3: Open
3. Electric Unit Heater EWH-1: On

E. Automatic Mode: On.

1. Exhaust Fan EF-2 shall be running with Outdoor Air Damper CD-3 in the open positions whenever the Restroom 102 lights are on.
2. Exhaust Fan EF-2 shall not be running with Outdoor Air Damper CD-3 in the closed positions whenever the Restroom 102 lights are off.
3. Energize Electric Wall Heater EWH-1 heating stage(s) and fan when the Restroom 102 space tem- perature is below the Restroom 102 heating setpoint temperature of 70°F (adjustable).
4. De-energize Electric Wall Heater EWH-1 heating stage(s) and fan when the Restroom 102 space temperature is above the Restroom 102 heating setpoint temperature of 70°F (adjustable).

F. DDC Control Requirements:

1. Input Device:

a. Restroom 102 light switch status; transference: DDC controller.
b. Exhaust Fan EF-2 run status/proof; transference: DDC controller.
c. Restroom 102 space temperature sensor or DDC-compatible thermostat; transference: DDC controller.
d. Outdoor Air Damper CD-3 position or end-switch status; transference: DDC controller.
e. Electric Wall Heater EWH-1 status and available safety status; transference: DDC controller.

2. Output Devices:

a. Binary command to Exhaust Fan EF-2.
b. Open/close command to Outdoor Air Damper CD-3.
c. Binary enable to Electric Wall Heater EWH-1 and associated fan, or interface to interface to packaged controls, as required for a complete sequence.

3. Operator Workstation Indications:

a. DDC system graphic.
b. Restroom 102 light status.
c. Exhaust Fan EF-2 command status and run status.
d. Outdoor Air Damper CD-3 command/position.
e. Restroom 102 space temperature.
f. Restroom 102 heating setpoint.
g. Electric Wall Heater EWH-1 enable/status.

4. Alarms:

a. Exhaust Fan EF-2 failure to start or prove when commanded.
b. Available Electric Wall Heater EWH-1 safety trip or fault indication.

3.04 INTERLOCKED EXHAUST (Janitor/Storage 103)

A. Units Served:

1. Exhaust Fan EF-1
2. Outdoor Air Damper CD-1
3. Exhaust Air Damper CD-4
4. Electric Wall Heater EUH-2

B. General

1. Interlock Outdoor Air Damper CD-1 and Exhaust Air Damper CD-4 to be open when Exhaust Fan EF-1 is running (closed when Exhaust Fan EF-2 is not running).
2. Fan speed control is for balancing purposes only and should not be located where occupants can adjust.
3. Provide BAS/DDC control to monitor Exhaust Fan EF-1 status, Outdoor Air Damper CD-1 com- mand/position, Exhaust Air Damper CD-4 command/position, Janitor/Storage 103 space tempera- ture, and Electric Wall Heater EUH-2 enable/status as available. BAS/DDC shall coordinate the automatic sequence described herein.

C. Manual Mode: Off

1. Exhaust Fan EF-1: Not Running
2. Outdoor Air Damper CD-1: Closed
3. Exhaust Air Damper CD-4: Closed
4. Electric Wall Heater EUH-2: Off

D. Manual Mode: On

1. Exhaust Fan EF-1: Running
2. Outdoor Air Damper CD-1: Open
3. Exhaust Air Damper CD-4: Closed
4. Electric Unit Heater EUH-2: On

E. Automatic Mode: On.

1. Exhaust Fan EF-1 shall be running with Outdoor Air Damper CD-1 and Exhaust Air Damper CD-4 in the open positions whenever the Janitor/Storage 103 lights are on.
2. Exhaust Fan EF-1 shall not be running with Outdoor Air Damper CD-1 and Exhaust Air Damper CD-4 in the closed positions whenever the Janitor/Storage 103 lights are off.
3. Energize Electric Wall Heater EUH-2 heating stage(s) and fan when the Janitor/Storage 103 space temperature is below the Janitor/Storage 103 heating setpoint temperature of 70°F (adjustable).
4. De-energize Electric Wall Heater EUH-2 heating stage(s) and fan when the Janitor/Storage 103 space temperature is above the Janitor/Storage 103 heating setpoint temperature of 70°F (adjustable).

F. DDC Control Requirements:

1. Input Devices:

    a. Janitor/Storage 103 light switch status were used for the sequence; transference: DDC controller.
    b. Exhaust Fan EF-1 run status/proof; transference: DDC controller.
    c. Janitor/Storage 103 space temperature sensor or DDC-compatible thermostat; transference: DDC controller.
    d. Outdoor Air Damper CD-1 position or end-switch status; transference: DDC controller.
    e. Exhaust Air Damper CD-4 position or end-switch status; transference: DDC controller.
    f. Electric Wall Heater EUH-2 status and available safety status; transference: DDC controller.

2. Output Devices:

    a. Binary command to Exhaust Fan EF-1.
    b. Open/close command to Outdoor Air Damper CD-1.
    c. Open/close command to Exhaust Air Damper CD-4.
    d. Binary enable to Electric Wall Heater EUH-2 and associated fan, or interface to packaged controls, as required for a complete sequence.

3. Operator Workstation Indications:

    a. DDC system graphic.
    b. Janitor/Storage 103 sequence enable or light status, as applicable.

c. Exhaust Fan EF-1 command status and run status.
d. Outdoor Air Damper CD-1 command/position.
e. Exhaust Air Damper CD-4 command/position.
f. Janitor/Storage 103 space temperature.
g. Janitor/Storage 103 heating setpoint.
h. Electric Wall Heater EUH-2 enable/status.

4. Alarms:

a. Exhaust Fan EF-1 failure to start or prove when commanded.
b. Available Electric Wall Heater EUH-2 safety trip or fault indication.

3.05 UNIT HEATERS

A. Control Sequence

1. Units Served

a. EWH-1
b. EUH-1
c. EUH-2

2. General:

a. Units shall be interlocked with building power and safety cutouts to prevent overheating.
b. Provide BAS/DDC control and monitoring for the unit heaters identified above. BAS/DDC shall monitor the applicable space temperature and command heater enable/fan operation to satisfy the adjustable heating setpoint. Where unit heaters are also addressed under inter- locked exhaust sequences above, BAS/DDC shall coordinate heater operation with the associated exhaust sequence.
c. Local high-limit, thermal cutout, and manufacturer-provided protective controls shall remain integral to the unit and shall interrupt heater operation as required. BAS/DDC shall monitor available status and alarm points associated with these devices.

3. Normal Mode - Off

a. Fan: Off
b. Heating Element: Off

4. Automatic Mode - On:

a. Units shall be controlled by a space thermostat set at 70 °F (adj).
b. On call for heat, energize unit heater fan and heating elements.
c. When space heating requirements are satisfied, de-energize heating elements and fan if not equipped with fan off-delay.

5. DDC Control Requirements:

a. Inputs: Space temperature sensor/thermostat status, unit heater run status where available, and available safety cutout status.
b. Outputs: Binary unit heater enable and/or staged heat enable as furnished with the unit.

c. Operator Workstation Indications: Space temperature, adjustable heating setpoint, unit command/status, and available alarm or safety status.

END OF SECTION

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. Electrical equipment coordination and installation.
2. Common electrical installation requirements.
3. Firestopping of electrical installation

1.3 SUBMITTALS

A. General

1. Make all submittals in accordance with Division 1, herein, and individual sections in Divisions 26.
2. Identify all submittals with corresponding specification section number and name. Each submittal shall typically be limited to one specification section, except in cases where similar equipment or services are commonly furnished in one package, e.g., short-circuit, coordination, and arc-flash studies; or low-voltage distribution equipment such as switchboards, panelboards, disconnects, and motor controls; or interior lighting, exterior lighting, emergency and exit lighting.
3. Clearly identify all submittals with project name and location, and manufacturer's name. Contractor shall thoroughly review and approve all submittals for accuracy and completeness prior to submitting to Architect. Mark each submittal with company name, reviewer's initials and date of review. Submittals not so approved and marked will be rejected, and resubmittal will be required.
4. Provide a complete list of all requirements for which submitted products are NOT in conformance with Specifications and Drawings, and associated reasons for non-conformance. Unless noted otherwise on submittal, products are assumed to meet all Specification and Drawing requirements and are expected to be furnished in accordance with those requirements.
5. Clearly mark product data copies to identify pertinent products, models, or part numbers. Circle, highlight, or otherwise clearly identify specific items that are being proposed on the submitted product data or shop drawings. Show performance characteristics and capacities, dimensions and clearances required, and wiring diagrams and controls.

6. Submit indexed and bound sets of shop drawings and/or product data sheets for items listed in individual sections of Divisions 26 prior to ordering material and starting construction.
7. Re-submittals shall be new and complete, void of previous submittal comments and engineer's review stamp, revised to incorporate all comments and additional information as noted or requested on previous submittals, and inclusive of all previous submittal information not requiring revisions.
8. Submit a minimum of one (1) electronic copy and two (2) hard copies of bound and indexed operation and maintenance instruction manuals, parts lists, new and revised, up-to-date shop drawings and product data sheets, void of previous submittal comments and engineer's review stamp, incorporating all previous comments, additional requested information, addendum and bulletin changes, etc., and record drawings for items listed in individual sections of Divisions 26 test reports, as part of close-out documents.
9. Submit documentation of electrical inspection final approval.

1.4 QUALITY ASSURANCE

A. Furnish only new, first-class quality, materials and equipment, delivered, erected, connected and finished in every detail, selected and arranged to fit properly into building spaces. Where no specific kind or quality of material is specified, furnish first-class standard article, approved by Architect.

B. Furnish services of one or more experienced superintendents, to be in charge of installation of work, and all skilled workmen, electricians and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

C. Provide all component parts of each item of equipment or device with manufacturer's nameplate, giving name of manufacturer, description, size, type, serial number, electrical characteristics, etc., to facilitate maintenance or replacement. Nameplate of Subcontractor or distributor is not acceptable.

D. Job conditions, which govern when and how products shall be installed, are generally covered in Division 1 and specifically covered in individual paragraphs of Division 26.

E. Do NOT install any product where it might be exposed to environment that is extremely different to that in which it was intended to be normally used.

F. Perform all work in close cooperation with other trades and utility companies.

G. Comply with latest edition or revision of each standard or code mentioned in these specifications and as follows:

1. American National Standard Institute (ANSI)
2. American Society for Testing Materials (ASTM)
3. National Electrical Manufacturer's Association (NEMA)
4. Underwriters' Laboratories (UL)
5. National Fire Protection Association (NFPA) -
6. State and Local Municipality Building and Electrical Codes and Ordinances.

H. 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.

I. Execute all work in conformity with best standards of practice. Lay out and install work in accordance with drawings, manufacturer's instructions, shop drawings, and field layouts of other trades.

J. Drawings are diagrammatic and indicate the general arrangement and intent of systems and work included in these documents.

K. Furnish all labor, material and equipment to install and successfully test electrical systems and work, complete and in place, as herein specified and as shown on drawings.

L. Program all monitoring and control systems for all equipment with input from Owner.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Division 1 for general requirements pertaining to delivery, storage and handling.

B. Protect materials before, during and after installation.

C. In event of damage, immediately make all repairs and replacements necessary at no additional cost.

D. Deliver all materials to job-site in original unopened containers, where applicable, with all labels intact and legible at time of use. Store in strict accordance with manufacturer's recommendations.

E. Examine all equipment and material delivered to jobsite prior to installation to ensure all specification requirements and shop drawing notes and comments have been incorporated by manufacturer. Installation of equipment or material signifies Contractor’s acceptance and approval of equipment or material from manufacturer.

1.6 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. In cases of interferences between various items of equipment and building features, or if simplified construction is made possible by relocation of certain equipment, bring such conditions to attention of Architect. Changes in arrangements may be made only if authorized by Architect.

C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

D. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

E. Substitutions and Changes

1. Comply with Instructions to Bidders.
2. Contractor is responsible to notify all parties concerned of any changes or substitutions he has been authorized to make, and must include in his notice a full description, including drawings if necessary, of any deviation from dimensions shown on plans of any trade.
3. If Contractor provides equipment other than that upon which design is based, it shall be his responsibility to coordinate its installation with work of all other trades and with space available, and pay for any changes caused to other trades as a result of this substitution.
4. If other contractors provide equipment other than that upon which design is based, electrical contractor shall coordinate electrical equipment and connections, including sizes of switches, fuses, breakers, starters, wiring, etc., with requirements of furnished equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material shall be produced by company which has been engaged in manufacture of such types of materials for period of at least five (5) years.

B. Provide electrical products as described under specific paragraphs in this division. Refer to various paragraphs for correct product identification (e.g. “Low-Voltage Electrical Power Conductors and Cables”, Section 260519).

2.2 SPARE MATERIAL

A. Refer to individual sections for spare material requirements.

Sleeves and sleeve seals have been removed from this section and located in Section 260544.

PART 3 - EXECUTION

3.1 PREPARATION

A. Drawings constituting part of these documents are diagrammatic and indicate general arrangement of systems and work included in documents.

B. Coordinate necessary preparation required for electrical equipment installation with all trades.

C. Carefully check and coordinate location and level of all lighting fixtures, conduits, junction boxes, etc., located in exposed ceiling areas. If conflicts occur, follow space preference below (in order of first to last):

1. Recessed lighting fixtures.
2. High pressure ductwork.
3. Air terminal units.
4. Low pressure ductwork.
5. Cable tray.
6. Soil, waste, vent, and storm piping.
7. Sprinkler piping.
8. Liquid heat transfer and refrigerant piping.
9. Domestic water piping.
10. Electrical conduit.

D. Locate conduits, junction boxes, etc., to allow access to air terminal units, piping, control valves, etc., for maintenance and repair. Conversely ensure light fixtures, etc. are clear of piping etc. to allow access for maintenance.

E. Verify locations of outlets and types of connections required for equipment installed by others.

F. Relocate any improperly located outlet, and replace any incorrect connection caused by lack of preparation or coordination. Also, repair to the Architect's/Owner's satisfaction any hole, etc., caused by these relocations/replacements.

3.2 ADJUSTMENTS AND CLEANING

A. Cutting and Patching

1. Do all cutting and patching necessary for installation of electrical work with approval, and under supervision of, Architect.
2. Do not impair strength or function of work being cut or patched, i.e., do not weaken structural members and waterproof holes through exterior walls and ground floor. Use rotary type drilling tools and concrete cutting saws to cut

concrete and masonry walls. Do not use torches for cutting steel.

B. Wall, Floor and Ceiling Openings

1. Place all sleeves necessary for electrical installation and advise other Contractors of all openings necessary for installation of electrical work.
2. Provide sleeves necessary for installation of fire alarm, telephone, video, data, sound, etc., system cables. If system wiring has not been installed at time of building official's inspection, seal all sleeves. Subsequent penetrations and sealing will be done by System Contractor.
3. Repair and finish all holes placed for conduit if such holes are placed after general construction is completed.
4. For fire-rated stud wall or partitions, provide 24 inch minimum horizontal separation between boxes on opposite sides of same wall or partition unless noted otherwise on Drawings and where an engineered solution such as applying UL listed fire stop material similar to Hilti CP 617 firestop putty pads, around backs of offending boxes is indicated on Drawings.

C. Excavation and Backfill

1. Perform excavation and backfilling necessary to install the electrical system in accordance with Contract Documents and appropriate sections of Divisions 26.

D. Concrete Work

1. Bases for outdoor lighting standards, raised pads for switchboards, distribution panels, switchgear, substations and similar equipment, and pads for transformers, including the setting of mounting bolts, constructed by Division 3 Contractor.
2. Furnish mounting bolts, place conduit; and deliver mounting and placement templates to Division 3 Contractor.

E. Painting

1. Furnish panelboards and cabinets in finished areas with prime coat of paint. Furnish panelboards and cabinets in unfinished areas with standard factory finish.
2. Paint all fire alarm system panels, emergency panels and associated junction boxes, and pull boxes red.

F. Protection

1. Provide final protection of all electrical conduit, wiring, enclosures, equipment and panels, and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of substantial completion.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
3. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
4. Protect all electrical and electronic equipment from falling metal shavings before and during construction.

G. Housekeeping and Clean-up

1. Remove from site all debris and rubbish accumulating as result of electrical installation. Dispose of all debris and rubbish. Leave all electrical equipment rooms broom clean.
2. Clean interiors of all cabinets, pull boxes, and equipment enclosures. Clean all electrical equipment, including lighting fixtures, at time of Substantial Completion.
3. Refer to Division 1 for additional requirements.

3.3 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Install all equipment and systems according to manufacturer's recommendations, and as outlined in individual paragraphs of these documents, to provide complete and totally operational systems.

C. Comply with working clearances and dedicated spaces per NEC Article 110.

D. Mount all equipment on exterior walls and in damp and wet locations on steel channel support providing separation between equipment and mounting surface(s).

E. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

F. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

G. Right of Way: Give to piping systems installed at a required slope.

3.4 FIRESTOPPING

A. Firestop Systems for Electrical Low-Voltage Cabling Sleeves:

1. Provide for re-penetration of cables.
2. Smoke gaskets shall eliminate need for sealant or putty.
3. Hilti Firestop Speed Sleeves, Model CP653BA.

    a. Nominal size 2", with 1.7" inside diameter, 2.3" outside diameter, 4.7" flange, 12.4" length.
    b. Nominal size 4", with 3.6" inside diameter, 4.3' outisde diameter, 4.7" flange, 12.4" length.

3.5 FIELD QUALITY CONTROL

A. Conduct following tests on electrical installation during the course of construction:

1. Test conductors for grounds and shorts.
2. Test ground system.
3. Check all motors for proper rotation prior to coupling to equipment.
4. Test emergency system.
5. Test all ground fault protection equipment before temporary service is removed. Obtain test procedure from manufacturer and review procedure with Architect before conducting test.
6. Test phasing of switchboards and panelboards for compliance with NEC Article 408.
7. Test other systems as recommended by system manufacturer and as specified elsewhere.

B. Upon completion of the project:

1. Adjust voltage taps on all transformers for an optimum operating level.
2. Aim all adjustable lighting fixtures.
3. Adjust all auxiliary systems for optimum performance.
4. Measure load balance under near full-load conditions on all panelboards with true RMS reading meters, and reconnect loads as may be necessary to obtain reasonable balance of load between phases. Relabel affected equipment, devices, junction boxes, wiring, panelboard directories, etc., due to load reconnection and branch circuit number changes. Provide two (2) copies of final balance report indicating measured load current on each phase and neutral current for each panelboard.
5. Perform following tests and inspections, to verify tightness of connections, and prepare reports.

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of all electrical connections in switchgear, switchboards, panelboards, switches, circuit breakers, motor controls, busway, transformers, generators, transfer switches, etc., and each splice in cables and conductors for No. 3 AWG and larger, while carrying normal load. Remove front and rear covers of equipment and boxes so joints, splices, and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of 11 months after date of Substantial Completion.
    c. Instrument: Use an infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record device.
    d. Report: Prepare a certified report that identifies each piece of equipment checked and describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

END OF SECTION 260500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Copper building wire rated 600 V or less.
2. Bus Charger DC Power Cables.
3. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

A. DLO: Diesel Locomotive Cable.

B. RoHS: Restriction of Hazardous Substances.

C. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

Select from the following paragraphs.

A. No submittals required.

B. Product Data: For each type of product.

C. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

A. Certified field quality-control reports.

B. Length of cables for each feeder on project, including cabling to distribution equipment (switchboards, distribution panelboards, panelboards, busway, etc.). Branch circuits are not included in the requirement. Include both estimated length used for bidding and actual length installed, for use in short-circuit, coordination and arc flash hazard studies.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire Company.
2. American Bare Conductor.
3. Belden Inc.
4. Cerro Wire LLC.
5. Encore Wire Corporation.
6. General Cable Technologies Corporation.
7. Okonite Company (The).
8. Service Wire Co.
9. Southwire Company.
10. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 ASTM B 496 for stranded conductors.

E. Conductor Insulation:

1. Comply with NEMA WC 70/ICEA S-95-658.
2. Type USE-2 and Type SE: Comply with UL 854.
3. Type RHH and Type RHW-2: Comply with UL 44.
4. Type THHN and Type THWN-2: Comply with UL 83.
5. Type THW and Type THW-2: Comply with UL 83.
6. Type XHHW-2: Comply with UL 44.

F. Shield:

1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.2 BUS CHARGER DC POWER CABLES

A. Description: Heavy duty flexible power cable, insulated, drawn tinned copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 2000 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire Company.
2. American Bare Conductor.
3. Belden Inc.
4. Cerro Wire LLC.
5. Encore Wire Corporation.
6. General Cable Technologies Corporation.
7. Okonite Company (The).
8. Service Wire Co.
9. Southwire Company.
10. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper, ASTM B33 for tinned annealed copper, and ASTM B172 for rope-lay-stranded copper conductors having bunch stranded members.

E. Conductor Insulation:

1. Comply with NEMA WC 70/ICEA S-95-658.
2. Type RHH/RHW-2: Comply with UL 44.
3. Type HDFPC-DLO: Comply with UL Subject 2806

F. Shield:

1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M Electrical Products.
2. AFC Cable Systems; a part of Atkore International.
3. FCI - Burndy Products.
4. Gardner Bender.
5. Hubbell Power Systems, Inc.
6. Ideal Industries, Inc.
7. ILSCO.
8. NSi Industries LLC.
9. O-Z/Gedney; a brand of Emerson Industrial Automation.
10. Service Wire Co.
11. TE Connectivity Ltd.
12. Thomas & Betts Corporation; A Member of the ABB Group.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Duplex connectors for Type MC cable, permitting termination of (2) cables per fitting, are not acceptable.

E. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper or Aluminum as required for conductor material.
2. Type: One or Two hole with standard or long barrels as required.
3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Stranded copper for feeders smaller than No. 4 AWG; stranded copper or aluminum for feeders No. 4 AWG and larger. Conductors shown on drawings are sized as copper. Provide aluminum conductors with equivalent ampacity and impedance to copper conductors shown on drawings. Increased conductor, lug, and conduit fill sizing are responsibility of Electrical Contractor. Note that lugs must be suitable for aluminum regarding size and material.

B. Branch Circuits: Stranded copper.

C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type USE, single conductor in raceway.

B. Exposed Feeders: Type THHN/THWN-2, Type RHH/RHW-2, Type XHHW-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, Type RHH/RHW-2, Type XHHW-2, single conductors inraceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, Type RHH/RHW-2, Type XHHW-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, Type RHH/RHW-2, Type XHHW-2, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, Type RHH/RHW-2, Type XHHW-2, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, Type RHH/RHW-2, Type XHHW-2, single conductors in raceway.

H. VFC Output Circuits: Type XHHW-2 in metal conduit Type TC-ER cable with braided shield Type TC-ER cable with dual tape shield.

I. Bus Charger Output Power Circuits: Type 2kV HDFPC-DLO, RHH/RHW-2.Single cables in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Do not use conductors smaller than No. 12 AWG for branch circuit wiring.

B. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

C. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables. Install wiring after concrete and masonry work is complete and after moisture is swabbed from conduit.

D. Make conductor lengths for parallel feeders identical.

E. Use manufacturer-approved pulling compound or lubricant where necessary;

compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

H. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems." Secure cables at not more than 30 inch (760 mm) intervals, nor more than 6 inches (150 mm) from boxes, cabinets, racks, outlets, etc.

I. Lace or clip groups of feeder conductors at distribution centers, pull-boxes and wireways.

J. Use No. 10 AWG minimum wire size from panelboard to first outlet for any 277 volt branch circuit exceeding 125 feet between branch circuit panel and first outlet, and for any 120 volt branch circuit exceeding 75 feet between branch circuit panel and first outlet. Increase wire size one size for each additional 125 feet of length for any 277 volt branch circuit, and for each additional 75 feet of length for any 120 volt branch circuit, and adjust conduit size as required.

K. Based upon final feeder or branch circuit routing, up-size conductors to provide a maximum voltage drop of 2 percent for feeders and 3 percent for branch circuits, and a maximum voltage drop on both feeders and branch circuits of 5 percent, as described in NEC Articles 210.19A and 215.2A1 information notes.

L. De-rate branch circuit conductors for multiple home-runs sharing a single raceway per NEC Article 310.15B3.

M. Provide an individual neutral conductor for each phase conductor of branch circuits. Common neutral conductors are NOT allowed.

N. Provide separate neutral conductors for dimmer controlled lighting circuits.

O. Install only switch legs in conduits to switch boxes. Do NOT route power supply conductors through lighting switch boxes.

P. Install emergency system wiring in separate raceways from all other systems.

Q. Install receptacle and lighting circuits in separate raceways.

R. Install 208/120V and 480/277V circuits in separate raceways.

S. Make connections only in junction, pull and outlet boxes; terminal cabinets; and equipment enclosures.

T. Visually inspect, then test all feeders for grounds and short circuits prior to energizing the cable. Replace defective runs, or repair them at Architect's option.

3.4 INSTALLATION OF CABLES NOT ENCLOSED IN RACEWAY

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Install cables per manufacturer’s recommendations without damaging conductors, shields, or jackets.

C. Install exposed cables parallel and perpendicular to building lines and surfaces of exposed structural members. Follow surface contours where possible.

D. Support cables according to Division 26 Section 260529 “Hangers and Supports for Electrical Systems.” Secure cables at not more than 30 inch (760 mm) intervals nor more than 6 inches (150 mm) from boxes, cabinets, racks, outlets, etc.

E. Do not bend cables at less than 1.5 times manufacturer’s recommended minimum bending radii.

F. Do not exceed manufacturer’s recommended maximum pulling tensions.

G. Do not splice, tap, or terminate cables other than in outlets, terminals, or panels or cabinets.

H. Protect cables passing through metal studs, walls, etc., with suitable rubber grommets or conduit sleeves.

I. Separate unshielded voice, video, and data communication cables from EMI sources, power cables, transformers, and power equipment per TIA/EIA 569A requirements.

3.5 CONNECTIONS

A. Use screw on wire connector for copper conductor sizes No. 10 gauge and smaller except at motor connections. Use tool applied compression or split bolt type for all motor connections and for conductors larger than #10. Protect compression and split bolt type splices with suitable electrical tape.

B. Size all connectors to match cable size.

C. Use tools recommended by vendor for applying pressure connectors.

D. Suitable terminal lugs that are factory installed on equipment may be used for terminating cables.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

F. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

G. Splice only in accessible junction or outlet boxes.

H. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. Perform each of the following visual and electrical tests:

a. Verify conductor and cable data matches drawing and specification requirements.
b. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
c. Test bolted connections for high resistance using one of the following:

1) A low-resistance ohmmeter.
2) Calibrated torque wrench.
3) Thermographic survey.

d. Inspect compression-applied connectors for correct cable match and indentation.
e. Inspect for correct identification.
f. Inspect cable jacket and condition.
g. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.

h. Continuity test on each conductor and cable.
i. Uniform resistance of parallel conductors.
j. Verify color coding meets specification requirements.

3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each connection or splice in conductors No. 3 AWG and larger. Remove box and equipment covers so connections or splices are accessible to portable scanner. Correct deficiencies determined during the scan.

   a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   b. Record of Infrared Scanning: Prepare a certified report that identifies connections or splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each connection or splice 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backboards.
2. Category 5e balanced twisted pair cable.
3. Balanced twisted pair cabling hardware.
4. RS-485 cabling.
5. Control cabling.
6. Control-circuit conductors.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

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. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inch (1520 mm) or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inch (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

B. Painting: Paint plywood on all sides and edges with flat black latex or alkyd paint. Comply with requirements in Section 099123 "Interior Painting."

2.3 CATEGORY 6 BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden
2. ADC
3. Berk-Tek; a Nexans company
4. CommScope, Inc.
5. Draka Cableteq USA
6. Genesis Cable Products; Honeywell International, Inc
7. Mohawk; a division of Belden Networking, Inc
8. Superior Essex Inc
9. Leviton Voice and Data Division
10. 3M Communication Markets Division
11. Molex Premise Networks.
12. Or Approved Equal.

C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100 ohm, No. 23 AWG solid copper.

E. Shielding/Screening: Shielded twisted pairs (FTP).

F. Cable Rating: Riser.

G. Jacket: Blue-White/Blue thermoplastic.

2.4 BALANCED TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden
2. ADC
3. Berk-Tek; a Nexans company
4. CommScope, Inc.
5. Draka Cableteq USA
6. Genesis Cable Products; Honeywell International, Inc
7. Mohawk; a division of Belden Networking, Inc
8. Superior Essex Inc
9. Leviton Voice and Data Division
10. 3M Communication Markets Division
11. Molex Premise Networks.
12. Or Approved Equal.

C. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables must be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain balanced twisted pair cable hardware from single source from single manufacturer.

E. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19 inch (483 mm) equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated.

G. Patch Cords: Factory-made, four-pair cables in 48 inch (1200 mm) lengths; terminated with an

eight-position modular plug at each end.

1. Patch cords must have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords must have latch guards to protect against snagging.

H. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.
2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
3. Marked to indicate transmission performance.

I. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standards.

    a. Category 6, unshielded balanced twisted pair cable must comply with IEC 60603-7-4.
    b. Category 6, shielded balanced twisted pair cable must comply with IEC 60603-7.5.

4. Marked to indicate transmission performance.

J. Faceplate:

1. Two port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. Eight port, vertical double gang faceplates designed to mount to double gang wall boxes.
3. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
4. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 TWIN-AXIAL DATA HIGHWAY CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Plastic insulation.

3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.6 RS-232 CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden
2. Allied Wire & Cable Inc.
3. General Cable Technologies Corporation.
4. Genesis Cable Products; Honeywell International, Inc
5. Southwire Company.
6. Or Approved Equal.

B. PVC-Jacketed, TIA 232-F:

1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Polypropylene insulation.
3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
4. PVC jacket.
5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. NFPA 70 Type: Type CM.
7. Flame Resistance: Comply with UL 1581.

C. Plenum-Type, TIA 232-F:

1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PE insulation.
3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
4. Fluorinated ethylene propylene jacket.
5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.7 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.

2.8 CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.9 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Wire & Cable Inc.
2. General Cable Technologies Corporation.
3. Encore Wire Corporation.
4. Southwire Company.
5. Or Approved Equal.

B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

2.10 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Wire & Cable Inc.
2. CommScope, Inc.
3. Comtran Corporation.
4. Draka Cableteq USA
5. Genesis Cable Products; Honeywell International, Inc
6. Prysmian Group North America.
7. Radix Wire.
8. Superior Essex Inc

9. Or Approved Equal.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, No. 16 AWG.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Control-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Low-Voltage Circuits: No. 12 AWG, minimum, in pathway.

2.11 SOURCE QUALITY CONTROL

A. Factory test balanced twisted pair cables according to TIA-568-C.2.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes must be no smaller than 4 inch (102 mm) square by 2-1/8 inch (53 mm) deep with extension ring sized to bring edge of ring to within 1/8 inch (3.1 mm) of the finished wall surface.
2. Flexible metal conduit must not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits 3 inch (75 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96 inch (2440 mm) dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; cable must not contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and must be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inch (760 mm) and not more than 6 inch (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lay on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire must be copper, and grounding methods must comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch (12 mm) at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment..
2. Cable must not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Below each feed point, neatly coil a minimum of 72 inch (1830 mm) of cable in a coil not less than 12 inch (305 mm) in diameter.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire must have a unique tag.

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

B. End-to-end cabling will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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 grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
1. Ground rods.
2. Ground rings.
3. Grounding arrangements and connections for separately derived systems.

B. Certified field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. Include the following:

a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
1) Ground rods.

2) Ground rings.

3) Grounding arrangements and connections for separately derived systems.

b. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NFPA 70B.

1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
2) Include recommended testing intervals.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Dossert; AFL Telecommunications LLC.
3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning & Grounding.
7. ILSCO.
8. O-Z/Gedney; a brand of Emerson Industrial Automation.
9. Robbins Lightning, Inc.
10. Siemens Power Transmission & Distribution, Inc.
11. Thomas & Betts Corporation; A Member of the ABB Group.

2.3 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
1. Stranded Conductors: ASTM B 8.
2. Tinned Conductors: ASTM B 33.

3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of tin-plated annealed copper, 1/4 by 4 inches in cross section, 12 inches minimum length, with 9/32-inch holes spaced 1-1/8 inches apart for NEMA 2-hole connectors and insulators, wall-mounted steel mounting brackets, insulators and holes for NEMA 2-hole connectors and insulators, unless otherwise indicated. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V, and shall be Lexan or PVC, impulse tested at 5000 V.

1. Harger Series T-GBI-M for power grounding applications.
2. Harger Series GBI-TMGB for telecommunications grounding applications, with 12-inch or 24-inch length as indicated. Meet BICSI and EIA/TIA 607 Standards.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Underground Connectors: Cadweld exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions, or Burndy Hyground irreversible compression-type, UL listed, except in ground test wells which require heavy-duty UL listed, bolted connections.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Conduit Hubs: Mechanical type, terminal with threaded hub.

G. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

H. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

I. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

J. Straps: Solid copper, cast-bronze clamp copper lugs. Rated for 600 A.

K. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one two-piece clamp.

L. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

M. Water Pipe Clamps:

1. Mechanical type, two pieces with stainless-steel bolts.

a. Material: Die-cast zinc alloy.
b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet.

B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install stranded conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum.

1. Bury at least 24 inches below grade.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded or irreversible compression-type connectors except as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall

be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install at least three ground rods, separated by at least twenty (20) feet, and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install No. 4/0 AWG tinned-copper conductor for ground ring and for taps to equipment grounding terminals. Route taps in one inch (25 mm) nonmetallic conduit from two points on ground ring. Bury ground ring not less than 6 inches from the foundation.

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Water Heater: Install a separate insulated equipment grounding conductor to each electric water heater. Bond conductor to heater units, piping, connected equipment, and components.

C. Signal and Communication Equipment: For alarm, voice and data, and other communication equipment, provide one (1) No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch minimum grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

D. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate

insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. After completion of individual ground rod resistance tests, interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.
3. For grounding electrode system, install at least three ground rods separated by at least twenty (20) feet from each other and located at least the same distance from other grounding electrodes, and interconnected with No. 4/0 AWG bare grounding conductors and from two points on grid to ground bus in service equipment.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Building Expansion Joints and Conduit Expansion Fittings: Install bonding jumper to maintain continuous ground continuity.
3. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
4. Use exothermic-welded or irreversible compression-type connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass

water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Grounding for Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

G. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building.

1. Install No. 2/0 AWG tinned-copper conductor for ground ring and for taps to building columns.
2. Bury ground ring not less than 30 inches from building's foundation.

H. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
b. Perform tests by fall-of-potential method according to IEEE 81.

c. Measurement of ground grid and building ground ring resistance must be accomplished using AVO Biddle's Slope Method where rods have been connected to grids or building ground rings prior to testing. If measurements do not meet requirements cited above, take corrective action as required. Re-measure grid resistance to ground until acceptable values are achieved.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Measured ground resistances shall not exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 5ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment and Raised Floor Systems: 1 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole, Building Ground Ring, and Fence Grounds: 5ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, install additional ground rods and conductors as required. Re-measure grid resistance to ground until acceptable values are achieved.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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. Steel slotted support systems.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.

1.3 ACTION SUBMITTALS

A. Delegated-Design Submittal: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to

AWS D1.1/D1.1M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit; a part of Atkore International.
b. B-line, an Eaton business.
c. ERICO International Corporation.
d. Flex-Strut Inc..
e. GS Metals Corp.
f. G-Strut.
g. Haydon Corporation.
h. Metal Ties Innovation.
i. Thomas & Betts Corporation; A Member of the ABB Group.
j. Unistrut; Part of Atkore International.
k. Wesanco, Inc.

2. Standard: Comply with Metal Framing Manufacturer's Association Standard MFMA-4 factory-fabricated components for field assembly.
3. Material for Channel, Fittings, and Accessories: Galvanized steel.
4. Channel Width: Selected for applicable load criteria.
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Conduit and Cable Support Devices: Steel and malleable-iron Stainless-steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel

plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Hilti, Inc..
2) ITW Ramset/Red Head; Illinois Tool Works, Inc..
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc..

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) B-line, an Eaton business.
2) Empire Tool and Manufacturing Co., Inc..
3) Hilti, Inc..
4) ITW Ramset/Red Head; Illinois Tool Works, Inc..
5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
6. Toggle Bolts: Stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA 101

3. NECA 105.

B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Support overhead electrical systems from building structural framing. Do NOT support electrical systems from roof decks, floor slabs, pipes, ducts, mechanical equipment, or other conduit, except as noted.

1. Electrical system support hanger loads less than 70 pounds may be suspended from floor slabs with preset inserts or approved anchors.
2. For concrete frame construction, electrical system support hanger loads less than 200 pounds may be suspended from floor or roof slabs with preset inserts or approved anchors.
3. If necessary, install appropriately sized steel support members spanning structural framing members to support electrical systems.

D. Do NOT support conduits or cables from suspended ceilings unless they are 1/2 inch or smaller trade size branch circuit conduits or cables that conform to NEC 300.11 and feed only equipment mounted in or on suspended ceiling.

E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

G. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

H. Mounting straps for non-metallic conduit shall allow movement during expansion and contraction, yet secure conduit to structure.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: Use methods described in NECA 1.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that [meet][comply with seismic-restraint] strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with manufacturer’s installation requirements for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with

items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

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. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

B. For following systems:

1. Electrical power wiring.
2. Communications systems, including telephone and data.
3. Video distribution system.
4. Sound systems, including paging, intercom, sound reinforcement.
5. Security systems, including card access, video CCTV, door monitoring.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, tele-power poles, hinged-cover enclosures, and cabinets.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AFC Cable Systems; a part of Atkore International.
    b. Allied Tube & Conduit; a part of Atkore International.
    c. Anamet Electrical, Inc.
    d. Calconduit.
    e. Electri-Flex Company.
    f. FSR Inc.
    g. Korkap.
    h. Opti-Com Manufacturing Network, Inc (OMNI).
    i. O-Z/Gedney; a brand of Emerson Industrial Automation.
    j. Patriot Aluminum Products, LLC.
    k. Perma-Cote.
    l. Picoma Industries, Inc.
    m. Plasti-Bond.
    n. Republic Conduit.
    o. Southwire Company.
    p. Thomas & Betts Corporation; A Member of the ABB Group.
    q. Topaz Electric; a division of Topaz Lighting Corp.
    r. Western Tube and Conduit Corporation.
    s. Wheatland Tube Company.

2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. IMC: Comply with ANSI C80.6 and UL 1242.
5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

    a. Comply with NEMA RN 1.
    b. Coating Thickness: 0.040 inch, minimum.

6. EMT: Comply with ANSI C80.3 and UL 797.
7. FMC: Comply with UL 1; zinc-coated steel.

8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AFC Cable Systems; a part of Atkore International.
    b. Allied Tube & Conduit; a part of Atkore International.
    c. Anamet Electrical, Inc.
    d. Calconduit.
    e. Electri-Flex Company.
    f. FSR Inc.
    g. Korkap.
    h. Opti-Com Manufacturing Network, Inc (OMNI).
    i. O-Z/Gedney; a brand of Emerson Industrial Automation.
    j. Patriot Aluminum Products, LLC.
    k. Perma-Cote.
    l. Picoma Industries, Inc.
    m. Plasti-Bond.
    n. Republic Conduit.
    o. Southwire Company.
    p. Thomas & Betts Corporation; A Member of the ABB Group.
    q. Topaz Electric; a division of Topaz Lighting Corp.
    r. Western Tube and Conduit Corporation.
    s. Wheatland Tube Company.

2. Comply with NEMA FB 1 and UL 514B.
3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
6. Fittings for EMT:

    a. Material: Steel. Die cast type are not allowed.
    b. Type: Setscrew.

7. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
9. Bushings: Impact resistant plastic, 105 deg C rated. Grounding type shall be insulated steel with proper ground lug.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AFC Cable Systems; a part of Atkore International.
    b. Anamet Electrical, Inc.
    c. Arnco Corporation.
    d. CANTEX INC.
    e. CertainTeed Corporation.
    f. Champion Fiberglass, Inc.
    g. Condux International, Inc.
    h. Electri-Flex Company.
    i. FRE Composites.
    j. Kraloy.
    k. Lamson & Sessions.
    l. Niedax Inc.
    m. RACO; Hubbell.
    n. Thomas & Betts Corporation; A Member of the ABB Group.
    o. Topaz Electric; a division of Topaz Lighting Corp.
    p. United Fiberglass.

2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Fiberglass:

    a. Comply with NEMA TC 14.
    b. Comply with UL 2515 for aboveground raceways.
    c. Comply with UL 2420 for belowground raceways.

4. RNC: Type EPC-40-PVC and EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

    a. Utilize PVC coated rigid steel conduit elbows for sizes 1-1/4 inch and larger, unless phase conductors are indicated to be installed in separate conduits.

5. LFNC: Comply with UL 1660.

B. Nonmetallic Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AFC Cable Systems; a part of Atkore International.
    b. Anamet Electrical, Inc.
    c. Arnco Corporation.

d. CANTEX INC.
e. CertainTeed Corporation.
f. Champion Fiberglass, Inc.
g. Condux International, Inc.
h. Electri-Flex Company.
i. FRE Composites.
j. Kraloy.
k. Lamson & Sessions.
l. Niedax Inc.
m. RACO; Hubbell.
n. Thomas & Betts Corporation; A Member of the ABB Group.
o. Topaz Electric; a division of Topaz Lighting Corp.
p. United Fiberglass.

2. Fittings, General: Listed and labeled for type of conduit, location, and use.
3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

a. Fittings for LFNC: Comply with UL 514B.

4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line, an Eaton business.
2. Hoffman; a brand of Pentair Equipment Protection.
3. MonoSystems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 Type 3R unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Moulded Products, Inc.
2. Hoffman; a brand of Pentair Equipment Protection.
3. Lamson & Sessions.
4. Niedax Inc.

B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

F. Solvents and Adhesives: As recommended by conduit manufacturer.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Adalet.
2. Cutler-Hammer; Eaton Corporation.
3. Crouse-Hinds, an Eaton business.
4. EGS/Appleton Electric.
5. Erickson Electrical Equipment Company.
6. FSR Inc.
7. General Electric Co.; Electrical Distribution & Control Division.
8. Hoffman; a brand of Pentair Equipment Protection.
9. Hubbell Incorporated.
10. Hubbell Incorporated; Wiring Device-Kellems.
11. Kraloy.
12. Milbank Manufacturing Co.
13. MonoSystems, Inc.
14. Oldcastle Enclosure Solutions.
15. O-Z/Gedney; a brand of Emerson Industrial Automation.
16. Plasti-Bond.

17. RACO; Hubbell.
18. Siemens Energy & Automation, Inc.
19. Spring City Electrical Manufacturing Company.
20. Square D; Group Schneider.
21. Stahlin Non-Metallic Enclosures.
22. Thomas & Betts Corporation; A Member of the ABB Group.
23. Topaz Electric; a division of Topaz Lighting Corp.
24. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloyaluminum, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:

1. Material: Cast metal.
2. Type: Fully adjustable Semi-adjustable.
3. Shape: Rectangular, unless otherwise indicated.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum galvanized, cast iron with gasketed cover.

J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

K. Device Box Dimensions: 4 inches square by 2-1/8 inches deep Insert dimension.

L. Gangable boxes are prohibited.

M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic Fiberglass.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

N. Cabinets:

1. NEMA 250, Type 1, unless otherwise indicated, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel, sized as indicated on Drawings.
2. Hinged door in front cover with flush latch and concealed hinge and screws. Size door to allow access to terminals without removing cover.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Plywood backboard, 3/4 inch (19 mm) thick, finished with fire retardant sealer.
6. Terminal Strips

    a. Below 50 volts: Screw terminal type.
    b. 51 to 250 volts: 250 volt screw terminal type with barrier between each set of terminals and individual terminal points for each conductor.
    c. 251 to 600 volts: 600 volt terminal strips similar to (b) above.

7. Accessory feet where required for freestanding equipment.
8. Identification

    a. Identify terminal strips with permanent numbers.

9. Wiring Diagrams

    a. Provide wiring diagram on inside of each cabinet door showing units and conductors connected to cabinet.

2.6 HANDHOLES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes:

1. Handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Precast Concrete Handholes and Boxes: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom. Frame and cover must form top of enclosure and must have load rating consistent with that of handhole or box.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Advance Concrete Products
    b. Hartford Concrete Products
    c. Or approved equal.

2. Standard: Comply with ASTM C1037.
3. Structural Design: AASHTO HS 20 wheel loading.

4. Configuration: Units must be designed for flush burial and have closed bottom unless otherwise indicated.
5. Frame and Cover: Per City of Madison standard.
6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at installation location with ground-water level at grade.
7. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus additional 12 inch vertically and horizontally to accommodate alignment variations. Refer to plans for dimensions.
8. Handholes must have inserts for cable racks and pulling-irons installed before concrete is poured.

C. Polymer-Concrete Handholes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Quazite: Hubbell Power Systems, Inc.
   b. Or approved equal.

2. Standard: Comply with SCTE 77.
3. Size: As indicated on Drawings
4. Load Rating: UL listed and labeled for Tier 10 loading, with 10,400 lb. design load and 22,568 lb. minimum test load.
5. Color of Frame and Cover: Gray.
6. Configuration: Designed for flush burial with two (2) stackable sections and open bottom unless otherwise indicated.
7. Cover: Weatherproof, gasketed, secured by stainless-steel, tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
8. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
9. Cover Legend: Molded lettering, "ELECTRIC.", "COMMUNICATIONS", or other lettering as required by type of cables being installed.
10. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
11. Handholes 12 Inches Wide by 24 Inches Long Insert dimensions and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.7 BACKBOARDS FOR TERMINATION OF SYSTEMS WIRING

A. Description: 3/4 inch (19.1 mm) thick, exterior type, A-C grade plywood. Provide one (1) 4 foot by 8 foot piece per location, unless otherwise shown on Drawings.

B. Finish: Two (2) coats of UL listed fire-retardant paint.

2.8 WALLPLATES

A. To match other wiring device wallplates. Refer to Section 262726 “Wiring Devices.”

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit, Not Subject to Physical Damage: GRC, IMC, RNC, Type EPC-40-PVC RNC, Type EPC-80-PVC.
2. Exposed Conduit, Subject to Physical Damage: GRC, IMC, RNC, Type EPC-80-PVC.
3. Concealed Conduit, Aboveground: GRC IMC RNC, Type EPC-40-PVC.
4. Covered Locations, Open to Exterior: GRC, IMC.
5. Exposed Conduit, Parking Ramps and Garages: RNC, Type EPC-80-PVC.
6. Underground Conduit:

    a. RNC, Type EPC-40-PVC Type EPC-80-PVC, direct buried.
    b. RNC, Type EPC-40-PVC in concrete on grade
    c. Type EB-20 for concrete encased duct bank.

7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
8. Exposed Boxes and Enclosures, Aboveground: NEMA 250, Type 4. Rigid PVC construction with suitable covers, UL rated for 90 degree conductors.
9. Boxes Flush Mounted in Building Walls, Exterior Side: Weatherproof cast aluminum outlet box, gasketed extension as required, plugs for all unused openings, ground screw mounting lugs, zinc die-cast weatherproof cover, grey finish.
10. Terminate PVC conduit prior to entering building in suitable PVC-to-rigid steel conduit adaptor fitting.
11. Handholes for Underground Wiring:

    a. Handholes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete units, SCTE 77, Tier 15 structural load rating.
    b. Handholes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
    c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77, (13 345-N) Tier 5 structural load rating.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit, Not Subject to Physical Damage: EMT.

2. Exposed Conduit, Subject to Physical Damage: GRC or IMC. Raceway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. Gymnasiums.

3. For Supporting Lighting Fixtures: GRC or IMC.
4. Circuits over 600 Volts: GRC or IMC, except where RNC is specified.
5. Hazardous Locations: GRC or IMC.
6. Conduit in All Concrete, Except Concrete on Grade: GRC.
7. Conduit Concealed in Ceilings and Interior Walls and Partitions: EMT.
8. Connection to Recessed Lighting Fixtures: FMC, except use LFMC in damp or wet locations.
9. Connection to Vibrating Equipment Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment: LFMC, except use FMC in dry locations for 120 volt motors 1/3 HP or less. Provide only sufficient length of flexible conduit necessary to avoid transmission of vibrations.
10. Conduit, Damp or Wet Locations: GRC or IMC.
11. Boxes and Enclosures, Indoor Dry Locations: NEMA 250, Type 1, hot dip galvanized construction or cadmium plated, pressed sheet steel, blanked for conduit, attached lugs for mounting, full access screw-on or hinged cover. Provide flush mounted boxes with overlapping cover with flush-head cover retaining screws, prime coated.

    a. Ceiling Outlet Boxes, Flush or Surface Mounted: 4 inch by 2-1/8 inch deep (102 mm x 54 mm deep), octagonal boxes for receiving three or less 1/2 in. (12 mm) conduits.
    b. Wall Outlet Boxes, Flush Mounted, Gypsum Wallboard

        1) 4 inch by 2-1/8 inch deep (102 mm x 54 mm) square boxes with matching square-drawn/tile cover for single or two (2) gang outlets.
        2) 4-11/16 inch by 2-1/8 inch deep (119 mm x 54 mm) square boxes with matching square-drawn/tile covers for single or two (2) gang outlets. Use for all 1 inch or 1-1/4 inch conduit entries.
        3) 2-1/2 inches deep (64 mm) gangable switch boxes at wall switch locations.
        4) 4 inch by 3-1/2 inch deep (102 mm x 89 mm) square boxes with matching square-drawn/tile cover for single or two (2) gang outlets. Use for all communication/data outlets, unless wall thickness dictates shallower box.

    c. Wall Outlet Boxes, Flush Mounted, Masonry: 3-1/2 inches (89 mm) deep masonry boxes, single or multiple gang, as required or as indicated on the Drawings.
    d. Wall Outlet Boxes, Surface Mounted: 4 inches by 2-1/8 inches deep (102 mm x 54 mm) square.

12. Outlet Boxes, Indoor Damp or Wet Locations, Equipment connections in Shops: NEMA 250, Type 4. Type FD (deep) or FS (shallow) cast device box, copper-free aluminum, blank body for drilling and tapping of required openings, gasketed extension as required, ground screw, aluminum gasketed, wet location cover, stainless steel screws.
13. Outlet Boxes, Flush Mounted in Building Walls, Exterior Side: Weatherproof cast aluminum outlet box, gasketed extension as required, plugs for all unused openings, ground screw, mounting lugs, zinc die-cast weatherproof cover, grey finish.
14. Boxes and Enclosures, Exterior Locations: Rigid PVC construction with suitable covers, UL rated for 90° conductors.

    a. Wall Outlet Boxes: "FS" type, rigid PVC, UL rated for 90° conductors, or malleable iron. Die cast "Bell" boxes will not be allowed.

C. Minimum Raceway Size: 1/2-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use set-screw, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION OF RACEWAYS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports. Mount exposed conduits tight to walls. Provide offsets at boxes and equipment.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Coordinate installation of raceways in masonry and concrete with construction process.

D. Route conduit to avoid structural obstructions, minimizing crossovers.

E. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

F. Do not fasten conduits onto the bottom side of a metal deck roof.

G. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes and other heat sources. Install horizontal raceway runs above water and steam piping.

H. Install conduit free from dents and bruises. Plug ends to prevent entry or dirt or moisture.

I. Complete raceway installation and clean out raceway before starting conductor installation.

J. Arrange stub-ups so curved portions of bends are not visible above finished slab.

K. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

L. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

M. Conceal conduit within finished walls, ceilings, and floors, excluding overhead in rooms without finished ceilings, mechanical equipment rooms, connections to motors, and connections to surface panelboards, unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

N. Support conduit within 12 inches of enclosures to which attached.

O. Route all exposed conduits and conduits above dropped ceilings parallel or perpendicular to building lines. Locate as close to building surfaces or structure as possible.

P. Do NOT install conduit horizontally in slabs except where indicated on Drawings.

Q. Locate each conduit through roof separate sleeve provided under Division 7. Do NOT locate raceways in sleeves with other pipes. Coordinate all roof penetrations with roofing installation. Arrange raceways to cross expansion joints at right angles.

1. Install UL approved expansion fittings, complete with grounding jumpers, where metallic conduits cross building expansion joints.

R. Stub-Ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in

hubs or in an enclosure.

S. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

T. Install bushings on all conduit terminations, except where insulated throat connectors are used. Use insulated steel type bushings where grounding or bonding is required. Use plastic type bushings at other locations.

U. To avoid conductor derating and mutual heating, do NOT group conduits in earth. Separate conduits immediately after leaving equipment.

V. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

W. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

X. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

Y. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Z. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

AA. Install pull wires in all empty and/or spare raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap all empty and/or spare raceways and install identification tags. Cap underground raceways designated as spare above grade alongside raceways in use.

BB. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
2. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

CC. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.

2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

DD. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

EE. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

FF. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

GG. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or

structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

HH. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

II. Seal around all conduits through walls and floors to maintain fire and smoke rating and prevent sound transmission.

3.3 INSTALLATION OF BOXES AND CABINETS

A. Conceal all pull boxes and junction boxes wherever possible. Mount boxes flush in all areas other than mechanical rooms, electrical rooms, and above removable ceilings.

B. Locate pull boxes and junction boxes above removable ceilings or in electrical rooms, utility rooms, or storage areas to permit access to interior of the box.

C. Size pull boxes and junction boxes to provide ample room for conductors, cable bends, and terminations where applicable. Utilize NEC as minimum sizing guide only.

D. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.

E. Coordinate locations and mounting heights of outlets mounted above counters with built-in units, window sills, heating/cooling equipment, etc., prior to installation. Adjust outlet mounting height to agree with required location for equipment served.

F. Recessed Boxes in Masonry Walls: Coordinate cutting of masonry walls to achieve neat openings for boxes. Adjust position of outlets in finished masonry walls to suit masonry course lines. Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

G. Do NOT install boxes back-to-back in opposite sides of same wall or partition. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Do NOT use through-the-wall type boxes.

H. Locate boxes so that cover or plate will not span different building finishes.

I. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

J. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

K. Do NOT use sectional or handy boxes unless specifically requested.

L. Verify that there is insulation behind boxes mounted in exterior walls to prevent condensation in boxes.

M. Mount all outlet boxes plumb and parallel with door or window frames, countertops and other building lines.

N. Identify all conductors within pull boxes and junction boxes per Section 260553 - “Identification for Electrical Systems”.

O. Refer to Section 260500 - “Common Work Results for Electrical for openings in fire-rated walls, partitions, floors, and ceilings.

P. Securely anchor all fittings and boxes.

Q. Install one (1) 3/4 inch conduit in floor slab from low voltage compartment of each floor box to accessible ceiling plenum, unless noted otherwise.

R. Mount cabinets on, or in, wall with top of box no higher than 72 inches above floor.

S. Terminate conduit in cabinets with lock nut and bushing or lock nut and grounding bushing.

T. Terminate wiring in cabinets on terminal blocks or strips.

U. Vacuum clean cabinets on completion of installation.

3.4 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at

building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
8. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.5 INSTALLATION OF UNDERGROUND HANDHOLES

A. Excavate sufficient material to provide sufficient space for installation of handhole and to perform work in satisfactory manner.

B. Install handholes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

C. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

D. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

E. Install handholes with bottom below frost line.

F. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

G. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

H. Install drains in bottom of handholes where indicated.

I. Apply waterproofing to exterior surfaces of pre-cast concrete handholes. After ducts has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars.

J. Ground handhole per Section 260526 - "Grounding and Bonding for Electrical Systems."

K. Plug all openings to prevent infiltration or leakage.

L. Provide two (2) entry tools for tamper resistant hardware.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.8 RACEWAY SYSTEMS FOR COMMUNICATIONS, VIDEO DISTRIBUTION, SOUND, AND SECURITY SYSTEMS WIRING.

A. Equipment and wiring will be installed under separate contract by Owner’s Special System Contractors.

B. Provide all raceway components, including cabinets, terminal boards, surface raceways, backboxes, baffles, conduit and boxes, as required to form a complete empty raceway system. Extend conduits and/or surface raceways to nearest accessible system cabinet, backboard, or terminal room.

C. Each run of conduit shall contain not more than two 90 degree bends and no run shall exceed 100 ft. in length. Minimum radii for bends: 9-1/2 inches for 3/4 inch conduit, 10-1/2 inches for 1 inch conduit, and a minimum of ten times the trade size diameter bends for larger sizes. Do NOT use conduit fittings in lieu of bends.

D. Provide bushed fittings on all conduit terminations.

E. Provide pullboxes in conduit runs exceeding 100 ft. (30 m) in length, and in runs with more than two right angle bends. Do NOT use conduit fittings in lieu of bends.

F. Identify all cabinets, and pull and junction boxes as to system usage.

G. Provide nylon pull cord in each conduit run.

H. Provide identification tags on all conduit runs.

I. Provide cover plates on all outlet boxes.

J. Provide plywood backboards and duplex receptacles in equipment room(s). Confirm location on job-site prior to installation. Paint all backboards with prime coat of fire resistant paint and finish coat of enamel in color to match wall. In unfinished rooms, provide gray finish coat.

K. Coordinate all work with Owner and Owner's Special System Contractor.

L. Provide underground conduit to property line for utility service entrance. Verify exact location with serving utility. Refer to Drawings for details.

END OF SECTION 260533

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:
1. Section 260500 "Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:
1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel Plastic Stainless steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
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. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels for equipment, wiring devices, control stations, etc.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.
10. Panelboard directories.

1.3 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 electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

C. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with OSHA Specifications for accident prevention signs contained in the Code of Federal Regulations as 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

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.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Power Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for service feeder and branch-circuit conductors.

1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
2. Colors for 208/120-V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.
d. Neutral: White.

3. Colors for 480/277-V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.
d. Neutral: Gray.

4. Color for Equipment Grounds: Green.
5. Colors for Isolated Grounds: Green with white stripe.

C. Raceways and Cables Carrying Power Circuits at More Than 600 V:

1. Black letters on an orange field.

2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
3. High Voltage Warning: "WARNING - HIGH VOLTAGE - KEEP OUT".

F. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Champion America.
c. emedco.
d. Grafoplast Wire Markers.
e. HellermannTyton.
f. LEM Products Inc.
g. Marking Services, Inc.
h. Panduit Corp.
i. Seton Identification Products.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. HellermannTyton.
c. Marking Services, Inc.
d. Panduit Corp.
e. Seton Identification Products.

C. Self-Adhesive Wraparound Labels: Preprinted Write-on, 3-mil- thick, polyester vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. A'n D Cable Products.
    b. Brady Corporation.
    c. Brother International Corporation.
    d. emedco.
    e. Grafoplast Wire Markers.
    f. Ideal Industries, Inc.
    g. LEM Products Inc.
    h. Marking Services, Inc.
    i. Panduit Corp.
    j. Seton Identification Products.

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
3. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
4. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. A'n D Cable Products.
    b. Brady Corporation.
    c. Brother International Corporation.
    d. emedco.
    e. Grafoplast Wire Markers.
    f. HellermannTyton.
    g. Ideal Industries, Inc.
    h. LEM Products Inc.
    i. Marking Services, Inc.
    j. Panduit Corp.
    k. Seton Identification Products.

2. Minimum Nominal Size:

    a. 1-1/2 by 6 inches for raceway and conductors
    b. 3-1/2 by 5 inches for equipment.
    c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. HellermannTyton.
c. Marking Services, Inc.
d. Panduit Corp.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Panduit Corp.

2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carlton Industries, LP.
b. Champion America.
c. HellermannTyton.
d. Ideal Industries, Inc.
e. Marking Services, Inc.
f. Panduit Corp.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Carlton Industries, LP.
c. emedco.
d. Marking Services, Inc.

C. Tape and Stencil: 4-inch- wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. HellermannTyton.
b. LEM Products Inc.
c. Marking Services, Inc.
d. Seton Identification Products.

D. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carlton Industries, LP.
b. Seton Identification Products.

E. Underground-Line Warning Tape:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Ideal Industries, Inc.
c. LEM Products Inc.
d. Marking Services, Inc.
e. Reef Industries, Inc.
f. Seton Identification Products.

2. Tape:

a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
b. Printing on tape shall be permanent and shall not be damaged by burial operations.
c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

3. Color and Printing:

a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE" .
c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV

CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

4. Tag:

a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright yellow-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
b. Width: 3 inches.
c. Overall Thickness: 5 mils.
d. Foil Core Thickness: 0.35 mil.
e. Weight: 28 lb/1000 sq. ft..
f. Tensile according to ASTM D 882: 70 lbf and 4600 psi.

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Carlton Industries, LP.
c. emedco.
d. Marking Services, Inc.
e. Seton Identification Products.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory screened printed permanent designations; punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Carlton Industries, LP.
c. emedco.
d. Grafoplast Wire Markers.
e. LEM Products Inc.
f. Marking Services, Inc.
g. Panduit Corp.
h. Seton Identification Products.

C. Write-on Tags:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carlton Industries, LP.
    b. LEM Products Inc.
    c. Seton Identification Products.

2. Polyester Tags: 0.010 inch Insert dimension thick, with corrosion-resistant grommet and cable tie for attachment.
3. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
4. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

A. Baked-Enamel Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carlton Industries, LP.
    b. Champion America.
    c. emedco.
    d. Marking Services, Inc.

2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
3. 1/4-inch grommets in corners for mounting.
4. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Brady Corporation.
    b. Champion America.
    c. emedco.
    d. Marking Services, Inc.

2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
3. 1/4-inch grommets in corners for mounting.
4. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by

one of the following:

a. Brady Corporation.
b. Carlton Industries, LP.
c. emedco.
d. Marking Services, Inc.

2. Engraved legend.
3. Thickness:

a. For signs up to 20 sq. in., minimum 1/16 inch thick.
b. For signs larger than 20 sq. in., 1/8 inch thick.

4. Engraved legend with black letters on white face. Emergency panels shall have white letters on red face.
5. Minimum letter height shall be 3/4 inch (10 mm) unless otherwise indicated.
6. Permanent self-adhesive.
7. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. HellermannTyton.
2. Ideal Industries, Inc.
3. Marking Services, Inc.
4. Panduit Corp.

B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.

4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

C. Device Plate Labels: Permanent self-adhesive backed, 3/8 inch (10 mm) wide, clear heavy-duty acrylic tape with machine printed 1/4 inch (6 mm) high black letters. Impression letters on plastic tape are not acceptable.

D. Underground Line Concrete Markers: 12 inches square by 4 inches thick concrete, chamfered top edges, arrows with stamped legend indicating route and type of underground line.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

E. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

F. Apply identification devices to surfaces that require finish after completing finish work.

G. Self-Adhesive Identification Products: Clean surfaces before application using materials and methods recommended by manufacturer of identification device.

H. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

I. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

J. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

K. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

L. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer or load shedding.

M. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

N. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

O. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

P. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high

visibility and accessibility.

Q. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

R. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

S. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

T. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

U. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

V. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

W. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

X. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

Y. Metal Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using UV-stabilized and plenum-rated cable ties.

Z. Nonmetallic Preprinted Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using UV-stabilized and plenum-rated cable ties.

AA. Write-on Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using UV-stabilized and plenum-rated cable ties.

BB. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on minimum 1-1/2-inch- high sign; where two lines of text are required, use signs minimum 2 inches high.

CC. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

DD. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

EE. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.

1. Locate identification at changes in direction, at both sides of penetrations of walls and floors, at 30-foot maximum intervals in straight runs, and at 15-foot maximum intervals in congested areas.

D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive vinyl tape to identify the phase. Locate at each load or terminal connection in control panels and panelboard gutters. Use self-adhesive wraparound labels to identify source, circuit number, and voltage of each set of conductors.

E. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation. Identify source, circuit number, and voltage of each set of conductors.

F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination. Handwritten lettering is not acceptable. For wires of different systems in common boxes, group each cable with its own system and identify each cable to indicate appropriate system.

G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation. Include wire number or terminal number from schematic, or interconnection diagrams on installation or shop drawings.

H. Motor Control Labels: Provide typed label inside each motor starter, adjustable frequency drive, etc., including those furnished by other divisions, identifying motor served, horsepower, voltage, phase, full-load current, code letter, and design letter.

I. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

J. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

K. Junction and Pull Box Identification: Stencil or neatly identify with permanent marker all junction and pull boxes as follows:

1.	Lighting and Power enclosed including panelboard names	-	208V, 240V or 480V, circuit numbers
2.	Data	-	DAT
3.	Television	-	TV
4.	Sound Reinforcement	-	SR
5.	Paging	-	PA
6.	Intercom	-	IC
7.	Emergency	-	E (white letters on red background)

L. Empty and/or Spare Raceways: Install identification tag stamped to indicate conduit destination and future use, i.e., sound, telephone, electric, etc.

M. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
   1. Install underground-line warning tape for direct-buried cables and cables in raceways.
   2. During construction, provide temporary identification of underground raceways and direct-buried cable routings by means of marker flags located directly above and along entire length of raceway and wiring.

N. Workspace Indication: Apply floor marking tape tape and stencil to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

O. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

P. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

   1. Apply to exterior of door, cover, or other access.
   2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

      a. Power-transfer switches.
      b. Controls with external control power connections.

   3. For equipment requiring workspace clearance according to NFPA 70, apply to door or cover of equipment, but not on flush panelboards and similar equipment in finished spaces, unless noted otherwise.

Q. Warning Labels for High Voltage Equipment and Boxes: Locate on entrance doors to each electrical room containing high voltage equipment, on each primary switch, on each unit substation, on each padmount transformer and on each junction box containing high voltage cable.

R. Arc Flash Warning Labeling: Self-adhesive labels.

   1. Comply with NFPA 70E and ANSI Z535.4.
   2. Comply with Section 260574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.

S. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.

T. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer load shedding.

U. Equipment Identification Labels:

   1. Label all equipment.

2. Utilize unique designation that is consistent with drawings, wiring diagrams, schedules, and operation and maintenance manual. Include equipment type, e.g.: UNIT SUB, MCC, DP, SWBD, ATS, XFMR, PNL, BUSWAY, FIRE ALARM, PA, PAGING, ACCESS CONTROL, NURSE CALL, etc.
3. Verify all equipment names with Owner and Engineer prior to making labels.
4. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system.
5. Systems include power, lighting, control, communication, signal, monitoring, and alarm, unless equipment is provided with its own identification.
6. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine plastic label. Impression letters on plastic tape will not be allowed. Unless otherwise indicated, provide a single line of text with 3/4 inch-high letters on 1-1/2 inch-high label; where additional lines of text are required, increase label height proportionally.
7. Outdoor Equipment: Stenciled legend 4 inches high.
8. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
9. Equipment to Be Labeled, shall include, but not be limited to, the following:

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
    b. Enclosures and electrical cabinets.
    c. Access doors and panels for concealed electrical items.
    d. Switchboards.
    e. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    f. Busway.
    g. Emergency system boxes and enclosures.
    h. Enclosed switches.
    i. Enclosed circuit breakers.
    j. Enclosed controllers.
    k. Variable-speed controllers.
    l. Push-button stations.
    m. Power-transfer equipment.
    n. Contactors.
    o. Remote-controlled switches, dimmer modules, and control devices.
    p. Time switches.
    q. Battery-inverter units.
    r. Power-generating units.
    s. Monitoring and control equipment.
    t. UPS equipment.
    u. Voice and data cable terminal equipment.
    v. Paging system equipment.
    w. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
    x. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

10. Identify equipment on inside of cover of flush panels and on outside of cover of surface panels as follows:

    a. Lighting and Power Panels (black letters on white background) - PANEL DESIGNATION (3/4 inch high letters), VOLTAGE (1/4 inch high letters), SOURCE PANEL FEEDING THIS PANEL AND OWNER'S ROOM NUMBER WHERE SOURCE PANEL IS LOCATED (1/4 inch high letters).
    b. Communications Cabinets - TELEPHONE OR OTHER USAGE (paging, etc.).
    c. Data Cabinets - DATA.
    d. Emergency Panels (white letters on red background) - EMERGENCY PANEL DESIGNATION (3/4 inch high letters), VOLTAGE (1/4 inch high letters), SOURCE PANEL FEEDING THIS PANEL AND OWNER'S ROOM NUMBER WHERE SOURCE PANEL IS LOCATED (1/4 inch high letters).

11. Identify each main breaker or switch (primary and secondary) in all distribution equipment with laminated label similar to above.
12. Equip each branch device in all distribution panelboards, switchboards, motor control centers, busway, unit-substations, etc., with laminated label similar to above. Identify load served and location of load. Use identifications compatible with Owner's program. For adjustable-trip circuit breakers, identify trip setting.

    a. Identify all control devices, circuit breakers, disconnect switches, motor starters, contactors, time switches, test switches, etc, including those furnished by other divisions or with pre-purchased equipment, with equipment fed and Owner's room number where equipment is located, source panel or equipment feeding this device, and Owner's room number where source panel or equipment is located. Height of label may be decreased where mounting space for label is limited.

V. Panelboard Directories:

1. Equip each branch circuit panelboard with typewritten or computer generated directory accurately indicating Owner's room number and equipment name being served.
2. Use identifications compatible with Owner's program, and readily identifiable without removing directory from its holder.

W. Device Plate Identification

Retain one or more of following subparagraphs to suit Project

1. Engrave device plates of all receptacles on emergency electrical system with word "EMERGENCY" , and on isolated ground system with words "ISOL.GND" . Separate nameplates secured to device plate are not acceptable.
2. Label device plates of all wall switches, receptacles, control stations, etc., indicating source, panel name, and circuit.

a. Label device plates of all wall switches, control stations, volume controls, etc., with permanent adhesive indicating equipment controlled.

END OF SECTION 260553

SECTION 260572 - OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

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 a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices and short-circuit current rating of all distribution equipment.

B. Based upon study results, select and furnish all distribution equipment, and set all protective devices, to provide the following:

1. Short-circuit current ratings equal to or greater than the available short-circuit current, as determined by this study, or equal to the interrupting rating shown in the specifications or on the Drawings, whichever is greater.
2. Coordination of the short-circuit protection per N.E.C. Article 240.12.
3. Protection from damaging or dangerous temperatures in conductors or conductor insulation under short-circuit conditions per N.E.C. Article 240.4 and ICEA P-32-382.
4. Coordination of ground-fault protection for service and disconnecting means in healthcare facilities per N.E.C. Article 517.17B.
5. Selective coordination of all overcurrent protective devices for emergency systems and legally required standby systems per N.E.C. Articles 700.28 and 701.27.
6. Protection from damaging temperatures in transformers under overcurrent conditions.
7. Selective coordination of all overcurrent protective devices for more than one elevator supplied by a single feeder per N.E.C. Article 620.62.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following simultaneously with or prior to the distribution system protective devices submittals. Submittals may be in digital form.

1. Short-circuit study input data, including completed computer program input data sheets.
2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

    a. Submit study report for action concurrent with or prior to the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
    b. Revised single-line diagram, reflecting field investigation results and results of short-circuit study.

3. Revised layouts for electrical rooms that require adjustments due to changes in distribution equipment sizes related to selections of overcurrent protective devices.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Short-Circuit Study Specialist Field Adjusting Agency.

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 3001 and 3002 Series Standards.

1.6 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Short-Circuit Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

A. Software Developers: Subject to compliance with requirements, provide software by one of the following:

1. ESA Inc.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.

B. Comply with IEEE 3001 and 3002 Series Standards.

C. Analytical features of fault-current-study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 3002 Series Standards.

D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor designations and kVA ratings.
5. Switchgear, switchboard, and panelboard designations.

D. Comments and recommendations for system improvements, where needed.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Output:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Calculated asymmetrical fault currents:

        1) Based on fault-point X/R ratio.
        2) Based on calculated symmetrical value multiplied by 1.6.
        3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. No AC Decrement (NACD) ratio.
    e. Equivalent impedance.
    f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
    g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Obtain all data necessary for the conduct of the study.

1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the following input data to support the short-circuit study. Comply with recommendations in IEEE 3002 Series Standards as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility maximum available fault current and impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
8. Motor horsepower and NEMA MG 1 code letter designation.
9. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 3002 Series Standards.

B. Calculate short-circuit currents according to IEEE 3002 Series Standards.

C. Base study on the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.

F. Study electrical distribution system from normal power source throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and shall apply to low-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:

1. Electric utility's supply termination point.
2. Low-voltage switchgear.
3. Switchboards.
4. Distribution panelboards.
5. Control panels.
6. Branch circuit panelboards.
7. Disconnect switches.
8. Motor controllers.

3.3 ADJUSTING

A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

3.4 LABELING

A. Label all new equipment and all equipment feeding new equipment with maximum available fault current per N.E.C. Article 110.24.

3.5 DEMONSTRATION

A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION 260572

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

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 computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

B. Based upon study results, select and furnish all distribution equipment, and set all protective devices, to provide the following:

1. Coordination of the short-circuit protection per N.E.C. Article 240.12.
2. Protection from damaging or dangerous temperatures in conductors or conductor insulation under short-circuit conditions per N.E.C. Article 240.4 and ICEA P-32-382.
3. Coordination of ground-fault protection for service and disconnecting means in healthcare facilities per N.E.C. Article 517.17B.
4. Selective coordination of all overcurrent protective devices for emergency systems and legally required standby systems per N.E.C. Articles 700.28 and 701.27.
5. Protection from damaging temperatures in transformers under overcurrent conditions.
6. Selective coordination of all overcurrent protective devices for more than one elevator supplied by a single feeder per N.E.C. Article 620.62.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following simultaneously with or prior to the distribution system protective devices submittals. Submittals may be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and equipment evaluation reports.
3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.

    1. Submit study report for action concurrent with or prior to the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

4. Revised layouts for electrical rooms that require adjustments due to changes in distribution equipment sizes related to short-circuit current ratings and selections of overcurrent protective devices.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Coordination Study Specialist Field Adjusting Agency.

B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 3001 and 3002 Series Standards.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the overcurrent protective devices to include in operation, maintenance manuals, and the following:

1. The following parts from the Protective Device Coordination Study Report:

    1. One-line diagram.
    2. Protective device coordination study.
    3. Time-current coordination curves.

2. Power system data.

1.7 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, provide software by one of the following:

1. ESA Inc.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.

B. Comply with IEEE 3001 and 3002 Series Standards.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 3002 Series Standards.

D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

1. Arcing faults.
2. Simultaneous faults.
3. Explicit negative sequence.
4. Mutual coupling in zero sequence.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor designations and kVA ratings.
5. Switchgear, switchboard, and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

F. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

1. Phase and Ground Relays:

1. Device tag.
2. Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
3. Recommendations on improved relaying systems, if applicable.

2. Circuit Breakers:

1. Adjustable pickups and time delays (long time, short time, ground).
2. Adjustable time-current characteristic.
3. Adjustable instantaneous pickup.
4. Recommendations on improved trip systems, if applicable.

3. Fuses: Show current rating, voltage, and class.

G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.

2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

    1. Power utility's overcurrent protective device.
    2. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
    3. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
    4. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
    5. Cables and conductors damage curves.
    6. Ground-fault protective devices.
    7. Motor-starting characteristics and motor damage points.
    8. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Provide adequate time margins between device characteristics such that selective operation is achieved.
6. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

    1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 PROTECTIVE DEVICE COORDINATION STUDY

A. Comply with IEEE 3002 Series Standards for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 3002 Series Standards for general study procedures.

C. The study shall be based on the device characteristics supplied by device manufacturer.

D. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:

    1. To normal system low-voltage load buses where fault current is 10 kA or less.

E. Study electrical distribution system from normal power source throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

F. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

    1. Inrush current when first energized.
    2. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    3. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

G. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 3002 Series Standards and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

H. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 3002 Series Standards. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

I. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and shall apply to low-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

J. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:

1. Electric utility's supply termination point.
2. Low-voltage switchgear.
3. Switchboards.
4. Distribution panelboards.
5. Control panels.
6. Branch circuit panelboards.
7. Motor controllers.

K. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, switchboard, and panelboard bus bars to withstand short-circuit stresses.

3.3 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

1. Determine load-flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
2. Determine load-flow and voltage drop based on 80 percent of the design capacity of the load buses.
3. Prepare the load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.4 MOTOR-STARTING STUDY

A. Perform a motor-starting study to analyze the transient effect of the system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of the motor starting on the power system stability.

B. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 3002 Series Standards and voltage sags so as not to affect the operation of other utilization equipment on the system supplying the motor.

3.5 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 3002 Series Standards for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Electrical power utility maximum available fault current and impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus, three phase and line-to-ground.
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
11. Maximum demands from service meters.
12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
15. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    1. Special load considerations, including starting inrush currents and frequent starting and stopping.
    2. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    3. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    4. Ratings, types, and settings of utility company's overcurrent protective devices.
    5. Special overcurrent protective device settings or types stipulated by utility company.
    6. Time-current-characteristic curves of devices indicated to be coordinated.
    7. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    8. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    9. Panelboards, switchboards ampacity, and SCCR in amperes rms symmetrical.
    10. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.6 FIELD ADJUSTING

A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Revise layouts for electrical rooms that require adjustments due to changes in distribution equipment sizes related to short-circuit current ratings and selections of overcurrent protective devices.

D. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.7 DEMONSTRATION

A. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:

1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.
2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
3. Adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION 260573

SECTION 260574 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

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 a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Study Submittals: Submit the following simultaneously with or prior to the distribution system protective devices submittals. Submittals may be in digital form.

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

a. Submit study report for action concurrent with or prior to the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
b. Revised single-line diagram, reflecting field investigation results and results of arc-flash study.

3. Revised layouts for electrical rooms that require adjustments due to changes in distribution equipment sizes related to selections of overcurrent protective devices.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Arc-Flash Study Specialist Field Adjusting Agency.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
2. Operation and Maintenance Procedures: Provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Manufacturers: Subject to compliance with requirements, provide software by one of the following:

1. ESA Inc.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 3002 Series Standards.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor designations and kVA ratings.
5. Switchgear, switchboard, and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

G. Arc-Flash Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

   a. Voltage.
   b. Calculated symmetrical fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. No AC Decrement (NACD) ratio.
   e. Equivalent impedance.
   f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
   g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Working distance.
6. Incident energy.
7. Hazard risk category.
8. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 ARC-FLASH WARNING LABEL

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies:

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

C. Calculate maximum and minimum contributions of fault-current size.

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include low-voltage equipment locations.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per

unit after 10 cycles).

H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility maximum available fault current and impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus, three phase and line-to-ground.
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
11. Busway manufacturer and model designation, current rating, impedance, lengths,

and conductor material.

12. Motor horsepower and NEMA MG 1 code letter designation.
13. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.4 LABELING

A. Label all new equipment with its associated arc-flash hazard warning per N.E.C. Article 110.16.

B. Equipment to be labeled shall include, but not be limited to the following:

1. Motor-controllers.
2. Low-voltage switchboards.
3. Panelboards.
4. Distribution panelboards.
5. Disconnect switches.
6. Control panels.

3.5 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.6 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 260574

SECTION 260800 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes Cx process requirements for the following electrical components, systems, assemblies, and equipment:

1. Electrical equipment connected to Normal power systems, including the following:
   a. Transformers.
   b. Secondary service electrical systems.
   c. Distribution and branch-circuit panelboards.
   d. Grounding systems.

2. Controls and instrumentation, including the following:

   a. Equipment monitoring systems.
   b. Energy monitoring and control systems.
   c. Electrical metering and metering system.
   d. Lighting control systems.

3. Systems testing and verification, including Normal and Essential power systems, and transitions from Normal to Essential power systems and back.

B. Provide documentation and testing of systems, as well as training of Owner's operation and maintenance personnel. Work with Commissioning Authority and in cooperation with other members of commissioning team to ensure compliance.

1.3 DEFINITIONS

A. BoD: Basis-of-Design Document

B. Cx: Commissioning

C. CxA: Commissioning Authority

D. Low Voltage: 600 V and below.

E. Medium Voltage: 601 V and above.

F. Normal Power Systems: A power system that provides primary power to a facility.

G. OPR: Owner's Project Requirements, as defined in Section 019113 "General Commissioning Requirements."

H. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Construction Checklists: Draft construction checklists will be created by CxA for Contractor review.

B. Construction Checklists: Include the following and comply with requirements in Section 019113 "General Commissioning Requirements" for construction checklists:

1. Instrumentation and control for electrical systems.
2. Instrumentation and control for lighting control systems.
3. Low-voltage power cables.
4. Control voltage power cables.
5. Electrical feeders and branch circuits.
6. Dry-type transformers.
7. Instrument transformers.
8. Low-voltage motor starters.
9. Low-voltage insulated case circuit breakers.
10. Low-voltage network protectors.
11. Low-voltage surge protective devices.
12. Metering devices.
13. Molded-case circuit breakers.
14. Low-voltage power circuit breakers.
15. Grounding systems.
16. Ground-fault protection systems.
17. Panelboards.
18. Receptacles and devices.
19. Variable-frequency drives.
20. Battery systems.
21. Battery chargers.
22. Lighting.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electrical systems and components to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Testing Technician Qualifications: Technicians to perform electrical Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level. Vocational school four-year-program graduate or an Associate's degree in electrical systems, or similar field. Degree may be offset by three years' experience as an apprentice or a journey-level electrician. Generally, required knowledge includes electrical and HVAC&R concepts, building operations, and application and use of tools and instrumentation to measure performance of electrical equipment, assemblies, and systems.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform electrical Cx work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:

    a. Equipment/instrument identification number.
    b. Planned Cx application or use.
    c. Manufacturer, make, model, and serial number.
    d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

2. Test equipment and instrumentation shall meet the following criteria:

    a. Capable of testing and measuring performance within the specified acceptance criteria.
    b. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
    c. Be maintained in good repair and operating condition throughout duration of use on Project.
    d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

C. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:

    a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:

1) Instrument or tool identification number.
2) Equipment schedule designation of equipment for which the instrument or tool is required.
3) Manufacturer, make, model, and serial number.
4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
c. Electrical proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

A. Prepare detailed construction checklists for electrical systems, subsystems, equipment, and components. Complete and submit construction checklists.

3.2 CONSTRUCTION CHECKLIST REVIEW

A. Review and provide written comments on draft construction checklists. CxA will create required draft construction checklists and provide them to Contractor.

B. Return draft Construction Checklist review comments within 10 days of receipt.

C. When review comments have been resolved, CxA will provide final construction checklists, marked "Approved for Use, (date)."

D. Use only construction checklists, marked "Approved for Use, (date)."

3.3 GENERAL TESTING REQUIREMENTS

A. Certify that electrical systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating according to the Contract Documents and approved Shop Drawings and submittals.

B. Certify that electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.

C. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.

E. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.

F. Construction Checklists: Prepare and submit detailed construction checklists for electrical systems, subsystems, equipment, and components.

1. Contributors to development of construction checklists shall include, but are not limited to, the following:

a. Electrical systems and equipment installers.
b. Electrical instrumentation and controls installers.

G. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

H. If tests cannot be completed because of a deficiency outside the scope of the electrical system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.

I. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

J. Coordinate schedule with, and perform Cx activities at the direction of the CxA.

K. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Sections specifying electrical systems and equipment.

L. Provide technicians, instrumentation, tools, and equipment to complete and document the following:

1. Performance tests.
2. Demonstration of a sample of performance tests.
3. Cx tests.

4. Cx test demonstrations.

3.4 Cx TESTS FOR ELECTRICAL SYSTEMS

A. Verification of Normal Power System Operation:

1. Prerequisites: Acceptance of results for construction checklists for Division 26 electrical components associated with Normal power system.
2. Equipment and Systems to Be Tested: Division 26 electrical equipment.
3. Test Purpose: Verify operation of Normal power system.
4. Test Conditions: Energize components of Normal power system, one at a time.
5. Acceptance Criteria: Proper operation of Normal power system over a 24-hour period.

B. Verification of Control and Instrumentation:

1. Prerequisites: Acceptance of results for construction checklists.

C. Test Purpose: Verify operation of control and monitoring systems for Normal and Essential power systems.

D. Test Conditions:

1. Energize components of Normal power system.
2. Test operation of equipment.

E. Acceptance Criteria: Operation of equipment according to OPR.

END OF SECTION 260800

SECTION 260923 - LIGHTING CONTROL DEVICES

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. Time switches.
2. Photoelectric switches.
3. Indoor occupancy and vacancy sensors.
4. Switchbox-mounted occupancy sensors.
5. Digital timer light switches.
6. Lighting contactors.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:

a. Occupancy sensors.
b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.

2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

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. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Invensys Controls.
4. Leviton Manufacturing Co., Inc.
5. NSi Industries LLC.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
2. Contact Configuration: DPDT.
3. Contact Rating: 20-A ballast load, 120-/240-V ac.
4. Programs: Eight on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
5. Programs: 2 channels; each channel is individually programmable with eight on-off set points on a 24-hour schedule.
6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
7. Astronomic Time: All channels.
8. Automatic daylight savings time changeover.
9. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

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. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Leviton Manufacturing Co., Inc.
4. NSi Industries LLC.
5. Tyco Electronics Corporation; a TE Connectivity Ltd. company.

B. Description: Solid state, with SPST dry contacts rated for 720 VA inductive, to operate connected load, contactor coils, or relay input; complying with UL 773A, and compatible with ballasts and LED lamps.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc , with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Fifteen-second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting, stem-and-swivel mounting, or electrical box mounting accessories as required to direct sensor to the north sky exposure.
6. Failure Mode: Luminaire stays ON.

2.3 INDOOR OCCUPANCYAND VACANCY SENSORS

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. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Manufacturing Co., Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. Lutron Electronics Co., Inc.
6. Philips Lighting Controls.
7. Watt Stopper.

B. General Requirements for Sensors:

1. Wall, Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Passive infrared, Ultrasonic, Dual technology.
3. Separate power pack.
4. Hardwired, Wireless connection to switch.
5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Operation:

a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A, Sensor is powered from the power pack.
8. Power: Line voltage.
9. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
10. Mounting:

a. Sensor: Suitable for mounting in any position on a standard outlet box.
b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc ; turn lights off when selected lighting level is present.

C. PIR Type: Wall, Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. .
2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
3. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 48 inches above finished floor.

D. Ultrasonic Type: Wall, Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch- high ceiling.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch- high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot- high ceiling in a corridor not wider than 14 feet.
6. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 84 inches above finished floor.

E. Dual-Technology Type: Wall, Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. , and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 48 inches above finished floor.

2.4 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

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. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Manufacturing Co., Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. Lutron Electronics Co., Inc.
6. Philips Lighting Controls.
7. Watt Stopper.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, using hardwired connection.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA LED load at 277 V, and 800-W incandescent.

2.5 DIGITAL TIMER LIGHT SWITCH

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. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Invensys Controls.
4. Leviton Manufacturing Co., Inc.
5. NSi Industries LLC.

B. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in 10 minute increments.

1. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 amps at 277-V ac for LED, and 1/4 horsepower at 120-V ac.
2. Integral relay for connection to BAS.
3. Voltage: Match the circuit voltage, or Dual voltage - 120 and 277 V.
4. Color: White.
5. Faceplate: Color matched to switch.

2.6 LIGHTING CONTACTORS

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. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a business of Emerson Network Power.
3. Eaton Corporation.
4. General Electric Company.
5. Square D.

B. Description: Electrically operated and mechanically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch .

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

END OF SECTION 260923

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

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: Distribution, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

1.3 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 each type and size of transformer.
2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, conduit entrance and available space, and location and size of each field connection.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

C. Certified Test Results: Provide for each transformer 500 kVA and above, indicating:

1. Core loss.
2. Coil Loss.
3. Magnetizing Current.
4. Sound Level.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For transformers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control reports.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design:

    a. Square D; by Schneider Electric

2. Approved Equal:

    a. ABB Inc.
    b. Acme Electric Corporation
    c. Controlled Power Company; an Emerson company
    d. Eaton Corporation
    e. Hammond Power Solutions Inc.
    f. Maddox Industrial Transformer, LLC.
    g. Powersmiths International Corp.
    h. Sola/Hevi-Duty; a brand of Emerson Electric Co.

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service. Fan-cooled units shall not be used.

B. 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.

C. Transformers to be designed for use with renewable solar energy and rated for bi-directional applications. Transformer nameplate to designate the unit as suitable for bi-directional operation.

D. Transformers Rated 15 kVA and Larger: Comply with DOE Code of Federal Regulation 10 CFR 431, as amended by final ruling 78 FR 23335.

E. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

F. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

G. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

H. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

I. Nameplate: Metallic, secured to outside front of enclosure with pins, screws, or permanent adhesive and embossed with all pertinent information such as connection diagrams, temperature ratings, electrical ratings, sound levels, impedances, weight, etc.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, drip-proof, unless otherwise indicated.

1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound to seal out moisture and air, and secured with rubber mounts.
2. Maximum enclosure temperature shall be 50 degree C rise above 40 degree C ambient.
3. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

D. Enclosure for Outdoor Transformers: Totally enclosed, nonventilated.

1. NEMA 250, Type 3R Type 4X, Stainless Steel: Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

F. Taps for Transformers 3 kVA and Smaller: None.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

I. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature, unless otherwise indicated.

J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150 115 80-deg C rise above 40-deg C ambient temperature, unless otherwise indicated.

K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.
3. Provide secondary neutral terminal sized at 200 percent of rated secondary current.
4. Provide electrostatic shielding as described below.

L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize inter-winding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

M. Neutral: Rated 200 percent of full load current for K-factor rated transformers.

N. Wall Brackets: Manufacturer's standard brackets.

2.4 IDENTIFICATION DEVICES

A. Labels: Engraved, laminated-plastic label for each distribution transformer, mounted with permanent adhesive. Identification and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
2. Ratio tests at the rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at the rated voltage connections.
4. No load losses, and excitation current and rated voltage at the rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation Resistance Tests:

    a. High-voltage to ground.
    b. Low-voltage to ground.
    c. High-voltage to low-voltage.

9. Temperature tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems." Connect secondary neutral and grounding to separately derived ground system.

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Flexible raceways for incoming and outgoing wiring according to Section 260533 - Raceways and Boxes for Electrical Systems".

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

E. Provide flexible connections at all conduit and conductor terminations and supports to

eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Verify nameplate data matches drawing and specification requirements.
2. Inspect physical and mechanical condition of equipment.
3. Confirm shipping brackets have been removed and isolation mounts are functioning correctly.
4. Verify all bolted connections meet manufacturer's recommended tightness.

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

B. Touch up scratched and marred surfaces to match original finish.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

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. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. HID: High-intensity discharge.

E. MCCB: Molded-case circuit breaker.

F. SPD: Surge protective device.

G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Submit simultaneously with or after the Overcurrent Protective Device Short-Circuit, Coordination, and Arc-Flash Studies.
2. Include dimensioned plans, elevations, sections, and details.

3. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
4. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
5. Detail bus configuration, current, and voltage ratings.
6. Short-circuit current rating of panelboards and overcurrent protective devices.
7. Include evidence of NRTL listing for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, maintenance manuals, and the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard, unless otherwise noted.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.9 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

D. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. 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.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Flush or Surface-mounted, as shown on Drawings, dead-front cabinets.

1. Rated for environmental conditions at installed location.

    a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    b. Outdoor Locations: NEMA 250, Type 3R.
    c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
    d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
    e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Height: 84 inches maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:

    a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: Galvanized steel.

F. Phase, Neutral, and Ground Buses:

1. Material and Type: Hard-drawn copper, 98 percent conductivity.

    a. Plating shall run entire length of bus.
    b. Bus shall be fully rated the entire length.
    c. Sequence type bussing interval connections, bus structure and main lugs or main protective devices with current ratings shown on Drawings.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Standard Neutral: Full capacity, equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
5. Split Bus: Vertical buses divided into individual vertical sections.

G. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated bus ampacity and conductor sizes shown on Drawings, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Gutter-Tap Lugs Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

H. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

I. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices. Provide blank covers for all unused device spaces.

1. Percentage of Future Space Capacity: Ten 20 percent, unless indicated otherwise.

J. Panelboard Short-Circuit Current Rating: Fully rated as shown on Drawings, or as required by Overcurrent Protective Device Short-Circuit Study, to interrupt symmetrical short-circuit current available at terminals. Series-connected ratings are NOT allowed. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

K. Circuit Breakers: Provide all circuit breakers on project from one manufacturer unless not commercially available.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1, Type 2.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design:

a. Square D; by Schneider Electric

2. Approved Equal:

a. ABB Inc.
b. Eaton Corporation

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only, as shown on Drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike. Provide two (2) keys with each panelboard.

F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; all panelboards keyed alike. Provide two (2) keys with each panelboard. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

G. Short circuit current ratings as shown on Drawings, but not less than 10,000 RMS symmetrical amperes for panelboards rated 240 V or less, and 14,000 RMS symmetrical amperes for panelboards rated above 240 V and less than or equal to 600 V.

H. Equal to NQ and NF type manufactured by Square D Company.

I. Standard Box Size: 5-3/4 inches (145 mm) deep, 20 inches (500 mm) wide.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design:

    a. Square D; by Schneider Electric

2. Approved Equal:

    a. ABB Inc.
    b. Eaton Corporation

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents or as shown on Drawings, whichever is higher.

1. Thermal-Magnetic Circuit Breakers:

    a. Inverse time-current element for low-level overloads.
    b. Instantaneous magnetic trip element for short circuits.
    c. Common simultaneous trip for 2 and 3 pole breakers.
    d. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Circuit breakers having 400A or higher trips shall have electronic trip unit.
4. Electronic Trip Circuit Breakers:

    a. RMS sensing.
    b. Field-replaceable rating plug or field-replicable electronic trip.
    c. Digital display of settings, trip targets, and indicated metering displays.
    d. Multi-button keypad to access programmable functions and monitored data.
    e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
    f. Integral test jack for connection to portable test set or laptop computer.
    g. Field-Adjustable Settings:

        1) Standard, High-range instantaneous trip.
        2) Long- and short-time pickup levels.
        3) Long and short time delay adjustments.
        4) Ground-fault pickup level, time delay, and I squared T response.

5. Circuit breakers having 1000 amp or higher trip shall be UL listed/labeled for operation at 100 percent of amp rating.
6. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
7. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
8. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
9. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
10. Subfeed Circuit Breakers: Vertically mounted.
11. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Individually insulated, braced and protected connectors.
c. Breaker handle indicates tripped status.
d. UL listed for reverse connection without restrictive line or load ratings.
e. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
f. Application Listing: Appropriate for application; Type HACR for heating, air-conditioning, and refrigerating equipment.
g. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
h. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system.
i. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
j. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
k. Rating Plugs: Three-pole breakers with ampere ratings greater than 400 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
l. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
m. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
n. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
o. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices, prohibiting upstream devices from tripping when downstream device senses and trips from ground fault.
p. Multipole units enclosed in a single housing with a single handle orfactory assembled to operate as a single unit.
q. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
r. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

C. Fused Switch: NEMA KS 1, Type HD, horsepower rated, quick-make, quick-break; clips for Class R rejection fuses; lockable handle.

1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
2. Fused Switch Features and Accessories:

a. Standard ampere ratings and number of poles.
b. Short circuit current rating of 200,000 RMS symmetrical amperes (with fuses).

c. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
d. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

2.5 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder or metal frame with transparent protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:

1. Install panelboards 60 inches or greater in height on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Install panelboards less than 60 inches in height on wall.
3. Attach panelboard to the vertical finished or structural surface behind the panelboard.
4. Provide steel channel supports to bridge studs above and below panelboards in stud partitions.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Mount panelboards such that top of switch or breaker handle is located 6'-6" or less above finished floor unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mount surface-mounted panelboards in wet or damp locations, such as concrete basement walls, to steel slotted supports 1 1/4 inch in depth. Orient steel slotted supports vertically.

J. Mechanically bolt panelboards of more than one (1) section together.

K. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

M. Install filler plates in unused spaces.

N. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

P. Provide breaker locking devices as required by other sections of Division 26.

3.3 IDENTIFICATION

A. Conductors: Identify field-installed conductors, interconnecting wiring, and components; complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Branch-Circuit Panelboard Directories: Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations and equipment being served. Use identifications compatible with Owner's program and readily identifiable without removing directory from its holder. Obtain Owner's approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Certify compliance with test parameters.
2. Verify nameplate data and overcurrent protective device sizes and types match drawing and specification requirements.
3. Inspect physical and mechanical condition of equipment.
4. Verify required anchoring of equipment to floor and wall.
5. Verify all bolted connections meet manufacturer's recommended tightness.
6. Test ground-fault protection of equipment per NFPA 70.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared scan tests and inspections and prepare reports:
    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Instruments and Equipment:
        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

5. Re-label affected equipment, devices, junction boxes, wiring, panelboard directories, etc. due to load reconnection and branch circuit number changes.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate, and maintain panelboards, overcurrent protective devices, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

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. Standard-grade receptacles, 125 V, 20 A.
2. USB receptacles.
3. GFCI receptacles, 125 V, 20 A.
4. SPD receptacles, 125 V, 20 A.
5. Twist-locking receptacles.
6. Pendant cord-connector devices.
7. Toggle switches, 120/277 V, 20 A.
8. Occupancy sensors.
9. Digital timer light switches.
10. Wall-box dimmers.
11. Wall plates.

1.3 DEFINITIONS

A. AFCI: Arc-fault circuit interrupter.

B. BAS: Building automation system.

C. EMI: Electromagnetic interference.

D. GFCI: Ground-fault circuit interrupter.

E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

F. RFI: Radio-frequency interference.

G. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with requirements in this Section.

F. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.

G. Device Color:

1. Wiring Devices Connected to Normal Power System: Ivory White unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Essential Electrical System: Red.
3. SPD Devices: Blue.

H. Wall Plate Color: For plastic covers, match device color.

I. Source Limitations: Obtain all wiring devices and associated wall plates on project from same manufacturer unless not commercially available.

2.2 STANDARD RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding, back and side wired.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 and FS W-C-596.

B. Tamper-Resistant Duplex Receptacles, 125 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding, back and side wired. Integral shutters that operate only when a plug is inserted in the receptacle.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Weather-Resistant Duplex Receptacle, 125 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding, back and side wired.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498.

5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

D. Tamper- and Weather-Resistant Duplex Receptacles, 125 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding, back and side wired. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.3 USB RECEPTACLES

A. Tamper-Resistant Duplex and USB Charging Duplex Receptacles :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Integral shutters that operate only when a plug is inserted in the line voltage receptacle.
3. Line Voltage Receptacles: Two pole, three wire, and self-grounding; NEMA WD 6, Configuration 5-20R.
4. USB Receptacles: Dual USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
5. Standards: Comply with UL 498, UL 1310, USB 3.0 devices, and FS W-C-596.
6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

2.4 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Feed through.
5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
6. Revisions to UL 943, effective June 29, 2015, require GFCI receptacles to have an auto-monitoring or self-test function, denying power or providing visual and/or audible indication, and to have a repeatable reverse line-load mis-wire function, denying power to the receptacle at the initial installation and any subsequent re-installations.End of life provision, denying power to receptacle face, or indicating with visual or audible means that device must be replaced, when receptacle can no longer provide ground fault protection (as indicated by the inability to pass its internal self-test function).
7. Reverse line-load mis-wire, denying power to receptacle face if device is mis-wired, at initial installation or re-installations.

B. Tamper-Resistant Duplex GFCI Receptacles, 125 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Hubbell Incorporated; Wiring Device-Kellems.
    b. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Feed through.
5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
6. End of life provision, denying power to receptacle face, or indicating with visual or audible means that device must be replaced, when receptacle can no longer provide ground fault protection (as indicated by the inability to pass its internal self-test function).
7. Reverse line-load mis-wire, denying power to receptacle face if device is mis-wired, at initial installation or re-installations.
8. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-15R.
4. Type: Feed through.
5. Standards: Comply with UL 498 and UL 943 Class A.
6. End of life provision, denying power to receptacle face, or indicating with visual or audible means that device must be replaced, when receptacle can no longer provide ground fault protection (as indicated by the inability to pass its internal self-test function).
7. Reverse line-load mis-wire, denying power to receptacle face if device is mis-wired, at initial installation or re-installations.
8. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.5 TOGGLE SWITCHES, 120/277 V, 20 A

A. Single-Pole Switches, 120/277 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Back and side wired.

3. Standards: Comply with UL 20 and FS W-S-896.

B. Two-Pole Switches, 120/277 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Back and side wired.

3. Standards: Comply with UL 20 and FS W-S-896.

C. Three-Way Switches, 120/277 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20 and FS W-S-896.

D. Four-Way Switches, 120/277 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Back and side wired.
3. Standards: Comply with UL 20 and FS W-S-896.

E. Pilot-Light, Single-Pole Switches: 120/277 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Illuminated when switch is on.
3. Standards: Comply with UL 20 and FS W-S-896.

F. Lighted Single-Pole Switches, 120/277 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Premise Wiring.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Handle illuminated when switch is off.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

G. Key-Operated, Single-Pole Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Factory-supplied key in lieu of switch handle.
3. Standards: Comply with UL 20 and FS W-S-896.

H. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120/277 V, 20A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: For use with mechanically held lighting contactors.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

I. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: For use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.6 OCCUPANCY AND VACANCY SENSORS

A. Wall Switch Sensor Light Switch, Dual Technology :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.

c. Leviton Manufacturing Co., Inc.

d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual (ultrasonic and passive infrared) technology.
3. Standards: Comply with UL 20.
4. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
5. Adjustable off time delay of up to 20 minutes.
6. Able to be locked to Automatic Manual-On mode.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.
8. Connections: Provisions for connection to BAS.
9. Connections: RJ-45 communications outlet.
10. Connections: Integral wireless networking.

B. Wall Sensor Light Switch, Passive Infrared:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cooper Industries.
b. Hubbell Premise Wiring.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using passive infrared technology.
3. Standards: Comply with UL 20.
4. Connections: Provisions for connection to BAS.
5. Connections: Hard wired.
6. Connections: Wireless.
7. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
8. Integral relay for connection to BAS.
9. Adjustable time delay of five 10 15 20 minutes.
10. Able to be locked to Automatic Manual-On mode.
11. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.

C. Wall Sensor Light Switch, Ultrasonic:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.

2. Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using ultrasonic technology.
3. Standards: Comply with UL 20.
4. Connections: Provisions for connection to BAS.

5. Connections: RJ-45 communications outlet.
6. Connections: Integral wireless networking.
7. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
8. Integral relay for connection to BAS.
9. Adjustable time delay of five 10 15 20 minutes.
10. Able to be locked to Automatic Manual-On mode.
11. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.

2.7 TIMER LIGHT SWITCH

A. Digital Timer Light Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.

2. Description: Switchbox-mounted, combination digital timer and conventional switch lighting-control unit, with backlit digital display, with selectable time interval in 10 20-minute increments.
3. Standards: Comply with UL 20.
4. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
5. Integral relay for connection to BAS.

2.8 DIMMERS

A. Wall-Box Dimmers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Lutron Electronics Co., Inc.
    e. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Modular, full-wave, solid-state dimmer switch with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
3. Control: Continuously adjustable slider; with single-pole or three-way switching.
4. Standards: Comply with UL 1472.
5. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

    a. 600 W; dimmers shall require no derating when ganged with other devices.

6. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.9 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices. Wall plates of same material shall match same finish and details. Where two-gang boxes are required for single-gang devices, provide special wall plates with device opening in one gang and second gang blank.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces and Flush Boxes in Unfinished Spaces: 0.10-inch thick, smooth, high-impact thermoplastic 0.035-inch- thick, satin-finished, Type 302 stainless steel, beveled type, with smooth rolled outer edge.
3. Material for Surface Boxes in Unfinished Spaces: Type 302 stainless steel.
4. Material for Damp Locations: Thermoplastic Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: Gasketed NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum thermoplastic with lockable cover. Provide spring-loaded gasketed doors for receptacles.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, except use mounting heights shown on Drawings, where indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. Use a torque screwdriver when a torque is recommended or required by manufacturer.
6. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
7. Tighten unused terminal screws on the device.
8. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
9. Mount switches vertically, plumb with building lines, and approximately 6 inches (151 mm) from door opening.
10. Mount receptacles vertically, unless otherwise noted on drawings, and at heights shown on drawings.
11. Secure switches and receptacles firmly to backbox, not to wall and/or coverplate, with device extending through coverplate on all sides.
12. Coordinate device mounting locations with architectural details.
13. Mount receptacles occupying same wall space as fintube radiation horizontally in toespace at 4 inches (105 mm) to top. Do not mount above fintube.
14. Install switches controlling 277 volt circuits in individual outlet boxes or in gang boxes with approved barriers between switches.
15. Provide G.F.C.I. outlet at each location shown on drawings. Do not use one G.F.C.I. outlet to protect downstream outlets.
16. Do not use common neutrals on dimmer circuits.
17. Install cover plates on all outlet boxes. Match plate configuration to devices within box.
18. Mount flush plates so all four (4) edges are in continuous contact with finished wall.
19. Install blank cover plates on all open outlet boxes.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left (neutral contact at top).

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Follow dimmer manufacturer's directions when ganging dimmers.
3. Verify that dimmers used for fan-speed control are listed for that application.
4. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black -filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight-blade convenience outlets in patient-care areas hospital-grade outletsfor the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz..

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

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. Cartridge fuses rated 600 V ac and less for use in the following:

a. Control circuits.
b. Panelboards.
c. Switchboards.
d. Enclosed controllers.
e. Enclosed switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bussmann, an Eaton business.
2. Edison; a brand of Bussmann by Eaton.
3. Littelfuse, Inc.
4. Mersen USA.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
2. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
3. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.

B. 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.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance, 601 to 6000 Amperes: Class L, time delay, 200,000 amperes RMS symmetrical interrupting rating.
2. Service Entrance, 1/10 to 600 Amperes: RK1, time delay, 300,000 amperes RMS symmetrical interrupting rating.
3. Feeders, 601 to 6000 Amperes: Class L, time delay, 300,000 amperes RMS symmetrical interrupting rating.
4. Feeders, 1/10 to 600 Amperes: Class RK1, time delay, 300,000 amperes RMS symmetrical interrupting rating.
5. Motor Branch Circuits, 1/10 to 600 Amperes: Class RK1, time delay, 300,000 amperes RMS symmetrical rating.
6. Large Motor Branch Circuits, 601 to 4000 Amperes: Class L, time delay, 300,000 amperes RMS symmetrical interrupting rating.
7. Other Branch Circuits: Class RK1, time delay.
8. Control Transformer Circuits: Class CC, time delay, control transformer duty.

3.3 INSTALLATION

A. Install fuses in each fusible device, including those furnished by others, after equipment is set in place. Arrange fuses so rating information is readable without removing fuse.

B. Replace all fuses that have opened during construction.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information (class, size, etc.) inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Non-fusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

B. Section also includes switches and circuit breakers added to existing distribution equipment and mounted therein.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of

overcurrent protective device. Provide in PDF and electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Submit simultaneously with or after the Overcurrent Protective Device Short-Circuit, Coordination, and Arc-Flash Studies.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1. Include the following:

a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device Provide in PDF and electronic format.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7**.**

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

E. Minimum interrupting capacity equal to upstream device, or as required by Overcurrent Protective Device Short-Circuit Study. Series rated equipment is NOT allowed.

F. Minimum interrupting capacity equal to that of existing equipment, for switches and circuit breakers added to existing distribution equipment.

2.3 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design:

a. Square D; by Schneider Electric

2. Approved Equal:

    a. ABB Inc.
    b. Eaton Corporation

B. Type HD, Heavy Duty:

1. Single throw.
2. Three pole.
3. 600-V ac.
4. 1200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with Class R rejection fuse clips or bolt pads to accommodate specified fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: One Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac 120-V ac 208-V ac 240-V ac 6-V dc 12-V dc 24-V dc.
5. Lugs: Mechanical Compression type, suitable for number, size, and conductor material.
6. Service-Rated Switches: Labeled for use as service equipment when used as main disconnecting means.

2.4 NON-FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design:

    a. Square D; by Schneider Electric

2. Approved Equal:

    a. ABB Inc.
    b. Eaton Corporation

B. Type HD, Heavy Duty, Three Pole, Single Throw, 240 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: One Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac 120-V ac 208-V ac 240-V ac 6-V dc 12-V dc 24-V dc.
4. Lugs: Mechanical Compression type, suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment when used as main disconnecting means.

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design:

a. Square D; by Schneider Electric

2. Approved Equal:

a. ABB Inc.
b. Eaton Corporation

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker..

E. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for 167 deg F rated wire 194 deg F rated wire, sized according to the 167 deg F temperature rating in NFPA 70.

G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Common simultaneqous trip for 2 and 3-pole breakers.

I. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

J. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip) for personnel protection.

K. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip) for equipment protection.

L. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles. Individually insulated, braced and protected connectors.
2. Lugs: Mechanical Compression type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching lighting loads; Type HACR for heating, air conditioning, and refrigerating equipment.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Communication Capability: Circuit-breaker-mounted Universal-mounted Integral Din-rail-mounted communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring and Control."
6. Shunt Trip: 120-V trip coil energized from separate circuit, with coil-clearing contact.
7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
8. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking two or more levels of ground-fault protection and prohibiting upstream devices from tripping on ground fault when downstream device senses and trips from ground fault.
11. Electrical Operator: Provide remote control for on, off, and reset operations.
12. Accessory Control Power Voltage: Integrally mounted, self-powered Remote mounted and powered; 24-V ac 120-V ac 208-V ac 240-V ac 12-V dc 24-V dc

120-V dc.

13. Service-Rated Circuit Breakers: Labeled for use as service equipment when used as main disconnecting means.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12) a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel) copper-free cast aluminum alloy (NEMA 250 Types 7, 9).

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the front cover of the enclosure (NEMA 250 Type 1), directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R), externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

G. Surface or recessed mounting as shown on Drawings.

H. Provisions for padlocking device in OFF position, and in ON and OFF positions for outdoor locations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of

the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R Type 4X.
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.3 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated. Anchor floor-mounting switches and circuit breakers to concrete base. Provide mounting brackets, wall bracing and accessories as required.

C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NFPA 70 and NECA 1.

F. Set field-adjustable switches and circuit-breaker trip ranges.

G. Paint enclosure trims of recessed circuit breakers to match adjacent wall color.

3.4 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.
3. Install typed label indicating fuse replacement information (class, size, etc.) on inside of door of each fusible switch or controller.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that the unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of

the lowest value.

c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

C. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent

poles or similar switches by more than 50 percent of the lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.

g. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

h. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections

are accessible to portable scanner.

b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Overcurrent Protective Device Coordination Study."

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of enclosed switches and circuit breakers. Remove paint splatters and other spots. Vacuum dirt and debris. Do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed switches and circuit breakers, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262816

SECTION 262913 - ENCLOSED CONTROLLERS

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 the following enclosed controllers rated 600 V and less:

1. Full-voltage manual.
2. Full-voltage magnetic.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

G. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller.

1. Submit simultaneously with or after the Overcurrent Protective Device Short-Circuit, Coordination, and Arc-Flash Studies.
2. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
3. Show tabulations of the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Nameplate legends.
d. Short-circuit current rating of integrated unit.
e. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

4. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

C. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include the following:

1. Routine maintenance requirements for enclosed controllers and installed components.
2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
3. Manufacturer's written instructions for setting field-adjustable overload relays.
4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

1.7 QUALITY ASSURANCE

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. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.10 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 GENERAL CONTROLLER REQUIREMENTS

A. Minimum interrupting capacity equal to upstream device or as required by Overcurrent Protective Device Short-Circuit Study. Series rated equipment is NOT allowed.

B. Minimum interrupting capacity equal to that of existing equipment, for controllers replacing existing equipment.

2.2 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A, sized for motor horsepower.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Basis of Design:

1) Square D; by Schneider Electric

b. Approved Equal:

1) ABB Inc.
2) Eaton Corporation
3) Rockwell Automation, Inc.; Allen-Bradley brand

2. Configuration: Nonreversing, unless noted otherwise.
3. Flush mounting, unless noted otherwise.
4. Red pilot light (two for two-speed motors).

C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle, or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Basis of Design:

1) Square D; by Schneider Electric

b. Approved Equal:

1) ABB Inc.
2) Eaton Corporation
3) Rockwell Automation, Inc.; Allen-Bradley brand

2. Configuration: Nonreversing, unless noted otherwise.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; ambient temperature-compensated bimetallic type.
4. Flush mounting, unless noted otherwise.
5. Red pilot light (two for two-speed motors).

D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Basis of Design:

1) Square D; by Schneider Electric

b. Approved Equal:

1) ABB Inc.

2) Eaton Corporation
3) Rockwell Automation, Inc.; Allen-Bradley brand

2. Configuration: Nonreversing, unless noted otherwise.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; ambient temperature-compensated, bimetallic type.
4. Flush mounting, unless noted otherwise.
5. Red pilot light (two for two-speed motors).
6. N.O. N.C. auxiliary contact.

E. Magnetic Controllers: Full voltage, across the line, electrically held.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Basis of Design:

1) Square D; by Schneider Electric

b. Approved Equal:

1) ABB Inc.
2) Eaton Corporation
3) Rockwell Automation, Inc.; Allen-Bradley brand

2. Annunciation and Controls: Run red transformer-type pilot light in cover (two for two-speed motors). Reset button and hand-off-auto switch in cover field convertible to off/auto or start/stop pushbutton, unless other devices are shown. Verify control switch requirements from Drawings.
3. Configuration: Nonreversing, unless otherwise noted.
4. Contactor Coils: Pressure-encapsulated type.

a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

5. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
6. Control Circuits: 120 -V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

a. CPT Spare Capacity: 100 percent.

7. Auxiliary Contacts: One set of spare normally open and normally closed contacts in addition to standard auxiliary holding contacts supplied with each starter, arranged to activate before switch blades open.
8. Bimetallic Overload Relays:

a. Inverse-time-current characteristic.
b. Class 10 tripping characteristic.
c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
d. Ambient compensated.
e. Automatic resetting.

9. External overload reset push button.

F. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means. Refer to requirements for magnetic controller as described above. Provide operating handle with lock-off facility. Refer to drawings for switch requirements, i.e., fusible, non-fusible or automatic motor circuit protector type. Restrict opening of switch enclosure by the use of defeater screw unless switch is in OFF position. Provisions for padlocking indoor starters in “OFF” position and outdoor starters in “OFF" and “ON" positions.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Basis of Design:

1) Square D; by Schneider Electric

b. Approved Equal:

1) ABB Inc.
2) Eaton Corporation
3) Rockwell Automation, Inc.; Allen-Bradley brand

2. Fusible Disconnecting Means:

a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with Class R rejection-type clips or bolt pads to accommodate Class R fuses.
b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

3. Auxiliary Contacts: One set of spare normally open and normally closed contacts in addition to standard auxiliary holding contacts supplied with each starter, arranged to activate before switch blades open.

4. Nonfusible Disconnecting Means:

a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
c. Auxiliary Contacts: One set of spare normally open and normally closed contacts in addition to standard auxiliary holding contacts supplied with each starter, arranged to activate before switch blades open.

5. MCP Disconnecting Means:

a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity of 42,000 AIC for 480 volt, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
d. N.C. N.O. alarm contact that operates only when MCP has tripped.
e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

6. MCCB Disconnecting Means:

a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity of 42,000 AIC for 480 volt; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
e. N.C. N.O. alarm contact that operates only when MCCB has tripped.

2.3 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 3R or Type 4X.
3. Other Wet or Damp Indoor Locations: Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.4 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy -duty, type.

a. Push Buttons: Unguarded types; maintained or momentary as indicated.
b. Pilot Lights: LED types; colors as indicated; push to test.
c. Selector Switches: Rotary type.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in each fusible-switch enclosed controller.

D. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

G. Install power factor correction capacitors. Connect to the load side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Install typed label indicating fuse and overload protection replacement information (class, size, etc.) inside door of each controller.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

7. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports including a certified report that identifies enclosed controllers. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 262913

SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

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 field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Requirements:

1. Section 262416 "Panelboards" for factory-installed SPDs.

1.3 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

I. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

J. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs 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 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Inc.
2. Advanced Protection Technologies Inc. (APT).
3. Eaton Corporation.
4. Emerson Electric Co.
5. GE Zenith Controls.
6. LEA International; Protection Technology Group.
7. Leviton Manufacturing Co., Inc.
8. PowerLogics, Inc.
9. Schneider Electric Industries SAS.

2.2 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified

testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449.

D. MCOV of the SPD shall be at least 125 percent of the nominal system voltage.

2.3 SERVICE ENTRANCE SUPPRESSOR

A. SPDs: Comply with UL 1449, Type 1, Type 2.

B. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1, Type 2

1. SPDs with the following features and accessories:

a. Integral disconnect switch.
b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
c. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
d. Surge counter.

C. Comply with UL 1283.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Line to Line: 2000 V for 480Y/277 V.

F. SCCR: Equal or exceed 200 kA.

G. Inominal Rating: 20 kA.

2.4 PANEL SUPPRESSORS

A. SPDs: Comply with UL 1449, Type 1, Type 2.

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.

B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

C. Comply with UL 1283.

D. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V for 208Y/120 V.
2. Line to Ground: 700 V for 208Y/120 V.
3. Neutral to Ground: 700 V for 208Y/120 V.
4. Line to Line: 1200 V for 208Y/120 V

E. SCCR: Equal or exceed 100 kA.

F. Inominal Rating: 20 kA.

2.5 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 3R, Type 4X.

2.6 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Wiring:

1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Controls: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

SECTION 265119 - LED INTERIOR LIGHTING

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. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 265219 "Emergency and Exit Lighting" for emergency lighting and exit signs.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Submit in collated and bound brochures, with fixture type clearly identified on each cut.

3. Include manufacturer and catalog number.
4. Include data on features, accessories, and finishes.
5. Include physical description and dimensions of luminaires.
6. Include emergency lighting units, including batteries and chargers.
7. Include LED driver, including efficiency.
8. Include lamp life, fixture output (delivered lumens), color temperature (CCT), color rendering (CRI), voltage, and energy efficiency data (luminaire watts).
9. Include photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project. Conform to IES LM-79andIES LM-80.

    a. Testing Agency Certified Data: Photometric data certified by a qualified independent testing agency.

1.5 INFORMATIONAL SUBMITTALS

A. Notarized Affidavits and Test Reports: Obtain from each manufacturer and light diffusing system manufacturer certifying that all light transmitting plastic is in compliance with Michigan State Fire Safety Board Requirements and Memorandums covering plastic materials as interior finishes.

B. Emergency Illumination Verification: Provide point-by-point plot of emergency illumination levels, in footcandles, for all areas of the building with emergency illumination.

1. Illumination levels shall be initial footcandles, at the floor, shown on a 2 foot square grid. Indicate maximum, minimum, and average footcandle levels, and maximum-to-minimum illumination uniformity ratio. Base calculations on 80 percent/50 percent/20 percent ceiling/wall/floor reflectances.
2. Base calculations on actual luminaires and lamp/driver systems installed.
3. Building footprint with luminaire layout, in electronic Auto-CAD format, will be available from the Architect.
4. Provide three (3) copies of all documentation for Architect review and comment. Revise calculations as required, and provide six (6) copies of final documentation.

C. Qualification Data: For testing laboratory providing photometric data for luminaires.

D. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

B. Warranties: Special warranties specified in this section.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Comply with Michigan State Fire Safety Board Requirements and Memorandams.

1.8 COORDINATION

A. Confirm compatibility and interface of ceiling system and other materials with luminaire mounting. Report discrepancies to Architect, and defer ordering until clarified.

B. Supply plaster frames, trim rings and backboxes to other trades.

C. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the manufacturers specified in the Lighting Fixture Legend on Drawings.

2.2 LUMINAIRE 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. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598.

E. Recessed Fixtures:

1. Comply with NEMA LE 4.
2. Provide integral thermal protection.

F. Bulb shape complying with ANSI C79.1.

G. Lamp base complying with ANSI C81.61orIEC 60061-1.

H. CRI of minimum 80. CCT of 3500 K.

I. Rated lamp life of minimum 50,000 hours.

J. Lamps dimmable from 100 percent to 1 percent of maximum light output unless otherwise indicated.

K. Internal driver, unless otherwise indicated.

L. Nominal Operating Voltage: As specified in the Lighting Fixture Legend on Drawings.

M. Drivers with Supply Voltage Greater than 150 Volts: Provide Bussman HLR in-line fuse holders and Bussman GLR fuses for each driver.

N. Remote Drivers: Provide enclosure with integral junction box for wire connections, where indicated on Drawings.

2.3 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Painting: All recessed troffers shall be factory painted after fabrication.

D. Diffusers and Globes:

1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch nominal unless otherwise indicated.
4. Light transmitting plastic in lighting fixtures and light diffusing systems shall conform to Michigan State Fire Safety Board Rules and Memorandums.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.4 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all fixtures delivered to jobsite prior to installation to ensure all specification requirements and shop drawings notes and comments have been incorporated by manufacturer. Installation of fixtures signifies Contractor's acceptance and approval of fixtures from manufacturer.

B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

C. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Remote Mounting of Drivers: Distance between the driver and luminaire shall not exceed that recommended by driver manufacturer. Verify, with driver manufacturers, maximum distance between driver and luminaire.

C. Install luminaires per manufacturer's recommendations, level, plumb, and square with ceilings and walls unless otherwise indicated.

D. Support fixtures directly from building structure by rod hangers or metal angle headers supported from framing structure or from appropriately rated ceiling grid system. Do NOT support from metal roof decks.

E. Provide all rod hangers, metal angle headers, anchors, clamps, etc., to support fixtures.

F. Provide supplemental support for fixture installations that put excessive stress on ceiling system.

G. Install lamps in each luminaire.

H. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them.

I. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

J. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.
4. In accessible ceilings, install to permit access to outlet or prewired fixture box from below.
5. Connect to boxes with flexible conduit and fixture wire, or MC or AC cable.

K. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls or using through bolts and backing plates on either side of wall.
2. Do not attach luminaires directly to gypsum board.

L. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch-diameter aircraft cable supports adjustable to 120 inches in length.
2. Ceiling mount with pendant mount with 5/32-inch-diameter aircraft cable supports adjustable to 120 inches in length.
3. Ceiling mount with hook mount.

M. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices. Route fixture wiring down one stem.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not run wiring horizontally between rows of fixtures.
5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

N. Recessed Lighting Fixtures:

1. In accessible ceilings, install to permit access to outlet or prewired fixture box from below.

2. Connect to boxes with flexible conduit and fixture wire, or MC cable.

O. Align lighting fixtures and clean diffusers prior to final acceptance.

P. Adjust aimable lighting fixtures as directed by Architect and to provide required light intensities.

Q. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

R. Drivers:

1. Factory mount drivers unless otherwise indicated.
2. Mount drivers located remote from fixture on steel channels to provide 1 inch air space between driver and mounting surface.

S. Emergency Lighting Units: Connect to same branch circuit serving normal lighting in room or area, ahead of any local switches.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 265119

SECTION 265219 - EMERGENCY AND EXIT LIGHTING

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. Emergency lighting units.
2. Exit signs.
3. Luminaire supports.

B. Related Sections include the following:

1. Section 265119 "LED Interior Lighting" for LED interior lighting.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

1. Arrange in order of luminaire designation.
2. Submit in collated and bound brochures, with fixture type clearly identified on each cut.
3. Include manufacturer and catalog number.

4. Include data on features, accessories, and finishes.
5. Include physical description of the unit and dimensions.
6. Battery and charger for light units.
7. Include lamp life, output of luminaire (lumens), color temperature (CCT), color rendering (CRI), voltage, and energy-efficiency data (luminaire watts).
8. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.

    a. Testing Agency Certified Data: Photometric data certified by a qualified independent testing agency.

1.5 INFORMATIONAL SUBMITTALS

A. Notarized Affidavits and Test Reports: Obtain from each manufacturer and light diffusing system manufacturer certifying that all light transmitting plastic is in compliance with Michigan State Fire Safety Board Requirements and Memorandums covering plastic materials as interior finishes.

B. Emergency Illumination Verification: Provide point-by-point plot of emergency illumination levels, in footcandles, for all areas of the building with emergency illumination.

1. Illumination levels shall be initial footcandles, at the floor, shown on a 2 foot square grid. Indicate maximum, minimum, and average footcandle levels, and maximum-to-minimum illumination uniformity ratio. Base calculations on 80 percent/50 percent/20 percent ceiling/wall/floor reflectances.
2. Base calculations on actual luminaires and ballast/driver systems installed.
3. Building footprint with luminaire layout, in electronic Auto-CAD format, will be available from the Architect.
4. Provide three (3) copies of all documentation for Architect review and comment. Revise calculations as required, and provide six (6) copies of final documentation.

C. Qualification Data: For testing laboratory providing photometric data for luminaires.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

B. Warranties: Special warranties specified in this section.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

B. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.8 COORDINATION

A. Confirm compatibility and interface of ceiling system and other materials with luminaire mounting. Report discrepancies to Architect, and defer ordering until clarified.

B. Supply plaster frames, trim rings and backboxes to other trades.

C. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two year(s) from date of Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Power Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.
2. Warranty Period for Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining six years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Emergency Lighting and Exit Signs: Subject to compliance with requirements, provide products by one of the manufacturers specified in the Lighting Fixture Legend on Drawings.

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

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. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Comply with UL 1598.

F. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.

G. Bulb Shape: Complying with ANSI C79.1.

H. Nominal Operating Voltage: As specified in the Lighting Fixture Legend on Drawings.

2.3 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Glass: Annealed crystal glass unless otherwise indicated.
2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
4. Light transmitting plastic in lighting fixtures and light diffusing systems shall conform to Michigan State Fire Safety Board Rules and Memorandums.

2.6 METAL FINISHES

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.

2.7 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all fixtures delivered to jobsite prior to installation to ensure all specification requirements and shop drawings notes and comments have been incorporated by manufacturer. Installation of fixtures signifies Contractor's acceptance and approval of fixtures from manufacturer.

B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

C. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

D. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires per manufacturer's recommendations, level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Support fixtures directly from building structure by rod hangers or metal angle headers supported from framing structure or from appropriately rated ceiling grid system. Do NOT support from metal roof decks.

D. Provide all rod hangers, metal angle headers, anchors, clamps, etc., to support fixtures.

E. Provide supplemental support for fixture installations that put excessive stress on ceiling system.

F. Install lamps in each luminaire.

G. Emergency Lighting Units: Connect to same branch circuit serving normal lighting in room or area, ahead of any local switches.

H. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing emergency lighting and exit signs, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 265219

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires with LED lamps and drivers.
2. Luminaire-mounted photoelectric relays.

B. Related Sections include the following:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 260943 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
3. Section 265119 "LED Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LER: Luminaire efficacy rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting fixture, including ballast housing if provided.

H. NAAMM: National Association of Architectural Metal Manufacturers.

1.3 ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Submit in collated and bound brochures, with fixture type clearly identified on each cut.

2. Include manufacturer and catalog number.
3. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
4. Details of attaching luminaires and accessories.
5. Details of installation and construction.
6. Luminaire materials.
7. Photometric data based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each luminaire type, complete with indicated lamps, drivers or , and accessories. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project. Conform to IES LM-79 and IES LM-80.

    a. Testing Agency Certified Data: Photometric data shall be certified by a qualified independent testing agency.

8. Photoelectric relays.
9. LED drivers or ballasts, including energy-efficiency data.
10. Include lamp life, fixture output (delivered lumens), color temperature (CCT), color rendering (CRI), voltage, and energy-efficiency data (luminaire watts).
11. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
3. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

B. Warranties: Special warranties specified in this section.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

B. 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.

C. Comply with IEEE C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

E. Provide luminaires from a single manufacturer for each luminaire type.

F. Each solid-state luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces of luminaires, mounting arms, etc., by applying a strippable, temporary protective covering before shipping.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide products by one of the manufacturers specified in the Lighting Fixture Legend on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

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. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

C. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

F. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

H. Exposed Hardware Material: Stainless steel.

I. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

J. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint or anodizing applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color support materials.
   1. Color: As selected from manufacturer's standard catalog of colors.

M. LED LAMPS AND DRIVERS

   1. CRI of minimum 80. CCT of 3500K unless noted otherwise.
   2. L70 lamp life of 50,000.
   3. Lamps dimmable from 100 percent to 10 of maximum light output.
   4. Internal driver.
   5. Nominal Operating Voltage: As shown on the Lighting Fixture Legend on Drawings.

6. Lamp Rating: Lamp marked for outdoor use.

N. SOURCE LIMITATIONS

1. Obtain Luminaires from single source from a single manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all fixtures delivered to jobsite prior to installation to ensure all specification requirements and shop drawing notes and comments have been incorporated by manufacturer. Installation of fixtures signifies Contractor's acceptance and approval of fixtures from manufacturer.

3.2 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming at night. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

END OF SECTION 265600

SECTION 321613.19 – DOCKING GUIDE STRIP

PART 1 - GENERAL

1.1 SUMMARY

A. Work of this Section includes the complete construction of the docking guide strip. The construction includes providing and installing the docking guide strip as identified on the Contract Drawings including but not limited to the docking guide strip, shims, anchor bolts, and washers.
   1. Tapers shall be provided at the end as shown on plans.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each type of product, in manufacturer's standard sizes.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For docking guide strips, to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
   1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost.

PART 2 - PRODUCTS

2.1 DOCKING GUIDE STRIP

A. Source Limitations: Obtain each type of docking guide strip, anchors, and fasteners from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

B. Docking Guide Strip: Custom formulated, synthetic fender designed to reduce street curb damage at bus stops. Provide material with integral, consistent color, UV stabilized throughout the material.
1. Subject to compliance with requirements, provide Polymer Industries POLYSLICK Bus Curb-S or comparable product as approved by Architect.
2. Material: Ultra High Molecular Weight Polyethylene blend with additives to protect it from ultraviolet degradation. Physical Characteristics:

Property	Method	Unit	Typical Value
Specific Gravity (Relative Hardness)	ASTM D 792	g/cm^3	0.932
Hardness	ASTM D 2240	Shore D	65
Tensile Break	ASTM D 638	psi	4,350
Elongation at Break	ASTM D 638	%	300
Abrasion	Internal	Steel=100	16
Notched	ASTM D 256	ft.-lbs./in.	No Break
Double Notched	ASTM D 256A	ft.-lbs./in.	18
Linear Coefficient of Thermal Expansion	ASTM D 696	$°K^{-1}$	2×10^{-4}
Static	ASTM D 1894	Unitless	0.2
Dynamic	ASTM D 1894	Unitless	0.15

3. Color: Safety yellow.
4. Provide backing boards, lock washers, and anchorages as recommended by the manufacturer and as shown on Drawings.
5. Exposed edges shall have fillet or radius as follows:
   a. 1-inch at the top
   b. 1/4-inch at the bottom
   c. 1/2-inch on the ends
6. Shapes and Sizes: As shown on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions.

B. Verify lines, levels, and dimensions before proceeding with work of this section.

C. Confirm acceptance of structural concrete prior to drilling anchorages.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Review reinforcing details to avoid drilling anchorages into steel.

B. P23rovide joint sealant where concrete is adjacent to the top of the docking guide strip.

3.3 ANCHORING DOCKING GUIDE STRIPS

A. Docking guide strips shall be installed per the manufacturer’s recommendations.
   1. Special attention shall be paid to the installation requirements regarding thermal expansion. Countersunk holes for attachment shall be drilled to accommodate the expansion.
   2. Lock washers and/or adhesives shall be installed per manufacturer’s recommendations.
   3. Five-foot transitions at each end of the wheel guide shall be constructed so as to provide all curb edges as flush.

END OF SECTION 321613.19

PLANS:

REVISE: NOTE E4 ON SHEET E002 AS FOLLOWS:

BUS CHARGING SYSTEM POWER CABINETS, OVERHEAD PANTOGRAPH, MANAGEMENT CONTROL PANEL, AND MAIN SWITCHBOARD DESIGNED AND FURNISHED BY OTHERS UNDER SEPARATE PACKAGE. FURNISH AND INSTALL EQUIPMENT RACEWAY REQUIREMENTS AS SHOWN ON PLANS FOR THE ELECTRICAL SERVICE AND BUS CHARGING SYSTEM. ELECTRICAL SERVICE CONDUCTORS AND EQUIPMENT CONDUCTORS FOR THE BUS CHARGING SYSTEM FURNISHED AND INSTALLED BY OTHERS. COORDINATE INSTALLATION OF BUS CHARGING SYSTEM RACEWAYS WITH THE BUS CHARGING SYSTEM CONTRACTOR.

Please acknowledge this addendum on page E1 of the contract documents and/or in Section E: Bidder's Acknowledgement on Bid Express.

Electronic version of these documents can be found on the Bid Express website at:

https://www.bidexpress.com

If you are unable to download plan revisions associated with the addendum, please contact the Engineering office at 608-266-4761 to receive the material by another route.

Sincerely,

_____ For:
James M. Wolfe, P.E., City Engineer

JMW:RES

ELECTRICAL SYMBOL LEGENDS

POWER GENERAL NOTES:

A. REFER TO CIVIL, ARCHITECTURAL, PLUMBING, AND MECHANICAL PLANS FOR WORK AFFECTING DIV. 26.

B. REFER TO ARCHITECTURAL DRAWING ELEVATION DETAILS FOR ADDITIONAL WITH ELECTRICAL AND LIGHTING DEVICE LOCATIONS.

C. DO NOT PLACE ANY CONDUITS IN NEW RAISED FLOOR SLABS UNO. DO NOT CROSS CONDUITS IN SLAB ON GRADE FLOORS.

D. COORDINATE INSTALLATION OF WALL MOUNTED ELECTRICAL & MECHANICAL EQUIPMENT WITHIN ELECTRICAL ROOM TO ENSURE AVAILABLE WALL SPACE IS PROVIDED FOR FUTURE EQUIPMENT AS SHOWN.

E. LOCATE AND INSTALL ALL SHIPPED LOOSE MOTOR STARTERS. REFER TO "MEP" DRAWINGS FOR SPECIFIC EQUIPMENT.

F. PROVIDE ALL RACEWAYS, BOXES, SLEEVES, ETC. AS REQUIRED FOR A COMPLETE EMPTY RACEWAY SYSTEM FOR FUTURE EQUIPMENT AND SYSTEMS AS SHOWN ON THE PLANS.

G. COORDINATE ALL SITE WORK WITH CIVIL UNDERGROUND UTILITIES.

H. PROVIDE SELF-DRILLING CONCRETE ANCHORS OR SLEEVE ANCHORS FOR ALL SUPPORT APPLICATIONS IN CONCRETE.

I. ROUTE ALL CONDUITS IN ROOMS WITH EXPOSED CEILINGS TIGHT TO DECK.

J. REFER TO STRUCTURAL DRAWINGS FOR DETAILS AND REQUIREMENTS FOR MAKING CONDUIT PENETRATIONS THROUGH FLOORS, WALLS, AND FOUNDATION. COORDINATE PLACEMENT OF CONDUIT AND SLEEVES THROUGH FOUNDATION WALL WITH STRUCTURAL CONTRACTOR. SEAL PENETRATIONS PER DIV. 26 SPECIFICATIONS.

LIGHTING GENERAL NOTES:

A. REFER TO ARCHITECTURAL, PLUMBING, AND MECHANICAL PLANS FOR WORK AFFECTING DIV. 26.

B. ALL EXIT SIGN LIGHTS TO BE CIRCUITED TO THE NEAREST CIRCUIT AND CONNECTED AHEAD OF ANY LOCAL SWITCHING CONTROLS, UNO.

C. REFER TO ARCHITECTURAL ELEVATIONS FOR COORDINATION OF BUILDING MOUNTED LIGHT FIXTURES.

D. LOCATE AND INSTALL OCCUPANCY SENSORS PER MANUFACTURER RECOMMENDATIONS TO ENSURE COMPLETE AREA COVERAGE, CIRCUIT LOADING, AND AVOIDANCE OF NUISSANCE OPERATIONS.

E. DO NOT ATTACH ANY FIXTURE, EQUIPMENT, OR SUPPORT FOR THE SAME DIRECTLY TO METAL ROOF DECK.

ADDENDUM 1: 4/17/26 RJS
REVISED PLAN NOTE.

POWER KEYED NOTES:

E1 LOCATE SIMPLEX RECEPTACLE OR HARDWIRED CONNECTION AS REQUIRED TO ELECTRONIC SENSOR FAUCET AND ELECTRONIC FLUSH VALVE TRANSFORMER ADJACENT / BENEATH SINK. COORDINATE EXACT REQUIREMENTS WITH PLUMBING CONTRACTOR. PROVIDE A 15A, 120V GFI CIRCUIT AND LABEL CONNECTION AS "GFI PROTECTED".

E2 PROVIDE 15A, 120V GFI CIRCUIT FOR HARDWIRED CONNECTION TO HAND DRYERS. COORDINATE EXACT REQUIREMENTS PRIOR TO CONNECTION.

E3 BUS CHARGING SYSTEM POWER CABINETS REQUIRE A MINIMUM FREE SPACE AROUND THEM FOR PROPER VENTILATION. PROVIDE NO LESS THAN 4" OF FREE SPACE BEHIND POWER CABINETS AND 6" OF FREE SPACE ON EITHER SIDE OF CABINET ROW. REFER TO MANUFACTURER'S INSTALLATION GUIDE FOR ADDITIONAL REQUIREMENTS.

E4 BUS CHARGING SYSTEM POWER CABINETS, OVERHEAD PANTOGRAPH, MANAGEMENT CONTROL PANEL, AND MAIN SWITCHBOARD DESIGNED AND FURNISHED BY OTHERS UNDER SEPARATE PACKAGE. FURNISH AND INSTALL EQUIPMENT RACEWAY REQUIRMENTS AS SHOWN ON PLANS FOR THE ELECTRICAL SERVICE AND BUS CHARGING SYSTEM. ELECTRICAL SERVICE CONDUCTORS AND EQUIPMENT CONDUCTORS FOR THE BUS CHARGING SYSTEM FURNISHED AND INSTALLED BY OTHERS. COORDINATE INSTALLATION OF BUS CHARGING SYSTEM RACEWAYS WITH THE BUS CHARGING SYSTEM CONTRACTOR.

E5 SECURITY CAMERA TO BE AXIS #M3077-PLVE. PROVIDE CAT6 DATA CABLE IN 1/2" CONDUIT FROM CAMERA TO PROPOSED SECURITY CAMERA PANEL LOCATION IN ELECTRICAL ROOM. SECURITY CAMERA PANEL AND FINAL TERMINATION CONNECTIONS BY OWNER. COORDINATE EXACT REQUIREMENTS WITH THE OWNER.

E6 STUB 1" CONDUIT FROM SOLAR PV DISCONNECT SWITCH INSIDE ELECTRICAL ROOM ALONG NORTH WALL A MINIMUM OF 1 FOOT AND CAP FOR FUTURE USE. LABEL DISCONNECT SWITCH "SOLAR PV UTILITY DISCONNECT". COORDINATE EXACT REQUIREMENTS WITH THE OWNER.

E7 PROVIDE WEATHERPROOF J-BOX FOR FUTURE SOLAR PV SYSTEM POWER CONNECTION. SURFACE MOUNT J-BOX TO ROOF'S NORTH PARAPET WALL 2'-0" ABOVE FINISH ROOF DECK. STUB 1" CONDUIT FROM J-BOX INSIDE ELECTRICAL ROOM ALONG NORTH WALL A MINIMUM OF 1 FOOT AND CAP FOR FUTURE USE. REFER TO ARCHITECTURAL PLANS FOR TYPICAL ROOF PENETRATION DETAIL. COORDINATE EXACT REQUIREMENTS WITH THE OWNER.

LIGHTING KEYED NOTES:

L1 CHAIN HANG LIGHT FIXTURES +8'-6" AFF. COORDINATE MOUNTING LOCATION WITH MECHANICAL EQUIPMENT, DUCTWORK, ETC. BEFORE INSTALLING. PLACE FIXTURES FOR OPTIMAL ILLUMINATION.

L2 ROOM EXHAUST FAN TO BE INTERLOCKED WITH OCCUPANCY SENSOR SWITCH. FAN TO OPERATE UPON ACTIVATION OF SENSOR SWITCH. ENSURE SENSOR SWITCH IS LOAD RATED FOR A FAN LOAD.

COMMON SYMBOLS

E#	POWER KEYED NOTE
L#	LIGHTING KEYED NOTE

ABBREVIATIONS

TYP	TYPICAL.
C	OUTLET MOUNTED OVER COUNTER TOP. MOUNT WITH BOTTOM OF BOX 6" ABOVE COUNTERTOP.
U.C.	OUTLET MOUNTED UNDER COUNTER TOP.
AFF	ABOVE FINISHED FLOOR.
WP	WEATHER PROOF, WATERTIGHT & CORROSION RESISTANT.
EXP	EXPLOSION PROOF
GFI	GROUND FAULT INTERRUPTING TYPE
IG	ISOLATED GROUND.
3 / E03	DETAIL No.3 ON DRAWING E03
ELEC. ROOM 109	ROOM TAG
1	REVISION TRIANGLE
UNO	UNLESS NOTED OTHERWISE

WHERE NOT INDICATED ON THE PLANS, BRANCH CIRCUIT CONDUCTORS AND CONDUITS SHALL BE SIZED, AT MINIMUM, BASED ON THE SCHEDULE BELOW. BRANCH CIRCUIT LENGTH SHALL BE LIMITED TO 75'-0" WHERE POSSIBLE. THE WIRING FOR ANY BRANCH CIRCUIT EXCEEDING 75'-0" IN LENGTH SHALL BE UPSIZED TO MAINTAIN < 3% VOLTAGE DROP.

BRANCH CIRCUIT WIRING MINIMUM REQUIREMENTS

	WIRE SIZE (AWG)		CONDUIT SIZE	
OCPD SIZE	PHASE/NEUTRAL	GROUND	3W+GRD	4W+GRD
20A	#12	#12	3/4"	3/4"
30A	#10	#12	3/4"	3/4"
40A	#8	#12	3/4"	3/4"
55A	#6	#12	3/4"	1"
60A	#4	#10	1"	1-1/4"

ADD1	PLAN NOTE REVISION	04/17/26	RJS
MARK	REVISION	DATE	BY

Designed By: RJS | Date: 2026-02-24 | Scale:

14880

ELECTRICAL ABBREVIATIONS AND NOTES

METRO TRANSIT KENNEDY ROAD ON-ROUTE BUS CHARGER

MADISON, WI

CONTRACT NO: 9766

CITY OF MADISON

14880

E002

SECTION E: BIDDERS ACKNOWLEDGEMENT

METRO TRANSIT KENNEDY ROAD ON-ROUTE BUS CHARGER
CONTRACT NO. 9766

Bidder must state a Unit Price and Total Bid for each item. The Total Bid for each item must be the product of quantity, by Unit Price. The Grand Total must be the sum of the Total Bids for the various items. In case of multiplication errors or addition errors, the Grand Total with corrected multiplication and/or addition shall determine the Grand Total bid for each contract. The Unit Price and Total Bid must be entered numerically in the spaces provided. All words and numbers shall be written in ink.

1. The undersigned having familiarized himself/herself with the Contract documents, including Advertisement for Bids, Instructions to Bidders, Form of Proposal, City of Madison Standard Specifications for Public Works Construction - 2026 Edition thereto, Form of Agreement, Form of Bond, and Addenda issued and attached to the plans and specifications on file in the office of the City Engineer, hereby proposes to provide and furnish all the labor, materials, tools, and expendable equipment necessary to perform and complete in a workmanlike manner the specified construction on this project for the City of Madison; all in accordance with the plans and specifications as prepared by the City Engineer, including Addenda Nos. _____ through _____ to the Contract, at the prices for said work as contained in this proposal. (Electronic bids submittals shall acknowledge addendum under Section E and shall not acknowledge here)
2. If awarded the Contract, we will initiate action within seven (7) days after notification or in accordance with the date specified in the contract to begin work and will proceed with diligence to bring the project to full completion within the number of work days allowed in the Contract or by the calendar date stated in the Contract.
3. The undersigned Bidder or Contractor certifies that he/she is not a party to any contract, combination in form of trust or otherwise, or conspiracy in restraint of trade or commerce or any other violation of the anti-trust laws of the State of Wisconsin or of the United States, with respect to this bid or contract or otherwise.
4. I hereby certify that I have met the Bid Bond Requirements as specified in Section 102.5. *(IF BID BOND IS USED, IT SHALL BE SUBMITTED ON THE FORMS PROVIDED BY THE CITY. FAILURE TO DO SO MAY RESULT IN REJECTION OF THE BID).*
5. I hereby certify that all statements herein are made on behalf of Parisi Construction LLC (name of corporation, partnership, or person submitting bid) a corporation organized and existing under the laws of the State of Wisconsin a partnership consisting of _____; an individual trading as _____; of the City of _____ State of _____; that I have examined and carefully prepared this Proposal, from the plans and specifications and have checked the same in detail before submitting this Proposal; that I have fully authority to make such statements and submit this Proposal in (its, their) behalf; and that the said statements are true and correct.

_____
SIGNATURE

president
_____
TITLE, IF ANY

Sworn and subscribed to before me this 20th day of March, 2026.

_____
(Notary Public or other officer authorized to administer oaths)

My Commission Expires 12/4/2026

CHRISTINE AHERN NOTARY PUBLIC STATE OF WISCONSIN

Bidders shall not add any conditions or qualifying statements to this Proposal.

Section E: Bidder's Acknowledgement

This section is a required document for the bid to be considered complete. There are two methods for completing the Bidder Acknowledgement Report. Method one: The report can be downloaded, completed, and uploaded to this site to be included with your electronic bid. Method two: The report can be downloaded from the site and submitted by hand to the City of Madison. Either method of submission requires that the Bidder Acknowledgement Report be received by the bid due date.

Please select the method of submission below. The form is in the section below to download and upload to the site or download and submit by hand.

Please check the box in the Upload section if submitting the report by hand.

Method of Submittal for Bidder Acknowledgement (click in box below to choose) *

I will download Bidder Acknowledgement Downloadable Document, complete, and upload online.

The bidder acknowledges receipt of the following addenda to the contract for the above designated project. Please check the appropriate box for each addendum reviewed. If no addenda have been issued, then no boxes are required to be checked.

Any addenda issues after 12:00 P.M. on the Tuesday proceeding the bid due date shall include a provision extending the bid due date.

Addendum Acknowledgement

Acknowledge each Addenda reviewed by checking the appropriate checkboxes below.

☑ **Addendum 1**

*

☐ **Addendum 2**

☐ **Addendum 3**

☐ **Addendum 4**

☐ **Addendum 5**

☐ **Addendum 6**

Section F: Best Value Contracting (BVC) Fillable Online Form

Best Value Contracting

1. The Contractor shall indicate the non-apprenticeable trades used on this contract.

2. Madison General Ordinance (M.G.O.), 33.07(7), does provide for some exemptions from the active apprentice requirement. Apprenticeable trades are those trades considered apprenticeable by the State of Wisconsin. Please check applicable box if you are seeking an exemption.

☐ **Contractor has a total skilled workforce of four or less individuals in all apprenticeable trades combined.**

☐ **No available trade training program; The Contractor has been rejected by the only available trade training program, or there is no trade training program within 90 miles.**

☐ **Contractor is not using an apprentice due to having a journey worker on layoff status, provided the journey worker was employed by the contractor in the past six months.**

☐ **First time contractor on City of Madison Public Works contract requests a onetime exemption but intends to comply on all future contracts and is taking steps typical of a "good faith" effort.**

☐ **Contractor has been in business less than one year.**

☐ **Contractor doesn't have enough journeyman trade workers to qualify for a trade training program in that respective trade.**

☐ **An exemption is granted in accordance with a time period of a "Documented Depression" as defined by the State of Wisconsin.**

3. The Contractor shall indicate on the following section which apprenticeable trades are to be used on this contract. Compliance with active apprenticeship, to the extent required by M.G.O. 33.07(7), shall be satisfied by documentation from an applicable trade training body; an apprenticeship contract with the Wisconsin Department of Workforce Development or a similar agency in another state; or the U.S Department of Labor. This documentation is required prior to the Contractor beginning work on the project site.

☐ **The Contractor has reviewed the list and shall not use any apprenticeable trades on this project.**

LIST APPRENTICABLE TRADES (check all that apply to your work to be performed on this contract)

☐ **BRICKLAYER**

☐ **CARPENTER**

☑ **CEMENT MASON / CONCRETE FINISHER**

☐ **CEMENT MASON (HEAVY HIGHWAY)**

☑ **CONSTRUCTION CRAFT LABORER**

☐ **DATA COMMUNICATION INSTALLER**

☐ **ELECTRICIAN**

☐ **ENVIRONMENTAL SYSTEMS TECHNICIAN / HVAC SERVICE TECH/HVAC INSTALL / SERVICE**

☐ **GLAZIER**

☑ **HEAVY EQUIPMENT OPERATOR / OPERATING ENGINEER**

☐ **INSULATION WORKER (HEAT and FROST)**

☐ **IRON WORKER**

☐ **IRON WORKER (ASSEMBLER, METAL BLDGS)**

☐ **PAINTER and DECORATOR**

☐ **PLASTERER**

☐ **PLUMBER**

☐ **RESIDENTIAL ELECTRICIAN**

☐ **ROOFER and WATER PROOFER**

☐ **SHEET METAL WORKER**

☐ **SPRINKLER FITTER**

☐ **STEAMFITTER**

☐ **STEAMFITTER (REFRIGERATION)**

☐ **STEAMFITTER (SERVICE)**

☐ **TAPER and FINISHER**

☐ **TELECOMMUNICATIONS (VOICE, DATA and VIDEO) INSTALLER-TECHNICIAN**

☐ **TILE SETTER**

METRO TRANSIT KENNEDY ROAD ON-ROUTE BUS CHARGER
CONTRACT NO. 9766

Small Business Enterprise Compliance Report

This information may be submitted electronically through Bid Express or submitted with bid in sealed envelope.

Cover Sheet

Prime Bidder Information

Company: Parisi Construction LLC

Address: 508 S. Nine Mound Rd. Verona, WI 53593

Telephone Number: 6088485991 Fax Number: 6088485992

Contact Person/Title: Robert Endres, president

Prime Bidder Certification

I, Robert Endres (Name), president (Title) of Parisi Construction LLC (Company) certify that the information contained in this SBE Compliance Report is true and correct to the best of my knowledge and belief.

Witness' Signature

Bidder's Signature

4/3/2026

Date

METRO TRANSIT KENNEDY ROAD ON-ROUTE BUS CHARGER
CONTRACT NO. 9766

Small Business Enterprise Compliance Report

Summary Sheet

SBE Subcontractors Who Are NOT Suppliers

Name(s) of SBEs Utilized	Type of Work	% of Total Bid Amount
CA Blumm	trucking	5 %
		%
		%
		%
		%
		%
		%
		%
		%
		%
		%
		%
		%
Subtotal SBE who are NOT suppliers:		5 %

SBE Subcontractors Who Are Suppliers

Name(s) of SBEs Utilized	Type of Work	% of Total Bid Amount
		%
		%
		%
		%
		%
		%

Subtotal Contractors who are suppliers: _____ % x 0.6 = _____ % (discounted to 60%)

Total Percentage of SBE Utilization: _____%.

Metro Transit Kennedy Road On-Route Bus Charger

CONTRACT NO. 9766
DATE: 4/23/2026

Item	Quantity	Parisi Construction, LLC Price	Extension
Section B: Proposal Page			
10701 - TRAFFIC CONTROL - LUMP SUM	1.00	$15,900.00	$15,900.00
10711 - TYPE III BARRICADE - EACH	5.00	$360.00	$1,800.00
10712 - TEMPORARY PEDESTRIAN BARRICADE - L.F.	113.00	$5.10	$576.30
10720 - TRAFFIC CONTROL SIGN - PORTABLE ARROW BOARD - DAYS	96.00	$25.50	$2,448.00
10721 - TRAFFIC CONTROL SIGN - PORTABLE CHANGEABLE MESSAGE - DAYS	103.00	$51.00	$5,253.00
10911 - MOBILIZATION - LUMP SUM	1.00	$184,000.00	$184,000.00
20101 - EXCAVATION CUT - C.Y.	420.00	$36.50	$15,330.00
20221 - TOPSOIL - S.Y.	750.00	$7.10	$5,325.00
20322 - REMOVE CONCRETE CURB & GUTTER - L.F.	401.00	$9.70	$3,889.70
20323 - REMOVE CONCRETE SIDEWALK AND DRIVE - S.F.	1120.00	$5.50	$6,160.00
20401 - CLEARING - I.D.	33.00	$84.00	$2,772.00
20406 - GRUBBING - I.D.	33.00	$40.75	$1,344.75
20701 - TERRACE SEEDING - S.Y.	750.00	$2.00	$1,500.00
21011 - CONSTRUCTION ENTRANCE - EACH	1.00	$1,200.00	$1,200.00
21013 - STREET SWEEPING - LUMP SUM	1.00	$2,900.00	$2,900.00
21041 - INLET PROTECTION, TYPE D - COMPLETE - EACH	14.00	$400.00	$5,600.00
21061 - EROSION MATTING, CLASS I, URBAN TYPE A - S.Y.	750.00	$1.90	$1,425.00
30201 - TYPE "A" CONCRETE CURB & GUTTER - L.F.	92.00	$43.25	$3,979.00
30207 - TYPE "H" CONCRETE CURB & GUTTER - L.F.	29.00	$78.00	$2,262.00
30212 - SIDEWALK CURB - L.F.	71.00	$87.00	$6,177.00
30304 - 7 INCH CONCRETE SIDEWALK & DRIVE - S.F.	1880.00	$9.20	$17,296.00
30311 - CONCRETE MOUNTABLE MEDIAN ISLAND NOSE - S.F.	54.00	$110.00	$5,940.00
30340 - CURB RAMP DETECTABLE WARNING FIELDS - S.F.	82.00	$45.25	$3,710.50
40101 - CRUSHED AGGREGATE BASE COURSE, GRADATION NO. 1 - TON	184.00	$25.75	$4,738.00
40102 - CRUSHED AGGREGATE BASE COURSE, GRADATION NO. 2 - TON	251.00	$22.50	$5,647.50
40205 - HMA PAVEMENT 4 MT 58-28 S - TON	141.00	$120.00	$16,920.00
40301 - FULL WIDTH GRINDING - S.Y.	1160.00	$8.10	$9,396.00
40218 - TACK COAT - GAL.	88.00	$3.10	$272.80
40404 - 11 INCH CONCRETE PAVEMENT - S.Y.	390.00	$110.00	$42,900.00
50103 - RECONSTRUCT BENCH AND FLOWLINES - EACH	1.00	$1,400.00	$1,400.00
50211 - SELECT BACKFILL FOR STORM SEWER - T.F.	132.00	$1.00	$132.00
50212 - SELECT BACKFILL FOR SANITARY SEWER - T.F.	120.00	$1.00	$120.00
50225 - UTILITY TRENCH PATCH TYPE III - T.F.	81.00	$170.00	$13,770.00
50352 - 6 INCH SANITARY SEWER LATERAL - L.F	120.00	$250.00	$30,000.00
50390 - SEWER ELECTRONIC MARKERS - EACH	2.00	$110.00	$220.00
50401 - 12 INCH TYPE I RCP STORM SEWER PIPE - L.F.	121.00	$120.00	$14,520.00
50741 - TYPE "H" INLET - EACH	2.00	$5,200.00	$10,400.00
50791 - SANITARY SEWER TAP - EACH	1.00	$5,500.00	$5,500.00
50792 - STORM SEWER TAP - EACH	1.00	$1,600.00	$1,600.00
50803 - REINFORCED CONCRETE BEAM SUPPORT - EACH	3.00	$2,400.00	$7,200.00
60802 - PAVEMENT MARKING EPOXY, LINE, 6-INCH - L.F.	440.00	$10.25	$4,510.00
60823 - PAVEMENT MARKING EPOXY, SYMBOL, BIKE LANE - EACH	1.00	$180.00	$180.00
60834 - PAVEMENT MARKING EPOXY, WORD, ONLY - EACH	2.00	$290.00	$580.00

Metro Transit Kennedy Road On-Route Bus Charger

CONTRACT NO. 9766
DATE: 4/23/2026

Item	Quantity	Parisi Construction, LLC Price	Extension
60889 - PAVMENT MARKING REMOVAL, SYMBOL, BIKE LANE - EACH	1.00	$170.00	$170.00
60942 - TEMPORARY PAVEMENT MARKING TAPE, REMOVABLE, REFLECTIVE, LINE, 6-INCH - L.F.	970.00	$1.50	$1,455.00
70052 - FURNISH AND INSTALL 2 INCH SERVICE LATERALS - EACH	1.00	$12,800.00	$12,800.00
70101 - FURNISH AND INSTALL STYROFOAM - EACH	1.00	$200.00	$200.00
90001 - COLORING CONCRETE WISDOT RED - C.Y.	120.00	$200.00	$24,000.00
90002 - CONCRETE CURB INTEGRAL 6-INCH - L.F.	159.00	$45.50	$7,234.50
90003 - CONCRETE GUTTER 24-INCH MODIFIED - L.F.	284.00	$40.00	$11,360.00
90004 - MOUNTABLE CURB HEAD - L.F.	112.00	$31.25	$3,500.00
90005 - CONCRETE CURB INTEGRAL 12-INCH - L.F.	131.00	$57.00	$7,467.00
90006 - POSTS TUBULAR STEEL 2X2-INCH X 14-FT AND PRECAST SIGN POST BASE - EACH	4.00	$880.00	$3,520.00
90007 - SIGNS TYPE II REFLECTIVE H - S.F.	21.00	$71.00	$1,491.00
90008 - REMOVING SIGNS TYPE II - EACH	3.00	$69.00	$207.00
90009 - REMOVING SMALL SIGN SUPPORTS - EACH	3.00	$69.00	$207.00
90010 - TEMPORARY MARKING REMOVABLE MASK OUT TAPE 6-INCH - L.F.	990.00	$2.60	$2,574.00
90011 - PAVEMENT MARKING EPOXY, WORD, BUS - EACH	2.00	$290.00	$580.00
90012 - 4-INCH PVC STORM SEWER PIPE - L.F.	11.00	$140.00	$1,540.00
90013 - KENNEDY TERMINAL RESTROOM AND ELECTRICAL BUILDING - EACH	1.00	$425,000.00	$425,000.00
90014 - CHARGER FOUNDATION - EACH	1.00	$27,500.00	$27,500.00
90015 - ROUTE B KENNEDY SITE ELECTRICAL - LUMP SUM	1.00	$12,700.00	$12,700.00
90016 - ROUTE B KENNEDY ELECTRICAL SERVICE - LUMP SUM	1.00	$15,800.00	$15,800.00
90017 - DOCKING GUIDE STRIP - L.F.	130.00	$190.00	$24,700.00
90018 - PREFABRICATED SHELTER - EACH	1.00	$25,000.00	$25,000.00
90019 - KENNEDY TERMINAL FENCING - L.F.	32.00	$440.00	$14,080.00
90020 - KENNEDY TERMINAL BOLLARDS - EACH	5.00	$1,900.00	$9,500.00
67 Items	Totals		$1,099,380.05

Department of Public Works
Engineering Division
James M. Wolfe, P.E. City Engineer

City-County Building, Room 115
210 Martin Luther King, Jr. Boulevard
Madison, Wisconsin 53703
Phone: (608) 266-4751
Fax: (608) 264-9275
engineering@cityofmadison.com
www.cityofmadison.com/engineering

Assistant City Engineer
Bryan Cooper, AIA
Gregory T. Fries, P.E.
Chris Petykowski, P.E.

Deputy Division Manager
Kathleen M. Cryan

Principal Architect
Amy Loewenstein Scanlon, AIA

Principal Engineer 2
Janet Schmidt, P.E.

Principal Engineer 1
Kyle Frank, P.E.
Mark D. Moder, P.E.
Fadi El Musa Gonzalez, P.E.
Andrew J. Zwieg, P.E.

Financial Manager
Steven B. Danner-Rivers

BIENNIAL BID BOND

Parisi Construction, LLC
(a corporation of the State of WI) (individual), (partnership), (hereinafter referred to as the "Principal") and Western Surety Company a corporation of the State of SD (hereinafter referred to as the "Surety") and licensed to do business in the State of Wisconsin, are held and firmly bound unto the City of Madison, Wisconsin (hereinafter referred to as the "City"), in the sum equal to the individual proposal guaranty amounts of the total bid or bids of the Principal herein accepted by the City, for the payment of which the Principal and the Surety hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors and assigns.

The condition of this obligation is that the Principal has submitted to the City certain bids for projects from the time period of January 11, 2026 through January 10, 2028.

If the Principal is awarded the contract(s) by the City and, within the time and manner required by law after the prescribed forms are presented for its signature, the Principal enters into (a) written contract(s) in accordance with the bid(s), and files with the City its bond(s) guaranteeing faithful performance and payment for all labor and materials, as required by law, or if the City rejects all bids for the work described, then this obligation shall be null and void; otherwise , it shall remain in full force and effect.

In the event the Principal shall fail to execute and deliver the contract(s) or the performance and payment bond(s), all within the time specified or any extension thereof, the Principal and Surety agree jointly and severally to pay to the City within ten (10) calendar days of written demand a total equal to the sum of the individual proposal guaranty amounts of the total bid(s) as liquidated damages.

The Surety, for value received, hereby agrees that the obligations of it and its bond shall be in no way impaired or affected by any extension of time within which the City may accept a bid, and the Surety does hereby waive notice of any such extension.

This bond may be terminated by the Surety upon giving thirty (30) days written notice to the City of its intent to terminate this bond and to be released and discharged therefrom, but such termination shall not operate to relieve or discharge the Surety from any liability already accrued or which shall accrue before tlle expiration of such thirty (30) day period.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, on the day and year set forth below.

PRINCIPAL

Parisi Construction, LLC — COMPANY NAME — AFFIX SEAL — 1/5, 2026 — DATE

By: [signature] president
SIGNATURE AND TITLE

SURETY

Western Surety Company — COMPANY NAME — AFFIX SEAL — January 5, 2026 — DATE

By: [signature]
SIGNATURE AND TITLE Trudy A. Szalewski, Attorney-in-fact

This certifies that I have been duly licensed as an agent for the Surety in Wisconsin under National Provider No. 6502661 for the year 2026 and appointed as attorney in fact with authority to execute this bid bond, which power of attorney has not been revoked.

January 5, 2026
DATE

[signature]
AGENT SIGNATURE Trudy A. Szalewski

10700 W. Research Drive - #450
ADDRESS

Milwaukee, WI 53226
CITY, STATE AND ZIP CODE

414-225-5394
TELEPHONE NUMBER

Note to Surety and Principal: Any bid submitted which this bond guarantees may be rejected if the Power of Attorney form showing that the Agent of Surety is currently authorized to execute bonds on behalf of Surety is not attached to this bond.

CERTIFICATE OF BIENNIAL BID BOND

TIME PERIOD- VALID (FROM/TO) January 11, 2026 to January 10, 2028
NAME OF SURETY Western Surety Company
NAME OF CONTRACTOR Parisi Construction, LLC
CERTIFICATE HOLDER City of Madison, Wisconsin

This is to certify that a biennial bid bond issued by the above-named Surety is currently on file with the City of Madison.

This certificate is issued as a matter of information and conveys no rights upon the certificate holder and does not amend, extend or alter the coverage of the biennial bid bond.

Cancellation: Should the above policy be cancelled before the expiration date, the issuing Surety will give thirty (30) days written notice to the certificate holder indicated above.

SIGNATURE OF AUTHORIZED CONTRACTOR REPRESENTATIVE

DATE 1/5/2026

Western Surety Company

POWER OF ATTORNEY APPOINTING INDIVIDUAL ATTORNEY-IN-FACT

Know All Men By These Presents, That WESTERN SURETY COMPANY, a South Dakota corporation, is a duly organized and existing corporation having its principal office in the City of Sioux Falls, and State of South Dakota, and that it does by virtue of the signature and seal herein affixed hereby make, constitute and appoint

Kelly Cody, Roxanne Jensen, Marc Sacia, Individually of Green Bay, Wisconsin
Trudy A. Szalewski, Brian Krause, Individually of Milwaukee, Wisconsin

its true and lawful Attorney(s)-in-Fact with full power and authority hereby conferred to sign, seal and execute for and on its behalf bonds, undertakings and other obligatory instruments of similar nature

- In Unlimited Amounts -

and to bind it thereby as fully and to the same extent as if such instruments were signed by a duly authorized officer of the corporation and all the acts of said Attorney, pursuant to the authority hereby given, are hereby ratified and confirmed.

This Power of Attorney is made and executed pursuant to and by authority of the By-Law and Resolutions printed on the reverse hereof, duly adopted, as indicated, by the shareholders of the corporation.

In Witness Whereof, WESTERN SURETY COMPANY has caused these presents to be signed by its Vice President and its corporate seal to be hereto affixed on this 23rd day of May, 2023.

WESTERN SURETY COMPANY

Larry Kasten, Vice President

State of South Dakota
County of Minnehaha } ss

On this 23rd day of May, 2023, before me personally came Larry Kasten, to me known, who, being by me duly sworn, did depose and say: that he resides in the City of Sioux Falls, State of South Dakota; that he is a Vice President of WESTERN SURETY COMPANY described in and which executed the above instrument; that he knows the seal of said corporation; that the seal affixed to the said instrument is such corporate seal; that it was so affixed pursuant to authority given by the Board of Directors of said corporation and that he signed his name thereto pursuant to like authority, and acknowledges same to be the act and deed of said corporation.

My commission expires
March 2, 2026

M. BENT
NOTARY PUBLIC
SOUTH DAKOTA

M. Bent, Notary Public

CERTIFICATE

I, L. Nelson, Assistant Secretary of WESTERN SURETY COMPANY do hereby certify that the Power of Attorney hereinabove set forth is still in force, and further certify that the By-Law and Resolutions of the corporation printed on the reverse hereof is still in force. In testimony whereof I have hereunto subscribed my name and affixed the seal of the said corporation this 5th day of Jan , 2026.

WESTERN SURETY COMPANY

L. Nelson, Assistant Secretary

Form F4280-4-2023

Go to www.cnasurety.com > Owner / Obligee Services > Validate Bond Coverage, if you want to verify bond authenticity.

Authorizing By-Laws and Resolutions

ADOPTED BY THE SHAREHOLDERS OF WESTERN SURETY COMPANY

This Power of Attorney is made and executed pursuant to and by authority of the following By-Law duly adopted by the shareholders of the Company.

Section 7. All bonds, policies, undertakings, Powers of Attorney, or other obligations of the corporation shall be executed in the corporate name of the Company by the President, Secretary, and Assistant Secretary, Treasurer, or any Vice President, or by such other officers as the Board of Directors may authorize. The President, any Vice President, Secretary, any Assistant Secretary, or the Treasurer may appoint Attorneys in Fact or agents who shall have authority to issue bonds, policies, or undertakings in the name of the Company. The corporate seal is not necessary for the validity of any bonds, policies, undertakings, Powers of Attorney or other obligations of the corporation. The signature of any such officer and the corporate seal may be printed by facsimile.

This Power of Attorney is signed by Larry Kasten, Vice President, who has been authorized pursuant to the above Bylaw to execute power of attorneys on behalf of Western Surety Company.

This Power of Attorney may be signed by digital signature and sealed by a digital or otherwise electronic-formatted corporate seal under and by the authority of the following Resolution adopted by the Board of Directors of the Company by unanimous written consent dated the 27th day of April, 2022:

"RESOLVED: That it is in the best interest of the Company to periodically ratify and confirm any corporate documents signed by digital signatures and to ratify and confirm the use of a digital or otherwise electronic-formatted corporate seal, each to be considered the act and deed of the Company."

SECTION H: AGREEMENT

THIS AGREEMENT made this 29th day of May in the year Two Thousand and Twenty Six between **Parisi Construction, LLC** hereinafter called the Contractor, and the City of Madison, a Wisconsin municipal corporation, hereinafter called the City.

WHEREAS, the Common Council of the City of Madison ("Council") under the provisions of a resolution adopted on **May 19, 2026** and by virtue of authority vested in the Council, has awarded to the Contractor the work of performing certain public construction.

NOW, THEREFORE, the Contractor and the City, for the consideration hereinafter named, agree as follows:

1. **Scope of Work.** The Contractor shall, perform the construction, execution and completion of the following listed complete work or improvement in full compliance with the Plans, Specifications, Standard Specifications, Supplemental Specifications, Special Provisions and Agreement; perform all items of work covered or stipulated in the Proposal; perform all altered or extra work; and shall furnish, unless otherwise provided in the contract, all materials, implements, machinery, equipment, tools, supplies, transportation, and labor necessary to the prosecution and completion of the work or improvements:

   Metro Transit Kennedy Road On-Route Bus Charger
   CONTRACT NO. 9766

2. **Completion Date/Contract Time**. Construction work must begin within seven (7) calendar days after the date appearing on mailed written notice to do so shall have been sent to the Contractor and shall be carried at a rate so as to secure full completion SEE SPECIAL PROVISIONS, the rate of progress and the time of completion being essential conditions of this Agreement.

3. **Contract Price.** The City shall pay to the Contractor at the times, in the manner and on the conditions set forth in said specifications, the sum of **ONE MILLION NINETY-NINE THOUSAND THREE HUNDRED EIGHTY AND 5/100 ($1,099,380.05)** Dollars being the amount bid by such Contractor and which was awarded as provided by law.

4. **A. Non-Discrimination**. During the term of this Agreement, the Contractor agrees not to discriminate against any employee or applicant because of race, religion, marital status, age, color, sex, disability, national origin or ancestry, income level or source of income, arrest record or conviction record, less than honorable discharge, physical appearance, sexual orientation, gender identity, political beliefs, or student status. The Contractor further agrees not to discriminate against any subcontractor or person who offers to subcontract on this contract because of race, religion, color, age, disability, sex, sexual orientation, gender identity or national origin.

   B. Affirmative Action. The Contractor agrees that within thirty (30) days after the effective date of this agreement, the Contractor will provide to the City Affirmative Action Division certain workforce utilization statistics, using a form to be furnished by the City.

   If the contract is still in effect, or if the City enters into a new agreement with the Contractor, within one year after the date on which the form was required to be provided, the Contractor will provide updated workforce information using a second form, also to be furnished by the City. The second form

will be submitted to the City Affirmative Action Division no later than one year after the date on which the first form was required to be provided.

The Contractor further agrees that, for at least twelve (12) months after the effective date of this contract, it will notify the City Affirmative Action Division of each of its job openings at facilities in Dane County for which applicants not already employees of the Contractor are to be considered. The notice will include a job description, classification, qualifications and application procedures and deadlines, shall be provided to the City by the opening date of advertisement and with sufficient time for the City to notify candidates and make a timely referral. The Contractor agrees to interview and consider candidates referred by the Affirmative Action Division, or an organization designated by the Division, if the candidate meets the minimum qualification standards established by the Contractor, and if the referral is timely. A referral is timely if it is received by the Contractor on or before the date started in the notice.

Articles of Agreement

Article I

The Contractor shall take affirmative action in accordance with the provisions of this contract to ensure that applicants are employed, and that employees are treated during employment without regard to race, religion, color, age, marital status, disability, sex, sexual orientation, gender identity or national origin and that the employer shall provide harassment free work environment for the realization of the potential of each employee. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation and selection for training including apprenticeship insofar as it is within the control of the Contractor. The Contractor agrees to post in conspicuous places available to employees and applicants notices to be provided by the City setting out the provisions of the nondiscrimination clauses in this contract.

Article II

The Contractor shall in all solicitations or advertisements for employees placed by or on behalf of the Contractors state that all qualified or qualifiable applicants will be employed without regard to race, religion, color, age, marital status, disability, sex, sexual orientation, gender identity or national origin.

Article III

The Contractor shall send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding a notice to be provided by the City advising the labor union or worker's representative of the Contractor's equal employment opportunity and affirmation action commitments. Such notices shall be posted in conspicuous places available to employees and applicants for employment.

Article V

The Contractor agrees that it will comply with all provisions of the Affirmative Action Ordinance of the City of Madison, including the contract compliance requirements. The Contractor agrees to submit the model affirmative action plan for public works contractors in a form approved by the Affirmative Action Division Manager.

Article VI

The Contractor will maintain records as required by Section 39.02(9)(f) of the Madison General Ordinances and will provide the City Affirmative Action Division with access to such records and to persons who have relevant and necessary information, as provided in Section 39.02(9)(f). The City agrees to keep all such records confidential, except to the extent that public inspection is required by law.

Article VII

In the event of the Contractor's or subcontractor's failure to comply with the Equal Employment Opportunity and Affirmative Action Provisions of this contract or Section 39.03 or 39.02 of the Madison General Ordinances, it is agreed that the City at its option may do any or all of the following:

1. Cancel, terminate or suspend this Contract in whole or in part.

2. Declare the Contractor ineligible for further City contracts until the Affirmative Action requirements are met.

3. Recover on behalf of the City from the prime Contractor 0.5 percent of the contract award price for each week that such party fails or refuses to comply, in the nature of liquidated damages, but not to exceed a total of five percent (5%) of the contract price, or ten thousand dollars ($10,000), whichever is less. Under public works contracts, if a subcontractor is in noncompliance, the City may recover liquidated damages from the prime Contractor in the manner described above. The preceding sentence shall not be construed to prohibit a prime Contractor from recovering the amount of such damage from the non-complying subcontractor.

Article VIII

The Contractor shall include the above provisions of this contract in every subcontract so that such provisions will be binding upon each subcontractor. The Contractor shall take such action with respect to any subcontractor as necessary to enforce such provisions, including sanctions provided for noncompliance.

Article IX

The Contractor shall allow the maximum feasible opportunity to small business enterprises to compete for any subcontracts entered into pursuant to this contract. (In federally funded contracts the terms "DBE, MBE, and WBE" shall be substituted for the term "small business" in this Article.)

5. **Substance Abuse Prevention Program Required**. Prior to commencing work on the Contract, the Contractor, and any Subcontractor, shall have in place a written program for the prevention of substance abuse among its employees as required under Wis. Stat. Sec. 103.503

6. **Contractor Hiring Practices.**
Ban the Box - Arrest and Criminal Background Checks. (Sec. 39.08, MGO)

This provision applies to all prime contractors on contracts entered into on or after January 1, 2016, and all subcontractors who are required to meet prequalification requirements under MGO 33.07(7)(I), MGO as of the first time they seek or renew pre-qualification status on or after January 1, 2016. The City will monitor compliance of subcontractors through the pre-qualification process.

a. **Definitions**. For purposes of this section, “Arrest and Conviction Record” includes, but is not limited to, information indicating that a person has been questioned, apprehended, taken into custody or detention, held for investigation, arrested, charged with, indicted or tried for any felony, misdemeanor or other offense pursuant to any law enforcement or military authority.

“Conviction record” includes, but is not limited to, information indicating that a person has been convicted of a felony, misdemeanor or other offense, placed on probation, fined, imprisoned or paroled pursuant to any law enforcement or military authority.

“Background Check” means the process of checking an applicant’s arrest and conviction record, through any means.

b. **Requirements**. For the duration of this Contract, the Contractor shall:

1. Remove from all job application forms any questions, check boxes, or other inquiries regarding an applicant’s arrest and conviction record, as defined herein.

2. Refrain from asking an applicant in any manner about their arrest or conviction record until after conditional offer of employment is made to the applicant in question.

3. Refrain from conducting a formal or informal background check or making any other inquiry using any privately or publicly available means of obtaining the arrest or conviction record of an applicant until after a conditional offer of employment is made to the applicant in question.

4. Make information about this ordinance available to applicants and existing employees, and post notices in prominent locations at the workplace with information about the ordinance and complaint procedure using language provided by the City.

5. Comply with all other provisions of Sec. 39.08, MGO.

c. **Exemptions:** This section shall not apply when:

1. Hiring for a position where certain convictions or violations are a bar to employment in that position under applicable law, or

2. Hiring a position for which information about criminal or arrest record, or a background check is required by law to be performed at a time or in a manner that would otherwise be prohibited by this ordinance, including a licensed trade or profession where the licensing authority explicitly authorizes or requires the inquiry in question.

To be exempt, Contractor has the burden of demonstrating that there is an applicable law or regulation that requires the hiring practice in question, if so, the contractor is exempt from all of the requirements of this ordinance for the position(s) in question.

7. **Choice of Law and Forum Selection.** This Contract shall be governed by and construed, interpreted and enforced in accordance with the laws of the State of Wisconsin. The parties agree, for any claim or suit or other dispute relating to this Contract that cannot be mutually resolved, the

venue shall be a court of competent jurisdiction within the State of Wisconsin and the parties agree to submit themselves to the jurisdiction of said court, to the exclusion of any other judicial district that may have jurisdiction over such a dispute according to any law.

8. **Counterparts, Electronic Signature, and Delivery.** This Contract may be signed in counterparts, each of which shall be taken together as a whole to comprise a single document. Signatures on this Contract may be exchanged between the parties by facsimile, electronic scanned copy (.pdf) or similar technology and shall be as valid as original; and this Contract may be converted into electronic format and signed or given effect with one or more electronic signature(s) if the electronic signature(s) meets all requirements of Wisc. Stat. ch 137 or other applicable Wisconsin or Federal law. Executed copies or counterparts of this Contract may be delivered by facsimile or email and upon receipt will be deemed original and binding upon the parties hereto, whether or not a hard copy is also delivered. Copies of this Contract, fully executed, shall be as valid as an original.

Metro Transit Kennedy Road On-Route Bus Charger

CONTRACT NO. 9766

IN WITNESS WHEREOF, the Contractor has hereunto set his/her hand and seal and the City has caused this contract to be executed by its Mayor and City Clerk on the dates written below.

Countersigned:

Parisi Construction, LLC
Company Name

Witness	Date	President	Date
Witness	Date	Secretary	Date

CITY OF MADISON

Satya Rhodes-Conway, Mayor — Date: 05/29/2026

Lydia A. McComas, City Clerk — Date: 05/26/2026

Provisions have been made to pay the liability that will accrue under this contract.

David P Schmiedicke, Finance Director — Date: 05/28/2026

Approved as to form:

for Michael Haas, City Attorney — Date: 05/28/2026

Execution of this Agreement by City was authorized by Resolution Enactment No. RES-26-00269, ID No. 92867, adopted by the Common Council of the City of Madison on May 19, 2026.

SECTION I: PAYMENT AND PERFORMANCE BOND

LET ALL KNOW BY THESE DOCUMENTS PRESENTED, that we **Parisi Construction, LLC** as principal, and Western Surety Company Company of Chicago, IL as surety, are held and firmly bound unto the City of Madison, Wisconsin, in the sum of **ONE MILLION NINETY-NINE THOUSAND THREE HUNDRED EIGHTY AND 5/100 ($1,099,380.05)** Dollars, lawful money of the United States, for the payment of which sum to the City of Madison, we hereby bind ourselves and our respective executors and administrators firmly by these presents.

The condition of this Bond is such that if the above bounden shall on his/her part fully and faithfully perform all of the terms of the Contract entered into between him/herself and the City of Madison for the construction of:

Metro Transit Kennedy Road On-Route Bus Charger
CONTRACT NO. 9766

in Madison, Wisconsin, and shall pay all claims for labor performed and material furnished in the prosecution of said work, and save the City harmless from all claims for damages because of negligence in the prosecution of said work, and shall save harmless the said City from all claims for compensation (under Chapter 102, Wisconsin Statutes) of employees and employees of subcontractor, then this Bond is to be void, otherwise of full force, virtue and effort.

Signed and sealed this 20th day of May, 2026.

Countersigned:

Parisi Construction, LLC
Company Name (Principal)

PARISI CONSTRUCTION LLC ★ CORPORATE SEAL ★ VERONA, WISCONSIN

Witness

President

Seal

Secretary

Western Surety Company
Surety Seal

☒Salary Employee ☐Commission

By
Attorney-in-Fact Trudy A. Szalewski

This certifies that I have been duly licensed as an agent for the above company in Wisconsin under National Producer Number 6502661 for the year 2026, and appointed as attorney-in-fact with authority to execute this payment and performance bond which power of attorney has not been revoked.

May 20, 2026
Date

Agent Signature Trudy A. Szalewski

The foregoing Bond has been approved as to form:

05/28/2026
Date

City Attorney

Western Surety Company

POWER OF ATTORNEY APPOINTING INDIVIDUAL ATTORNEY-IN-FACT

Know All Men By These Presents, That WESTERN SURETY COMPANY, a South Dakota corporation, is a duly organized and existing corporation having its principal office in the City of Sioux Falls, and State of South Dakota, and that it does by virtue of the signature and seal herein affixed hereby make, constitute and appoint

Kelly Cody, Roxanne Jensen, Marc Sacia, Individually of Green Bay, Wisconsin
Trudy A. Szalewski, Brian Krause, Individually of Milwaukee, Wisconsin, Individually

its true and lawful Attorney(s)-in-Fact with full power and authority hereby conferred to sign, seal and execute for and on its behalf bonds, undertakings and other obligatory instruments of similar nature

- In Unlimited Amounts -

and to bind it thereby as fully and to the same extent as if such instruments were signed by a duly authorized officer of the corporation and all the acts of said Attorney, pursuant to the authority hereby given, are hereby ratified and confirmed.

This Power of Attorney is made and executed pursuant to and by authority of the Authorizing By-Laws and Resolutions printed at the bottom of this page, duly adopted, as indicated, by the shareholders of the corporation.

In Witness Whereof, WESTERN SURETY COMPANY has caused these presents to be signed by its Vice President and its corporate seal to be hereto affixed on this 25th day of February, 2026.

WESTERN SURETY COMPANY

Larry Kasten, Vice President

State of South Dakota
County of Minnehaha } ss

On this 25th day of February, 2026, before me personally came Larry Kasten, to me known, who, being by me duly sworn, did depose and say: that he resides in the City of Sioux Falls, State of South Dakota; that he is a Vice President of WESTERN SURETY COMPANY described in and which executed the above instrument; that he knows the seal of said corporation; that the seal affixed to the said instrument is such corporate seal; that it was so affixed pursuant to authority given by the Board of Directors of said corporation and that he signed his name thereto pursuant to like authority, and acknowledges same to be the act and deed of said corporation.

My commission expires
December 4, 2031

K. WALSH
NOTARY PUBLIC
SOUTH DAKOTA

K. Walsh, Notary Public

CERTIFICATE

I, Paula Kolsrud, Assistant Secretary of WESTERN SURETY COMPANY do hereby certify that the Power of Attorney hereinabove set forth is still in force, and further certify that the By-Laws and Resolutions of the corporation printed below this certificate are still in force. In testimony whereof I have hereunto subscribed my name and affixed the seal of the said corporation this 20th day of May, 2026

WESTERN SURETY COMPANY

Paula Kolsrud, Assistant Secretary

Authorizing By-Laws and Resolutions

ADOPTED BY THE SHAREHOLDERS OF WESTERN SURETY COMPANY

This Power of Attorney is made and executed pursuant to and by authority of the following By-Law duly adopted by the shareholders of the Company.

Section 7. All bonds, policies, undertakings, Powers of Attorney, or other obligations of the corporation shall be executed in the corporate name of the Company by the President, Secretary, and Assistant Secretary, Treasurer, or any Vice President, or by such other officers as the Board of Directors may authorize. The President, any Vice President, Secretary, any Assistant Secretary, or the Treasurer may appoint Attorneys in Fact or agents who shall have authority to issue bonds, policies, or undertakings in the name of the Company. The corporate seal is not necessary for the validity of any bonds, policies, undertakings, Powers of Attorney or other obligations of the corporation. The signature of any such officer and the corporate seal may be printed by facsimile.

This Power of Attorney is signed by Larry Kasten, Vice President, who has been authorized pursuant to the above Bylaw to execute power of attorneys on behalf of Western Surety Company.

This Power of Attorney may be signed by digital signature and sealed by a digital or otherwise electronic-formatted corporate seal under and by the authority of the following Resolution adopted by the Board of Directors of the Company by unanimous written consent dated the 27th day of April, 2022:

"RESOLVED: That it is in the best interest of the Company to periodically ratify and confirm any corporate documents signed by digital signatures and to ratify and confirm the use of a digital or otherwise electronic-formatted corporate seal, each to be considered the act and deed of the Company."

Go to www.cnasurety.com > Owner / Obligee Services > Validate Bond Coverage, if you want to verify bond authenticity.