PROJECT MANUAL

Capitol East Parking Garage

FOR

The City of Madison, Wisconsin

Issued for Final Bid
Construction Specifications
VOLUME II (Divisions 22 through 33)

GRAEF Project No. 2017-5051.00
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ENGINEER/ARCHITECT

GRAEF

BWBR

KEN SAIKI DESIGN
LANDSCAPE ARCHITECTS

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SECTION 22 05 00

BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Reference Standards.
2. Quality Assurance.
3. Continuity of Existing Services.
4. Protection of Finished Surfaces.
5. Sleeves and Openings.
6. Sealing and Firestopping.
7. Equipment Furnished By Others.
8. Provisions for Future.
9. Submittals.
10. Off Site Storage.
11. Codes.
12. Request and Certification for Payment.
13. Certificates and Inspections.
14. Operating and Maintenance Instructions.
15. Training of Owner Personnel.
16. Record Drawings.
17. Access Panels and Doors.
18. Identification.
19. Sealing and Firestopping.
20. Bedding and Backfill.
21. Demolition.
22. Excavation and Backfill.
23. Sheeting, Shoring and Bracing.
24. Dewatering.
25. Rock Excavation.
26. Surface Repair.
27. Concrete Work.
28. Cutting and Patching.
29. Building Access.
30. Equipment Access.
31. Coordination.
32. Identification.
33. Lubrication.
34. Sleeves.
35. Sealing and Firestopping.

B. Related Sections
1. Applicable provisions of Division 01 shall govern all work under this Section.
2. This section applies to all Division 22 specification sections related to plumbing.

1.2 REFERENCES

A. American Concrete Institute: (ACI)
   1. ACI 614 - Recommended Practice for Measuring, Mixing and Placing of Concrete

B. ASTM International: (ASTM)
   1. ASTM D1557 - Test Method for Moisture-Density Relations of Soils
   2. ASTM D2000 – Standard Classification System for Rubber Products in Automotive Applications.
   3. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials
   4. ASTM E814 - Test Method for Fire Tests of Through-Penetration Fire Stops

C. State of Wisconsin Department of Transportation: (WISDOT)
   1. Standard Specifications for Highway and Structure Construction, Current Edition, including latest supplements.

D. Underwriters Laboratories, Inc.: (UL)
   1. UL1479 - Fire Tests of Through-Penetration Firestops.
   2. UL723 - Surface Burning Characteristics of Building Materials.

1.3 REFERENCE STANDARDS

A. Abbreviations of standards organizations referenced in this and other sections are as follows:
   1. ABMA: American Boiler Manufacturers Association.
   2. ACPA: American Concrete Pipe Association.
   3. AGA: American Gas Association.
   4. AMCA: Air Movement and Control Association.
   5. ANSI: American National Standards Institute.
   6. ARI: Air Conditioning and Refrigeration Institute.
   7. ASME: American Society of Mechanical Engineers.
   8. ASPE: American society of Plumbing Engineers.
   9. ASSE: American Society of Sanitary Engineering.
   10. ASTM: American Society for Testing and Materials.
   11. AWWA: American Water Works Association.
   12. AWS: American Welding Society.
   13. CISPI: Cast Iron Soil Pipe Institute.
   14. CGA: Compressed Gas Association.
   15. CS: Commercial Standards, Products Standards Sections, Office of Engineering Standards Service, NBS.
   16. EPA: Environmental Protection Agency.
   17. FS: Federal Specifications, Superintendent of Documents, U.S. Government Printing Office.
   18. GAMA: Gas Appliance Manufacturers Association.
   19. IAPMO: International Association of Plumbing & Mechanical Officials.
   20. IEEE: Institute of Electrical and Electronics Engineers.
   21. ISA: Instrument Society of America.
   22. MCA: Mechanical Contractors Association.
   23. MICA: Midwest Insulation Contractors Association.
   24. MSS: Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
   25. NBS: National Bureau of Standards.
   26. NEC: National Electric Code.

27. NEMA: National Electrical Manufacturers Association.
28. NFPA: National Fire Protection Association.
29. NSF: National Sanitation Foundation.
30. PDI: Plumbing and Drainage Institute.
31. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association. Inc.
32. STI: Steel Tank Institute.
33. UL: Underwriters Laboratories Inc.

1.4 QUALITY ASSURANCE

A. Substitution of Materials: In accordance with Division 01 – General Requirements.

B. Products and materials used are to be new, undamaged, clean and in good condition.

C. Existing products and materials are not to be reused unless specifically indicated.

D. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, Contractor is responsible for all costs involved in integrating equipment or accessories into system and for obtaining intended performance from system into which these items are placed.

1.5 PROTECTION OF FINISHED SURFACES

A. Division 01 – General Requirements: Protection of Finished Surfaces.

1.6 SLEEVES AND OPENINGS

A. Division 01 – General Requirements: Sleeves and Openings.

1.7 SEALING AND FIRESTOPPING

A. Sealing and firestopping of sleeves and related openings between piping and sleeve and structural opening shall be responsibility of Contractor whose work penetrates opening.

B. Contractor responsible shall provide individuals skilled in such work to do sealing and fireproofing.

1.8 GOVERNING AGENCIES

A. Comply with requirements of State and local plumbing codes.

1.9 CERTIFICATES AND INSPECTIONS

A. Division 00 – General Conditions: Permits, Regulations, Utilities and Taxes.

1.10 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Shop Drawing submittals are to be bound, labeled, contain Project Manual cover page and a material index list page showing item designation, manufacturer and additional items supplied with installation.

C. Submit for all equipment and systems as indicated in respective specification sections, marking each submittal with that specification section number.

D. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and number, as indicated in contract documents. Include wiring diagrams of electrically powered equipment.

E. Firestopping System Submittals:
1. Contractor shall submit product data for each firestop system.
2. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project.
3. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgment can be based upon.

1.11 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Division 01 – General Requirements: Operating and maintenance instructions.

B. Assemble material in three-ring or post binders, using an index at front of each volume and tabs for each system or type of equipment.

C. In addition to data indicated in the General Requirements, include the following information:
1. Copies of all approved shop drawings.
2. Manufacturer's wiring diagrams for electrically powered equipment.
3. Records of tests performed to certify compliance with system requirements.
4. Certificates of inspection by regulatory agencies.
5. Parts lists for fixtures, equipment, valves and specialties.
6. Manufacturers’ installation, operation and maintenance recommendations for fixtures, equipment, valves and specialties.
7. Valve schedules.
8. Lubrication instructions, including parts list and frequency of lubrication.
9. Warranties.
10. Additional information as indicated in technical specification sections.

1.12 TRAINING OF OWNER PERSONNEL

A. Instruct Owner personnel in proper operation and maintenance of systems and equipment provided as part of this project.

B. Include not less than 4 hours of instruction, using Operation and Maintenance manuals during this instruction.

C. Demonstrate startup, operation, and shutdown procedures for all equipment. All training to be during normal working hours. Videotape all instructions and provide Owner with copy.

1.13 PROJECT RECORD DOCUMENTS

A. Division 01 – General Requirements: Record Drawings.

PART 2 - PRODUCTS

2.1 ACCESS PANELS AND DOORS

A. Plaster Walls and Ceilings:
   1. Provide minimum 16-gauge frame with not less than a 20-gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers, and similar wet areas, concealed hinges, screwdriver operated cam latch for general applications, key lock for use in public or secured areas, UL listed for use in fire rated partitions if required by application.
   2. Provide largest size access opening possible, consistent with space and item needing service; minimum size is 12-inch x 12-inch.

2.2 IDENTIFICATION

A. Stencils: Provide not less than one-inch high letters and numbers for marking pipe and equipment.

B. Engraved Name Plates: Provide white letters on a black background, 1/16-inch thick plastic laminate, beveled edges, screw mounting.
   1. Manufacturers:
      a. Setonply Style 2060 by Seton Name Plate Company.
      b. Emedolite Style EIP by EMED Company.
      c. W. H. Brady.
      d. Or approved equal.

C. Snap-Around Pipe Markers: Provide one-piece, preformed, vinyl construction, snap-around or strap-around pipe markers with applicable labeling and flow direction arrows, 3/4-inch minimum size for lettering. Provide nylon ties on each end of pipe markers.
   1. Manufacturers:
      a. Seton Setmark.
      b. Or approved equal.

D. Valve Tags: Provide round brass tags with 1/2-inch numbers, 1/4-inch system identification abbreviation, 1-1/4-inch minimum diameter, with brass jack chains, brass "S" hooks or one-piece nylon ties around valve stem.
   1. Manufacturers:
      a. EMED Company.
      b. Seton Name Plate Company.
      c. W. H. Brady.
      d. Or approved equal.

E. Underground Warning Tape: Detectable underground warning tape, 5.0-mil overall thickness, 6-inch width, 0.0035-inch thick aluminum foil core with polyethylene jacket bonded to both sides.

Color code tape and print caution along with name of buried service in bold letters on face of tape.

1. Manufacturers:
   a. Thor Enterprises.
   b. Magnatec by Carlton.
   c. MSI Marking Services.
   d. Seton.
   e. Or approved equal.

2.3 BEDDING, COVER AND BACKFILL

A. Place and compact bedding and cover 12 inches above top of pipe, compacted to 95 percent modified proctor.

B. Bedding, cover and backfill shall meet the following gradations:

Gradation for Bedding Sand		Gradation for Crushed Stone Chip Bedding	
Sieve Size	% Passing (by Wt)	Sieve Size	% Passing (by Wt)
1 inch	100	1/2 inch	100
No. 16	45 - 80	No. 4	75 - 100
No. 200	2 - 10	No. 100	10 - 25

C. Backfill above bedding and cover material in lawn areas shall be thoroughly compacted to density equal to adjacent soil and excavated material shall be free of large rocks, perishable, and frozen materials.

D. Backfill above bedding and cover material under existing and future utilities, paving, sidewalks, curbs, roads, and buildings shall be approved aggregate materials such as sand, gravel, or crushed stone and shall be compacted to 95 percent modified proctor.

E. Backfill material shall be free of large rocks, organic, perishable, and frozen materials.

2.4 SEALING AND FIRESTOPPING

A. Firestopping Systems:
   1. Manufacturers:
      a. 3M.
      b. Hilti.
      c. Rectorseal.
      d. STI/SpecSeal.
      e. Tremco.
      f. Or approved equal.
   2. Firestopping systems shall be provided by same manufacturer.
   3. Fire stop systems shall be UL listed, and tested by an independent testing laboratory and approved by authorities having jurisdiction.
   4. Use a product that has a rating not less than rating of wall or floor being penetrated.
   5. Reference architectural drawings for identification of fire and smoke rated walls and floors.

6. Use firestop putty, caulk sealant, intumescent wrapstrips, intumescent firestop collars, firestop blocks, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project.
7. Provide mineral wool backing where specified in firestopping manufacturer's application detail.

B. Non-Rated Penetrations:
1. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between uninsulated pipe and cored opening or a water-stop type wall sleeve.
2. Operating bolts of mechanical type seal shall be accessible from interior of building.
3. At pipe penetrations of non-rated interior partitions, floors and exterior walls, use polyurethane caulk in annular space between pipe insulation and sleeve.
4. For non-rated drywall, plaster, or wood partitions where sleeve is not required use polyurethane caulk in annular space between pipe insulation and wall material

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILL

A. Perform excavation and backfill work necessary to accomplish indicated plumbing systems installation.

B. Excavate to bottom of pipe and structure bedding, provide minimum of 4 inches in stable soils, 6 inches in rock or wet trenches, and 8 inches in unstable soil. Prepare bottoms of excavations to true, level surface.

C. At no time place excavated materials where materials will impede surface drainage unless such drainage is being safely rerouted away from excavation.

D. Verify locations of any water, drainage, gas, sewer, electric, telephone, or steam lines which may be encountered during excavation.

E. Underpin and support all lines. Cut off service connections encountered which are to be removed at limits of excavation and cap.

F. Elevations shown on Drawings are subject to such revisions as may be necessary to fit field conditions.

G. No adjustment in compensation will be made for adjustments up to two (2) feet above or below grades indicated on Drawings.

H. Bed pipe up to 12 inches above top of pipe. Take care during bedding, compaction and backfill not to disturb or damage piping.

I. Mechanically compact bedding and backfill to prevent settlement.

J. Initial loose backfill lift to not exceed 24 inches, compacted to 95 percent modified proctor density in accordance with ASTM D1557.

K. Subsequent loose lifts under pavements, curbs, walks, and structures are not to exceed 12 inches and be compacted to 95 percent modified proctor density.

L. In all other areas where construction above excavation is not anticipated within 2 years, mechanically compact backfill in lifts not exceeding 24 inches to 95 percent modified proctor density.

M. Place compaction equipment over each lift of material so that compaction equipment contacts all areas of surface of lift.

N. Excavate whatever materials are encountered as required to place pipe, manholes, and other work at elevations shown.

O. Remove debris and rubbish from excavations before placing bedding and backfill material.

3.2 SHEETING, SHORING AND BRACING

A. Provide shoring, sheet piling, and bracing in conformance with State and local codes to prevent earth from caving or washing into excavation.

B. Shore and underpin to properly support adjacent or adjoining structures.

C. Abandon in place shoring, sheet piling. and underpinning below top of pipe, or, if approved in advance by Engineer/Architect.

3.3 DEWATERING

A. Provide, operate and maintain pumps and other equipment necessary to drain and keep all excavation pits, trenches and entire subgrade area free from water under all circumstances.

B. Obtain general permit from authorities having jurisdiction for discharge of construction dewatering effluent. Obtain well permit from authorities having jurisdiction for dewatering wells discharging more than 70 GPM. Comply with permit requirements.

3.4 CUTTING AND PATCHING

A. Division 01 - General Requirements: Cutting and Patching.

3.5 BUILDING ACCESS

A. Arrange for necessary openings in building to allow for admittance or removal of all apparatus.

B. When building access was not previously arranged and must be provided by this Contractor, restore any opening to its original condition after apparatus has been brought into building.

3.6 EQUIPMENT ACCESS

A. Install piping, conduit, and accessories to permit access to equipment for maintenance. Coordinate exact location of wall and ceiling access panels and doors with General Contractor, making sure that access is available for all equipment and specialties.

B. Where access is required in plaster walls or ceilings, furnish access doors to General Contractor.

3.7 COORDINATION

A. Coordinate work with other contractors prior to installation. Any work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at installing contractor's expense.

B. Verify that devices are compatible for type of construction and surfaces on which they will be used.

3.8 IDENTIFICATION

A. Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion.

B. Where stenciling is not appropriate for equipment identification, engraved name plates shall be used.

C. Identify interior piping not less than once every 30 feet, not less than once in each room, adjacent to each access door or panel, and on both side of partition where accessible piping passes through walls or floors.

D. Place flow directional arrows at each pipe identification location. Use one coat of black enamel against a light background or white enamel against a dark background.

E. Identify exterior buried piping for entire length with underground warning tape except for sewer piping which is routed in straight lines between manholes or cleanouts.

F. Place tape 12 inches below finished grade along entire length of pipe.

G. Extend tape to surface at building entrances, meters, hydrants, and valves.

H. Where existing underground warning tape is broken during excavation, replace with new tape identifying appropriate service and securely spliced to ends of existing tape.

I. Identify valves with brass tags bearing system identification and valve sequence number.

J. Valve tags are not required at a terminal device unless valves are greater than ten feet from device, located in another room, or not visible from device.

K. Provide a typewritten valve schedule and pipe identification schedule indicating valve number and equipment or areas supplied by each valve and symbols used for pipe identification.

L. Locate schedules in mechanical room and in each Operating and Maintenance manual. Schedule in mechanical room to be framed under clear plastic.

3.9 LUBRICATION

A. Lubricate bearings with lubricant as recommended by manufacturer before equipment is operated for any reason.

B. Once equipment has been operated, maintain lubrication in accordance with manufacturer's instructions until Owner accepts work.

C. Maintain a log of lubricants used and frequency of lubrication; include this information in Operation and Maintenance Manuals at completion of project.

3.10 SLEEVES

A. Provide galvanized sheet metal sleeves for pipe penetrations through interior and exterior walls to provide a backing for sealant or firestopping.

B. Patch wall around sleeve to match adjacent wall construction and finish.

C. Grout area around sleeve in masonry construction.

D. In finished spaces where pipe penetration through wall is exposed to view, sheet metal sleeve shall be installed flush with face of wall.

E. In existing poured concrete walls where penetration is core drilled, pipe sleeve is not required.

F. Pipe sleeves are not required in interior non-rated drywall, plaster, or wood partitions and sleeves are not required in existing poured concrete walls where penetrations are core drilled.

G. Pipe sleeves in new poured concrete construction shall be schedule 40 steel pipe, sized to allow insulated pipe to run through sleeve, cast in place.

H. In piping floor penetrations, fire rated and non-fire rated, top of sleeve shall extend one-inch above adjacent finished floor.

I. In existing floor penetrations, core drill sleeve opening large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting, non-shrink grout.

J. If pipe penetrating sleeve is supported by a pipe clamp resting on sleeve, weld a collar or struts to sleeve that will transfer weight to existing floor structure.

K. For floor penetrations through existing floors in mechanical and wet locations listed below, core drill opening and provide a “Link Seal” as manufactured by the Thunderline Corporation. “Link Seal” shall consist of ASTM D2000 EPDM rubber compound interlocking links, Devlin pressure plates, and corrosion resistant fastener to prevent water from entering the penetration or core drill sleeve openings large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting non-shrink grout and cement.

L. Wet locations include:
1. Parking ramps.

M. For pipe penetrations through existing floors in food service areas, core drill sleeve opening large enough to insert Schedule 40 sleeve and grout area around sleeve with hydraulic setting non-shrink grout/cement.

N. Size sleeve to allow insulated pipe to pass through sleeve and paint sleeve.

O. Pipe sleeves are not required in cored floor pipe penetrations through existing floors that are not located in mechanical rooms, food service areas, or wet locations listed above.

3.11 SEALING AND FIRESTOPPING

A. Fire and Smoke Rated Penetrations:
   1. Install approved product in accordance with manufacturer's instructions where a pipe penetrates a fire/smoke rated surface.
   2. When pipe is insulated, use product which maintains integrity of insulation and vapor barrier.
   3. Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming.
   4. Firestop mortar alone is not adequate to support substantial weight.

B. Non-Rated Partitions:
   1. In exterior wall openings below grade, assemble rubber links of mechanical seal to proper size for pipe and tighten in place, in accordance with manufacturer's instructions.
   2. At interior partitions and exterior walls, pipe penetrations are required to be sealed.
   3. Apply sealant to both sides of penetration in such a manner that annular space between pipe sleeve or cored opening and pipe or insulation is completely blocked.

END OF SECTION

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SECTION 22 05 03

PIPES AND TUBES FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe and pipe fittings for the following systems:
   a. Domestic water piping, within 5 feet of building.
   b. Sanitary sewer piping, within 5 feet of building.
   c. Chemical resistant sewer piping.
   d. Storm water piping, within 5 feet of building.
   e. Pool water piping.
   f. Equipment drains and over flows.
   g. Compressed air piping.
   h. Medical gas piping.
   i. Unions and flanges.
   j. Underground pipe markers.
   k. Bedding and cover materials.

B. Related Sections:
1. Applicable provisions of Division 01 shall govern all work under this Section.
2. Section 22 05 00 – Basic Plumbing Materials and Methods: Material and method requirements.
3. Division 07 – Thermal and Moisture Protection: Product requirements for firestopping for placement by this section.
4. Division 08 – Openings: Product requirements for access doors for placement by this section.
5. Division 09 – Finishes: Product and execution requirements for painting specified by this section.
6. Section 22 05 23 - Valves for Plumbing Piping: Product requirements for valves for placement by this section.
7. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
8. Section 22 07 00 - Plumbing Insulation: Product requirements for piping insulation for placement by this section.
9. Division 31 – Earthwork: Soils for backfill in trenches.
10. Division 31 – Earthwork: Aggregate for backfill in trenches.
11. Division 31 – Earthwork: Product and execution requirements for excavation, backfilling and compaction required by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME):
1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.3 - Malleable Iron Threaded Fittings.

3. ASME B16.4 - Gray Iron Threaded Fittings.
4. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
5. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
6. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
7. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
8. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
9. ASME B31.9 - Building Services Piping.
10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
11. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International (ASTM):
1. ASTM A47 - Standard Specification for Ferritic Malleable Iron Castings.
2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
4. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
5. ASTM A395 - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
6. ASTM A536 - Standard Specification for Ductile Iron Castings.
7. ASTM B32 - Standard Specification for Solder Metal.
8. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
9. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
10. ASTM B75 - Standard Specification for Seamless Copper Tube.
11. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
12. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
13. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
14. ASTM B302 - Standard Specification for Threadless Copper Pipe, Standard Sizes.
15. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).
16. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
17. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
18. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
19. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
20. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
21. ASTM C1053 - Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
22. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
23. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.

24. ASTM D2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameters.
25. ASTM D2241 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
26. ASTM D2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
27. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
28. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
29. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
30. ASTM D2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
31. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
32. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
33. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
34. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
35. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
36. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
37. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
38. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
39. ASTM D2846 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
40. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
41. ASTM D2996 - Standard Specification for Filament-Wound Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
42. ASTM D2997 - Standard Specification for Centrifugally Cast Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
43. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
44. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
45. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
46. ASTM D3262 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
47. ASTM D3517 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe.

48. ASTM D3754 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe.
49. ASTM D3840 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications.
50. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
51. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
52. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
53. ASTM F441 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
54. ASTM F442 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).
55. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
56. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
57. ASTM F628 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core.
58. ASTM F679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
59. ASTM F1281 - Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe.
60. ASTM F1282 - Standard Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe.
61. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. American Welding Society: (AWS)
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association: (AWWA)
1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
4. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.
7. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. through 3 in., for Water Service.

8. AWWA C950 - Fiberglass Pressure Pipe.

E. Cast Iron Soil Pipe Institute: (CISPI)
1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
2. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

1.3 SUBMITTALS

A. Division 01 - General Requirements: Submittal procedures.

B. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.

C. Welders' Certificate: Include welders' certification of compliance with ASME Section IX and AWS D1.1.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years experience.

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.6 PRE-INSTALLATION MEETINGS

A. Division 01 - General Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - General Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Division 01 - General Requirements: Environmental conditions affecting products on site.

B. Do not install underground piping when bedding is wet or frozen.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 COORDINATION

A. Division 01 - General Requirements: Requirements for coordination.

B. Coordinate installation of buried piping with trenching.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Ductile Iron Pipe: AWWA C151, C104.
   1. Fittings: AWWA C110, ductile iron, standard thickness.
   2. Joints: AWWA C111, rubber gasket with rods.
   3. Jackets: AWWA C105 polyethylene jacket.

B. Copper Tubing: ASTM B88, Type K, annealed.
   1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
   2. Joints: Compression connection or Brazed, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

C. PVC Pipe: ASTM D1785, Schedule 40 ASTM D2241, SDR-26 for 160 psig pressure rating, SDR-41 for 100 psig pressure rating, SDR-21 for 200 psig pressure rating, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D2466, Schedule 40, PVC.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

D. PVC Pipe: AWWA C900 Class 150, polyvinyl chloride (PVC) material.
   1. Fittings: AWWA C110, ductile iron, standard thickness.
   2. Joints: ASTM D3139 compression gasket ring.

E. Polyethylene Pipe: AWWA C901, MPa pressure rating:
   1. Fittings: AWWA C901, molded or fabricated.
   2. Joints: Compression or Butt fusion.

F. Copper Tubing: ASTM B42, Temper O61 annealed.
   1. Fittings: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper and bronze.
   2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder, AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.

G. Copper Tubing: ASTM B42, Temper O61 annealed.
   1. Fittings: ASME B16.26 cast bronze.
   2. Joints: Flared.

H. Polyethylene Pipe: ASTM D2239 SIDR 19, or ASTM D2447 Schedule 40.
   1. Fittings: ASTM D2609, Polyethylene.
   2. Joints: Mechanical with stainless steel clamp.

I. Fiberglass Pipe: AWWA C950.

J. Polyethylene/Aluminum Composition Tubing: ASTM F1281 or ASTM F1282.
   1. Fittings and Joints: Brass compression type.

2.2 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Ductile Iron Pipe: AWWA C151.
   1. Fittings: AWWA C110, ductile iron, standard thickness.
   2. Joints: AWWA C111, rubber gasket with rods.
   3. Jackets: AWWA C105 polyethylene jacket.

B. Copper Tubing: ASTM B88, Type K, annealed.
   1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
   2. Joints: Compression connection or Brazed, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

C. PVC Pipe: ASTM D1785, Schedule 40, ASTM D2241, SDR-26 for 160 psig pressure rating, SDR-41 for 100 psig pressure rating, SDR-21 for 200 psig pressure rating, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D2466, Schedule 40, PVC.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

D. PVC Pipe: AWWA C900 Class 150, polyvinyl chloride (PVC) material.
   1. Fittings: AWWA C110, ductile iron, standard thickness.
   2. Joints: ASTM D3139 compression gasket ring.

E. Polyethylene Pipe: AWWA C901:
   1. Fittings: AWWA C901, molded or fabricated.
   2. Joints: Compression or Butt fusion.

F. Copper Tubing: ASTM B42, Temper H80 hard drawn.
   1. Fittings: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper and bronze.
   2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder, AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.

G. Copper Tubing: ASTM B42, Temper O61 annealed.
   1. Fittings: ASME B16.26 cast bronze.
   2. Joints: Flared.

H. Polyethylene Pipe: ASTM D2239, SIDR 19, or ASTM D2447 Schedule 40.
   1. Fittings: ASTM D2609, Polyethylene.
   2. Joints: Mechanical with stainless steel clamps.

I. Polyethylene/Aluminum Composition Tubing: ASTM F1281 or ASTM F1282.
   1. Fittings and Joints: Brass compression type.

2.3 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tubing: ASTM B88, Type L, drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder, AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.

B. Copper Tubing: ASTM B88, Type L, drawn, rolled grooved ends.
   1. Fittings: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper and bronze, or ASTM B584 bronze sand castings, grooved ends.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
      a. Housing Clamps: ASTM A395 and ASTM A536 ductile iron, enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion.
      b. Gasket: Elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
      c. Accessories: Stainless steel bolts, nuts, and washers.

2.4 SANITARY SEWER PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Cast Iron Soil Pipe: ASTM A74, service weight, bell and spigot ends.
   1. Fittings: Cast iron, ASTM A74.
   2. Joints: ASTM C564, rubber gasket joint devices.

B. Ductile Iron Pipe: AWWA C150 or AWWA C151, 50 minimum special class, bell and spigot ends.
   1. Fittings: AWWA C110, ductile iron, standard thickness.
   2. Joints: AWWA C111, rubber gasket joint devices.

C. ABS Pipe: ASTM D2751, SDR 23.5, Acrylonitrile-Butadiene-Styrene (ABS) material, bell and spigot style solvent sealed ends.
   1. Fittings: ABS, ASTM D2751.
   2. Joints: ASTM D2235, solvent weld.

D. ABS Pipe: ASTM F628, Acrylonitrile-Butadiene-Styrene (ABS) material.
   1. Fittings: ABS.
   2. Joints: ASTM D2235, solvent weld.

E. ABS Pipe: ASTM D2661, Acrylonitrile-Butadiene-Styrene (ABS) material.
   1. Fittings: ABS, ASTM D2661.
   2. Joints: ASTM D2235, solvent weld.

F. PVC Pipe: ASTM D2729, polyvinyl chloride (PVC) material, bell and spigot solvent sealed ends.
   1. Fittings: PVC, ASTM D2729.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

G. PVC Pipe: ASTM D3034, SDR 35, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D3034, PVC.
   2. Joints: ASTM F477, elastomeric gaskets.

H. PVC Pipe: ASTM D1785, Schedule 40, polyvinyl chloride (PVC) material, bell and spigot style solvent sealed joint ends.
   1. Fittings: ASTM D2466, Schedule 40, PVC.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 Solvent cement.

I. PVC Pipe: ASTM D2665, polyvinyl chloride (PVC) material.
   1. Fittings: PVC, ASTM D2665.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

J. Copper Tube: ASTM B88 Type L annealed.
   1. Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
   2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder.

2.5 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Soil Pipe: ASTM A74, service weight, bell and spigot ends.
   1. Fittings: Cast iron, ASTM A74.
   2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.

B. Cast Iron Pipe: CISPI 301, hub-less.
   1. Fittings: Cast iron, CISPI 301.
   2. Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.

C. Ductile Iron Pipe: AWWA C150 or AWWA C151, 50 minimum special class, bell and spigot ends.
   1. Fittings: AWWA C110, ductile iron, standard thickness.
   2. Joints: AWWA C111, rubber gasket joint devices.

D. ABS Pipe: ASTM D2751, SDR 23.5, Acrylonitrile-Butadiene-Styrene (ABS) material, bell and spigot style solvent sealed ends.
   1. Fittings: ABS, ASTM D2751.
   2. Joints: ASTM D2235, solvent weld.

E. ABS Pipe: ASTM F628, Acrylonitrile-Butadiene-Styrene (ABS) material.
   1. Fittings: ABS.
   2. Joints: ASTM D2235, solvent weld.

F. ABS Pipe: ASTM D2661, Acrylonitrile-Butadiene-Styrene (ABS) material.
   1. Fittings: ABS, ASTM D2661.

2. Joints: ASTM D2235, solvent weld.

G. PVC Pipe: ASTM D2729, polyvinyl chloride (PVC) material, bell and spigot solvent sealed ends.
1. Fittings: PVC, ASTM D2729.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

H. PVC Pipe: ASTM D3034 SDR 35, polyvinyl chloride (PVC) material.
1. Fittings: ASTM D3034, PVC.
2. Joints: ASTM F477, elastomeric gaskets.

I. PVC Pipe: ASTM D1785, Schedule 40, polyvinyl chloride (PVC) material, bell and spigot style solvent sealed joint ends.
1. Fittings: ASTM D2466, Schedule 40, PVC.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 Solvent cement.

J. Copper Tube: ASTM B75 (ASTM B75M), ASTM B88 Type L.
1. Fittings: ASME B16.23, cast bronze, or ASME B16.29 wrought copper.
2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder.

K. Plastic Pipe: ASTM D2665, polyvinyl chloride (PVC) material.
1. Fittings: PVC, ASTM D2665.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.6 SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74, service weight.
1. Fittings: Cast iron, ASTM A74.
2. Joints: ASTM C564, rubber gasket joint devices or lead and oakum.

B. Cast Iron Pipe: CISPI 301, hub-less, service weight.
1. Fittings: Cast iron, CISPI 301.
2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

C. Copper Tube: ASTM B306, DWV Type M.
1. Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder.

D. Copper Pipe: Temper H80 hard drawn.
1. Fittings: ASME B16.23, cast bronze, or ASME B16.29 wrought copper.
2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder.

E. ABS Pipe: ASTM D2751 or ASTM F628, Schedule 40, DWV, Acrylonitrile-Butadiene-Styrene (ABS) material.
1. Fittings: ABS, ASTM D2751.
2. Joints: ASTM D2235, solvent weld.

F. ABS Pipe: ASTM D2661 or ASTM D2751, Acrylonitrile-Butadiene-Styrene (ABS) material.
   1. Fittings: ABS, ASTM D2661.
   2. Joints: ASTM D2235, solvent weld.

G. PVC Pipe: ASTM D2729, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D2729, PVC.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

H. PVC Pipe: ASTM D2665, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D2665, PVC.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

I. PVC Pipe: ASTM D1785 Schedule 40 or ASTM D2241 SDR-26 for not less than 150 psi pressure rating, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D2466, Schedule 40, PVC.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 Solvent cement.

2.7 STORM WATER PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74, service type, bell and spigot ends.
   1. Fittings: Cast iron, ASTM A74.
   2. Joints: ASTM C564, rubber gasket joint devices or lead and oakum.

B. ABS Pipe: ASTM D2751, SDR 23.5, Acrylonitrile-Butadiene-Styrene (ABS) material, bell and spigot style solvent sealed ends.
   1. Fittings: ABS, ASTM D2751.
   2. Joints: ASTM D2235, solvent weld.

C. PVC Pipe: ASTM D2729, polyvinyl chloride (PVC) material, bell and spigot solvent sealed ends.
   1. Fittings: PVC, ASTM D2729.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

D. Copper Tube: ASTM B306 DWV.
   1. Fittings: ASME B16.23, cast bronze, or ASME B16.29 wrought copper.
   2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder.

E. PVC Pipe: ASTM D3034 SDR 35, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D3034, PVC.
   2. Joints: ASTM F477, elastomeric gaskets.

F. PVC Pipe: ASTM D2665 or ASTM D3034 SDR 26, polyvinyl chloride (PVC) material.
   1. Fittings: PVC, ASTM D2665 or ASTM D3034.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.8 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74, service weight, bell and spigot ends.
   1. Fittings: Cast iron, ASTM A74.

2. Joints: ASTM C564, rubber gasket joint devices or lead and oakum.

B. Cast Iron Pipe: CISPI 301, hubless, service weight.
1. Fittings: Cast iron, CISPI 301.
2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

C. ABS Pipe: ASTM D2751, SDR 35, Acrylonitrile-Butadiene-Styrene (ABS) material, bell and spigot style solvent sealed ends.
1. Fittings: ABS, ASTM D2751.
2. Joints: ASTM D2235, solvent weld.

D. PVC Pipe: ASTM D2729, polyvinyl chloride (PVC) material, bell and spigot solvent sealed ends.
1. Fittings: PVC, ASTM D2729.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

E. Copper Tube: ASTM B306, DWV.
1. Fittings: ASME B16.23, cast bronze, or ASME B16.29 wrought copper.
2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder.

F. ABS Pipe: ASTM D2680 or ASTM D2751, Acrylonitrile-Butadiene-Styrene (ABS) material.
1. Fittings: ABS.
2. Joints: ASTM D2235, solvent weld.

G. PVC Pipe: ASTM D2665 or ASTM D3034 SDR 26, polyvinyl chloride (PVC) material.
1. Fittings: PVC, ASTM D2665 or ASTM D3034.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

H. PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679, polyvinyl chloride (PVC) material.
1. Fittings: PVC, ASTM D2665, ASTM D3034, or ASTM F679.
2. Joints: ASTM F477, elastomeric gaskets.

2.9 STORM WATER PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74 service weight, plain ends.
1. Fittings: Cast iron, ASTM A74.
2. Joints: ASTM C564, neoprene gasket system or lead and oakum.

B. Cast Iron Pipe: CISPI 301, hubless, service weight.
1. Fittings: Cast iron, CISPI 301.
2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

C. Copper Tube: ASTM B306, DWV.
1. Fittings: ASME B16.23, cast bronze, or ASME B16.29 wrought copper.
2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder.

D. ABS Pipe: ASTM D2680 or ASTM D2751, Acrylonitrile-Butadiene-Styrene (ABS) material.
1. Fittings: ABS.

2. Joints: ASTM D2235, solvent weld.

E. PVC Pipe: ASTM D2665 or ASTM D3034, SDR 26, polyvinyl chloride (PVC) material.
1. Fittings: PVC, ASTM D2665 or ASTM D3034.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.10 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tubing: ASTM B88, Type L, drawn.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder.

B. PVC Pipe: ASTM D1785, Schedule 40, and Schedule 80 for sizes 8 inch and larger, or ASTM D2241, SDR 21 or 26, polyvinyl chloride (PVC) material.
1. Fittings: ASTM D2466, Schedule 40, PVC.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

C. ABS Pipe: ASTM D2680 or ASTM D2751, Acrylonitrile-Butadiene-Styrene (ABS) material.
1. Fittings: ABS, ASTM D2751.
2. Joints: ASTM D2235, solvent weld.

2.11 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
1. Ferrous Piping: Class 150, malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with soldered.
3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
4. PVC Piping: PVC.
5. CPVC Piping: CPVC.

B. Flanges for Pipe 2-1/2 inches and Larger:
1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. PVC Piping: PVC flanges.
4. CPVC Piping: CPVC flanges.
5. Gaskets: 1/16 inch thick preformed neoprene gaskets.

C. PVC Pipe Materials: For connections to equipment and valves with threaded connections, furnish solvent-weld socket to screwed joint adapters and unions, or ASTM D2464, Schedule 80, threaded, PVC pipe.

2.12 UNDERGROUND PIPE MARKERS

A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

B. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Domestic Water Service, Sewer Service" in large letters.

2.13 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type A1 as specified in Section 31 05 16 – Aggregates for Earthwork.

B. Cover: Fill Type A1 as specified in Section 31 05 16 – Aggregates for Earthwork.

C. Soil Backfill from Above Pipe to Finish Grade: Soil Type S1, as specified in Section 31 05 13 – Soils for Earthwork. Subsoil with no rocks over 6 inches in diameter, frozen earth or foreign matter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Division 01 – General Requirements: Verification of existing conditions before starting work.

B. Verify excavations are to required grade, dry, and not over-excavated.

C. Verify trenches are ready to receive piping.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

A. Verify connection size, location, and invert are as indicated on Drawings.

B. Establish elevations of buried piping with not less than 4 ft of cover.

C. Establish minimum separation of 5 feet from other services piping in accordance with Wisconsin code.

D. Excavate pipe trench in accordance with Division 31 – Earthwork.

E. Install pipe to elevation as indicated on Drawings.

F. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent modified density.

G. Install pipe on prepared bedding.

H. Route pipe in straight line.

I. Install pipe to allow for expansion and contraction without stressing pipe or joints.

J. Install shutoff and drain valves at locations indicated on Drawings in accordance with Section 22 05 23 – Valves for Plumbing Piping.

K. Install plastic ribbon tape continuous over top of pipe, above pipe line; coordinate with Division 31 - Earthwork.

L. Install trace wire continuous over top of pipe, above pipe line; coordinate with Division 31 – Earthwork.

M. Pipe Cover and Backfilling:
1. Backfill trench in accordance with Division 31 – Earthwork.
2. Maintain optimum moisture content of fill material to attain required compaction density.
3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 12 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
5. Do not use wheeled or tracked vehicles for tamping.

3.4 INSTALLATION - ABOVE GROUND PIPING

A. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

B. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors. Reference Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Reference Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.

F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Reference Section 22 07 00 – Plumbing Insulation.

G. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Division 08 – Openings.

H. Install non-conducting dielectric connections wherever jointing dissimilar metals.

I. Establish invert elevations, slopes for drainage to 1/8 inch per foot one percent minimum. Maintain gradients.

J. Slope piping and arrange systems to drain at low points.

K. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

L. Install piping penetrating roofed areas to maintain integrity of roof assembly.

M. Install valves in accordance with Section 22 05 23 – Valves for Plumbing Piping.

N. Install piping specialties in accordance with Section 22 05 15 – Piping Specialties.

O. Insulate piping. Refer to Section 22 07 00 – Plumbing Insulation.

P. Install pipe identification in accordance with Section 22 05 53 – Identification for Plumbing Piping and Equipment.

3.5 INSTALLATION - DOMESTIC WATER PIPING SYSTEMS

A. Install domestic water piping system in accordance with Section 22 11 00 – Facility Water Distribution.

3.6 INSTALLATION - SANITARY WASTE AND VENT PIPING SYSTEMS

A. Install sanitary waste and vent piping systems in accordance with Section 22 13 00 – Facility Sanitary Sewerage.

B. Install bell and spigot pipe with bell end upstream.

C. Support cast iron drainage piping at every joint.

3.7 INSTALLATION - STORM DRAINAGE PIPING SYSTEMS

A. Install storm drainage piping systems in accordance with Section 22 14 00 – Facility Storm Drainage.

B. Install bell and spigot pipe with bell end upstream.

C. Support cast iron drainage piping at every joint.

3.8 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

B. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

C. Test domestic water piping system in accordance with applicable code.

D. Test sanitary waste and vent piping system in accordance with applicable code.

E. Test storm drainage piping system in accordance with applicable code.

3.9 CLEANING

A. Division 01 – General Requirements: Requirements for cleaning.

B. Clean and disinfect domestic water distribution system in accordance with Section 22 11 00 – Facility Water Distribution.

END OF SECTION

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SECTION 22 05 13

MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Single and three phase motors.

B. Related Sections:
   1. Applicable provisions of Division 01 shall govern all work under this Section.
   2. Section 22 05 00 – Basic Plumbing Materials and Methods: Material and method requirements.
   3. Section 22 42 00 - Plumbing Fixtures.
   4. Division 26 - Electrical - Electrical for power wiring, starters, and other electrical devices.

1.2 REFERENCES

A. American Bearing Manufacturers Association: (ABMA)
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. Institute of Electrical and Electronic Engineers: (IEEE)
   1. IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.

C. National electrical Manufacturers Association: (NEMA)
   1. NEMA MG-1 - Motors and Generators.

D. National Fire Protection Association: (NFPA)
   1. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Submit with equipment which motor drives the following motor information: motor manufacturer, voltage, phase, hertz, rpm, full load efficiency, full load power factor, service factor, NEMA design designation, insulation class, and frame type.

C. Submit manufacturer's instructions in manuals with specific equipment to which they apply.

1.4 ELECTRICAL COORDINATION

A. Starters, disconnects, relays, wire, conduit, pushbuttons, pilot lights, and other devices required for control of motors or electrical equipment are provided by Contractor, except as specifically noted elsewhere in this division of specifications.

B. Should any discrepancy in size, horsepower rating, electrical characteristics or means of control be made to any motor or other electrical equipment after contracts are awarded, Contractor is to immediately notify Engineer/Architect of such discrepancy.

C. Costs involved in any changes required due to equipment substitutions initiated by Contractor shall be responsibility of Contractor.

1.5 PRODUCT CRITERIA

A. Motors to conform to all applicable requirements of NEMA, IEEE, and NEC standards and shall be listed by U.L. for service specified.

B. Select motors for conditions in which they will be required to perform; i.e., general purpose, splash-proof, explosion-proof, standard duty, high torque, or any other special type as required by equipment or motor manufacturer's recommendations.

C. Furnish motors for starting in accordance with utility requirements and compatible with starters as specified.

PART 2 - PRODUCTS

2.1 GENERAL

A. Work shall conform to requirements of Division 26 - Electrical.

B. Power wiring shall be provided by Electrical Contractor. Control wiring shall be provided by the Plumbing Contractor.

C. Plumbing Contractor shall provide wiring diagrams for use by the Electrical Contractor.

2.2 MOTORS

A. Motors smaller than 1/2 HP shall be NEMA standard motors rated for 120 volts, AC, single phase, 60 Hz.

B. Motors shall be capacitor start and capacitor run type and shall have internal overload protection.

C. Motors 1/2 HP and larger shall be NEMA standard motors rated for specified voltage, AC, three phase and 60 Hz.

D. Motors shall be Design B, squirrel cage, open drip-proof construction with standard T frame, ball bearings, Class B insulation, single winding, continuous duly rated and 1.15 service factor, unless noted otherwise.

E. Minimum power factor for motors one HP and larger is 85 percent at rated capacity. Capacitors for power factor correction are not acceptable.

F. Provide devices for motor overload protection unless integral with equipment.

G. Devices shall be sized according to actual measured current draw with motor operating under normal load conditions.

H. Provide temporary protective devices where installation is not complete.

2.3 MOTOR STARTERS

A. Motor starters shall be provided by Plumbing Contractor.

B. Provide a combination starter for each motor.

C. Starter shall conform to Allen-Bradley Company Bulletin 512, consisting of a Bulletin 509 full voltage starter and non-fusible disconnect switch mounted in a NEMA Type 1 general purpose enclosure.

D. Starter shall be equipped as standard with block type overload relays and external reset buttons.

E. Starter shall be equipped as standard with a transformer to provide a 120V, 60 Hz, secondary control circuit.

F. Provide a three position Hand-Off-Auto selector switch for field installation in the enclosure flange: Allen-Bradley Catalog No. 1481-N51A or 1481-N51B.

2.4 THREE PHASE, SINGLE SPEED MOTORS

A. Use NEMA rated three phase, 60 hertz motors for all motors 1/2-HP and larger unless specifically indicated.

B. Use NEMA general purpose, continuous duty, Design B, normal starting torque, T-frame or U-frame motors with Class B or better insulation unless manufacturer of equipment on which motor is being used has different requirements.

C. Use open drip-proof motors unless totally enclosed fan-cooled, totally enclosed non-ventilated, explosion-proof, or encapsulated motors are specified in equipment sections.

D. Use grease lubricated anti-friction ball bearings with housings equipped with plugged/capped provision for re-lubrication, rated for minimum ABMA 9, L-10 life of 20,000 hours.

E. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

F. Open drip-proof motors to have a 1.15 service factor. Other motor types may have minimum 1.0 service factors.

G. Motors 1-HP and larger, except specially wound motors and inline pump motors 56 frame and smaller, to be high efficiency design with full load efficiencies which meet or exceed values listed below when tested in accordance with NEMA MG 1.

2.5 MOTORS USED ON VARIABLE FREQUENCY DRIVES

A. Motors must be suitable for use with drive specified, including but not limited to motor cooling.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount motors on a rigid base designed to accept a motor, using shims if required under each mounting foot to get a secure installation.

B. When motor will be flexible coupled to driven device, mount coupling to shafts in accordance with coupling manufacturer's recommendations.

C. Using a dial indicator, check angular misalignment of two shafts; adjust motor position as necessary so that angular misalignment of shafts does not exceed 0.002 inches per inch diameter of coupling hub. Again using dial indicator, check shaft for run-out to assure concentricity of shafts; adjust as necessary so that run-out does not exceed 0.002 inch.

D. When motor will be connected to driven device by means of a belt drive, mount sheaves on appropriate shafts in accordance with manufacturer's instructions.

E. Use a straight edge to check alignment of sheaves; reposition sheaves as necessary so that straight edge contacts both sheave faces squarely.

F. After sheaves are aligned, loosen adjustable motor base so that belt(s) can be added and tighten base so that belt tension is in accordance with drive manufacturer's recommendations.

G. Frequently re-check belt tension and adjust if necessary during first day of operation and again after several days.

H. Verify proper rotation of each three-phase motor as it is being wired or before motor is energized for any reason.

I. Lubricate all motors requiring lubrication. Record lubrication material used and frequency of use. Include this in maintenance manuals.

END OF SECTION

SECTION 22 05 15

PLUMBING PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Plumbing piping specialties for all piping systems.

B. Related Sections
1. Applicable provisions of Division 01 shall govern all work under this Section.
2. Section 22 05 00 – Basic Plumbing Materials and Methods: Material and method requirements.
3. Section 22 05 23 - Valves for Plumbing Piping.
4. Section 22 07 00 - Plumbing Insulation.
5. Section 22 11 00 - Facility Water Distribution.
6. Section 22 13 00 - Facility Sanitary Sewerage.
7. Section 22 14 00 - Facility Storm Drainage.
8. Section 22 30 00 - Plumbing Equipment.

1.2 REFERENCE

A. ASTM International (ASTM):
1. ASTM A126 – Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. ASTM B30 – Specification for Copper Alloys in Ingot Form.
3. ASTM B62 – Specification for Composition Bronze or Ounce Metal Castings.
4. ASTM B650 - Specification for Electrodeposited Engineering Chromium Coatings on Ferrous Substrates.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Required for all items in this section. Include materials of construction, dimensional data, ratings/capacities/ranges, approvals, test data, pressure drop data where appropriate, and identification as referenced in this section and on Drawings.

C. Submit manufacturer's installation requirements.

1.4 DESIGN CRITERIA

A. Piping specialties shall be rated for highest pressures and temperatures in respective system in accordance with ANSI B30, but not less than 125 psig, unless specifically indicated otherwise.

PART 2 - PRODUCTS

2.1 THERMOMETERS

A. Manufacturers:
1. Ashcroft.
2. Marsh.
3. Taylor.
4. H. O. Trerice.
5. Ametek/U. S. Gauge.
6. Weiss.
7. Wika.
8. Weksler.
9. Or Approved Equal.

B. Thermometer: Stem type, cast aluminum case, 9-inch scale, clear acrylic window, adjustable angle brass stem with stem of sufficient length so end of stem is near middle of a pipe without reducing thickness of any insulation, red indicating fluid, black lettering against a white background, with scale ranges as follows:
1. Service: Hot Water.
2. Scale Range: 30 – 180 degrees F.
3. Increment: 2 degrees F.

2.2 THERMOMETER SOCKETS

A. Brass with threaded connections suitable for thermometer stems and temperature control sensing elements in pipeline. Furnish with extension necks for insulated piping systems.

2.3 TEST WELLS

A. Similar to thermometer sockets except with a brass cap that threads into inside of test well to prevent dirt from accumulating. Secure cap to body with a short chain. Furnish with extension necks, where appropriate, to accommodate pipeline insulation.

2.4 TEST PLUGS

A. Brass threaded pressure and temperature test plug with neoprene self-closing valve, valve retainer, brass threaded cap, rated for 150 psi and 0-200 degrees F.

2.5 PRESSURE GAUGES

A. Manufacturers:
1. Ametek/U. S. Gauge.
2. Ashcroft.
3. Marsh.
4. Taylor.
5. H. O. Trerice.
6. Weiss.
7. Wika.
8. Weksler.

9. Or Approved Equal.

B. Pressure Gauges: Cast aluminum case of not less than 4.5 inches in diameter, double strength glass window, black lettering on a white background, phosphor bronze bourdon tube with bronze bushings, recalibration from front of dial, 99 percent accuracy over middle half of scale, 98.5 percent accuracy over remainder of scale, with scale range as follows:

Service	Hot Water	Cold Water	Compressed Air
Scale Range, psig	0-100	0-100	0-200
Increment, psig	1	1	2

C. Pressure Snubbers: Bronze construction, 300 psig working pressure, 1/4-inch size.

D. Gauge Valves: Use ball valves as specified in Section 22 05 23 - General-Duty Valves for Plumbing Piping.

2.6 STRAINERS

A. Manufacturers:
1. Armstrong.
2. Illinois.
3. Keckley.
4. Metraflex.
5. Mueller Steam.
6. Sarco.
7. Watts.
8. Or Approved Equal.

B. Strainer: Y Type; cast bronze body, ASTM B62; 20 mesh stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; sweat, threaded or flanged body rated at not less than 150 psi WOG.

C. Strainer: Y Type; cast iron body, ASTM A126; 20 mesh stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; threaded or flanged ends; rated at not less than 150 psi WOG.

PART 3 - EXECUTION

3.1 INSTALLATION - THERMOMETERS

A. Stem Type: Install in piping systems as indicated on Drawings or details using a separable socket in each location.

3.2 INSTALLATION - THERMOMETER SOCKETS

A. Install at each point where a thermometer or temperature control-sensing element is located in a pipeline.

3.3 INSTALLATION - TEST WELLS

A. Install in piping systems as indicated on Drawings or details wherever provisions are needed for inserting a thermometer at a later date.

3.4 INSTALLATION - TEST PLUGS

A. Install in piping systems as indicated on Drawings or details wherever provisions are needed for short-term measurement of pressure or temperature.

3.5 INSTALLATION - PRESSURE GAUGES

A. Install in locations where indicated on Drawings or details, with scale range appropriate to system operating pressures.

B. Pressure Snubbers: Install in gauge piping for all gauges used on water services.

C. Gauge Valves: Install at each gauge location as close to main as possible and at each location where a gauge tapping is indicated.

3.6 INSTALLATION - STRAINERS

A. Install all strainers where indicated allowing sufficient space for screens to be removed. Install a ball valve in tapped screen retainer.

END OF SECTION

SECTION 22 05 23

VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Water System Valves.
2. Waste System Valves.
3. Specialty Valves and Valve Accessories.

B. Related Sections
1. Applicable provisions of Division 01 shall govern all work under this Section.
2. Section 22 05 00 – Basic Plumbing Materials and Methods: Material and method requirements.
3. Section 22 05 14 - Plumbing Specialties.
4. Section 22 30 00 - Plumbing Equipment.

1.2 REFERENCES

A. American National Standards Institute (ANSI):
1. ANSI Z21.22 - Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems.

B. American Society of Safety Engineers (ASSE):
1. ASSE 1003 - Water Pressure Reducing Valves for Domestic Water Supply Systems.

C. American Water Works Association (AWWA):
1. AWWA C504 – Rubber-Seated Butterfly Valves.
2. AWWA C509 – Resilient-Seated Gate Valves for Water Supply Service.
3. AWWA C550 – Protective Epoxy Interior Coatings for Valves and Hydrants.
4. AWWA C800 - Underground Service Line Valves and Fittings.

D. ASTM International (ASTM):
1. ASTM D4101 - Specification for Polypropylene Injection and Extrusion Materials

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Submit schedule of all valves indicating type of service, dimensions, materials of construction, and pressure/temperature ratings for all valves to be used on project. Temperature ratings specified are for continuous operation.

1.4 DESIGN CRITERIA

A. Where valve types are specified for individual plumbing services, each valve type shall be of same approved manufacturer unless prior written approval is obtained from Engineer.

B. Valves to be line size unless specifically noted otherwise.

PART 2 - PRODUCTS

2.1 WATER SYSTEM VALVES

A. Water system valves shall be rated at not less than 125 psig water working pressure at 240 degrees F unless noted otherwise.

B. Ball Valves: 3-Inch and smaller: Two or three piece bronze body; sweat ends, chrome plated bronze full port ball; glass filled teflon seat; teflon packing and threaded packing nut; blowout-proof stem; 600 psig WOG. Provide valve stem extensions for valves installed in all piping with insulation.
   1. Manufacturers:
      a. Apollo 70-200.
      b. Hammond 8511.
      c. Milwaukee BA150.
      d. NIBCO S580-70.
      e. Watts B-6001.
      f. Or approved equal.

C. Butterfly Valves:
   1. 2-1/2-Inch and Larger: Cast or ductile iron body; stainless steel shaft; bronze, copper or teflon bushings; EPDM resilient seat; EPDM seals; bronze, aluminum-bronze, EPDM encapsulated ductile iron or stainless steel disc. 200 psig WOG through 12-inch, 150 psig WOG through 24-inch. Valve assembly to be bubble tight to 175 psig with no downstream flange/pipe attached. Use tapped lug type valves with stud bolts or cap screws, or grooved end connection valves, permitting removal of downstream piping while using valve for system shutoff.
   2. Manufacturers:
      a. Centerline LT Series.
      b. DeZurik 632.
      c. Hammond 6200 Series.
      d. Milwaukee M or C Series.
      e. NIBCO LD2000/LC2860.
      f. Victaulic 300/608/700/709.
      g. Watts BF-03.
      h. Or approved equal.
   3. Provide 10 position locking lever handle actuators for valves 6-inch and smaller. Provide worm gear operators with external position indication for valves 8-inch and larger.

D. Swing Check Valves: 3-Inch and Smaller: Bronze body, sweat ends, Y-pattern, regrindable bronze seat, renewable bronze disc, Class 125, suitable for installation in a horizontal or vertical line with flow upward.
   1. Manufacturers:
      a. Crane 1342.
      b. Hammond IB941.
      c. NIBCO S413B.
      d. Watts CVYS.

e. Or approved equal.

E. Swing Check Valves: 4-Inch and Larger: Cast iron body, flanged ends, bronze trim, bolted cap, renewable bronze seat and disc, Class 125, non-asbestos gasket, suitable for installation in a horizontal or vertical line with flow upward.
1. Manufacturers:
a. Crane 373.
b. Hammond IR1124.
c. Milwaukee F2974.
d. NIBCO F918B.
e. Watts Series 411.
f. Or approved equal.

F. Spring Loaded Check Valves: 2-Inch and Smaller: Bronze body, sweat or threaded ends, bronze trim, stainless steel spring, stainless steel center guide pin, Class 125, teflon seat unless only bronze available.
1. Manufacturers:
a. ConBraCo 61 Series.
b. Mueller 203BP.
c. NIBCO S480Y.
d. Val-Matic S1400 Series.
e. Or approved equal.

G. Spring Loaded Check Valves: 2-1/2-Inch and Larger: Cast or ductile iron body, wafer or globe type, bronze trim, bronze or EPDM seat, stainless steel spring, stainless steel stem if stem is required, Class 125.
1. Manufacturers:
a. APCO 300 or 600 Series.
b. Centerline CLC with Full-Body Option.
c. Hammond IR9354.
d. Milwaukee 1800 Series.
e. Mueller Steam 101AP or 105AP.
f. NIBCO W910 or F910.
g. Val-Matic 1400 or 1800 or 8000 Series.
h. Or approved equal.

H. Stop and Waste Valves: 1-Inch and Smaller: Bronze body, sweat or threaded ends, 400 psi WOG, stainless steel ball and stem, full port ball valve, with threaded drain cap.
1. Manufacturers:
a. Watts B-6300/6301 SS Series.
b. Apollo.
c. Hammond.
d. Milwaukee.
e. NIBCO.
f. Or approved equal.

I. Balance Valves: 2-Inch and Smaller: Two or three piece bronze body ball valve, sweat or threaded ends, chrome plated brass full port ball, glass filled teflon seat, threaded packing nut, with adjustable memory stop position indicator and extended handle stem, suitable for 400 psig water working pressure at 240 degrees F.

1. Manufacturers:
   a. Watts B-6000/B-6001 BS.
   b. Apollo.
   c. Grinnell.
   d. Hammond.
   e. Milwaukee.
   f. NIBCO.
   g. Or approved equal.

J. Drain Valves: 3/4-inch ball valve with integral threaded hose adapter, sweat or threaded inlet connections, with threaded cap and chain on hose threads.
   1. Manufacturers:
      a. Watts B-6000-CC/B-6001-CC Series.
      b. Or approved equal.

2.2 WASTE SYSTEM VALVES

A. Gate Valves: 2-Inch and Smaller: Bronze body, bronze trim, threaded ends, solid wedge, rising stem, union bonnet, malleable iron hand wheel, suitable for 300 psi WOG.
   1. Manufacturers:
      a. Crane 431UB.
      b. Hammond IB629.
      c. Lunkenheimer 3151.
      d. Milwaukee 1151(M).
      e. NIBCO T134.
      f. Powell 2714.
      g. Stockham B120.
      h. Or approved equal.

B. Gate Valves: 2-1/2-Inch and Larger: Iron body, bronze trim, bolted bonnet, O.S. & Y., solid wedge, flanged, suitable for 200 psi WOG.
   1. Manufacturers:
      a. Crane 465-1/2.
      b. Hammond IR1140.
      c. Lunkenheimer 1430.
      d. Milwaukee F2885.
      e. NIBCO F617-O.
      f. Powell 1793.
      g. Stockham G623.
      h. Or approved equal.

C. Ball Valves: 3-Inch and Smaller: Two or three piece bronze body; sweat or threaded ends, chrome plated bronze ball; glass filled teflon seat; teflon packing and threaded packing nut; blowout-proof stem; 400 psig WOG.
   1. Manufacturers:
      a. Apollo 70-200.
      b. Hammond 8511.
      c. Milwaukee BA150.
      d. NIBCO S585-70.
      e. Watts B-6001.

f. Or approved equal.

D. Swing Check Valves: 1-1/2-Inch and Smaller: Bronze body, threaded ends, Y-pattern, regrindable bronze seat, renewable bronze disc, Class 125, suitable for installation in a horizontal or vertical line with flow upward.
1. Manufacturers:
a. Crane 1342.
b. Hammond IB941.
c. Nibco S413B.
d. Watts CVYS.
e. Or approved equal.

E. Swing Check Valves: 2-Inch and Larger: Cast iron body, flanged ends, bronze trim, bolted cap, renewable bronze seat and disc, Class 125, non-asbestos gasket, outside lever and weight or spring, suitable for installation in a horizontal or vertical line with flow upward.
1. Manufacturers:
a. Crane 383.
b. Milwaukee F2974.
c. NIBCO F918B.
d. Or approved equal.

F. Spring Loaded Check Valves: 2-Inch and Smaller: Bronze body, sweat or threaded ends, bronze trim, stainless steel spring, stainless steel center guide pin, Class 125, teflon seat unless only bronze available.
1. Manufacturers:
a. ConBraCo 61 Series.
b. Mueller 203BP.
c. NIBCO S480Y.
d. Val-Matic S1400 Series.
e. Or approved equal.

G. Spring Loaded Check Valves: 2-1/2-inch and Larger: Cast or ductile iron body, wafer or globe type, bronze trim, bronze or EPDM seat, stainless steel spring, stainless steel stem if stem is required, Class 125.
1. Manufacturers:
a. APCO 300 or 600 Series.
b. Centerline CLC with Full Body Option.
c. Hammond IR9354.
d. Milwaukee 1800 Series.
e. Mueller Steam 101AP or 105AP.
f. NIBCO W910 or F910.
g. Val-Matic 1400 or 1800 or 8000 Series.
h. Or approved equal.

2.3 SPECIALTY VALVES AND VALVE ACCESSORIES

A. Gauge Valves: Use 1/4-inch ball valves. Needle valves and gauge cocks will not be accepted.

B. Water Pressure Reducing Valves: Bronze body, diaphragm operated, with an integral thermal expansion bypass valve, inlet union, stainless steel strainer, renewable monel or stainless steel seat, and adjustable reduced pressure range, 300 psig at 160 degrees F. Pre-set for scheduled pressure.
   1. Manufacturers:
      a. A. W. Cash.
      b. Conbraco.
      c. Watts.
      d. Wilkins.
      e. Or approved equal.

C. Safety Relief Valves: Bronze body, temperature and pressure actuated, stainless steel stem and spring, thermostat with non-metallic coating, test lever, suitable for 125 psig water working pressure at 240 degrees F, sized for full BTUH input and operating pressure of equipment, with valve capacity on metal label. For equipment less than or equal to 200,000 BTUH input, provide AGA, UL, or ASME listed and labeled valve. Provide ASME listed and labeled valve for larger equipment.
   1. Manufacturers:
      a. Bell & Gossett.
      b. A. W. Cash.
      c. Conbraco.
      d. Watts.
      e. Wilkins.
      f. Or approved equal.
   2. Size temperature and pressure relief valve in accordance with AGA rating for BTUH input.

PART 3 - EXECUTION

3.1 GENERAL

A. Properly align piping before installation of valves.

B. Install and test valves in strict accordance with valve manufacturer's installation recommendations.

C. Do not support weight of piping system on valve ends.

D. Mount valves in locations allowing access for operation, servicing, and replacement.

E. Provide valve handle extensions for all valves installed in insulated piping.

F. Install valves with stem in upright or horizontal position. Install butterfly valves with stem in horizontal position.

G. Valves installed with stems down will not be accepted.

H. Prior to flushing of piping systems, place valves in full-open position.

3.2 SHUT-OFF VALVES

A. Install shut-off valves at each piece of equipment, at each branch take-off from mains for isolation or repair, as indicated on Drawings.

3.3 DRAIN VALVES

A. Provide drain valves for complete drainage of all systems.

B. Locations of drain valves include low points of piping systems, downstream of riser isolation valves, equipment locations specified or detailed, other locations required for drainage of systems and as indicated on Drawings.

3.4 SPRING LOADED CHECK VALVES

A. Install spring loaded check valve in each circulating pump discharge line, each clear water sump pump discharge line, and as indicated on Drawings.

3.5 SWING CHECK VALVES

A. Install swing check valves in re-circulation branch lines and as indicated on Drawings.

B. Provide weighted swing check valves at sanitary sump pump discharges.

3.6 PRESSURE REDUCING VALVES

A. Provide ball valve and strainer at inlet and ball valve at outlet. Install pressure gauges to indicate inlet and outlet pressure at each pressure -reducing valve.

3.7 SAFETY RELIEF VALVES

A. Install relief valves on pressure vessels and as indicated on Drawings.

B. Inlet and outlet piping connecting to valves must be same size as valve connections or larger.

C. Pipe discharge to drain where indicated or to floor.

END OF SECTION

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SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Supports of plumbing equipment and materials.
2. Piping system anchors.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 22 05 00 – Basic Plumbing Materials and Methods: Material and method requirements.
3. Section 22 07 00 - Plumbing Insulation: Insulation protection at support devices.
4. Division 03 - Concrete: Formwork and cast-in-place concrete for equipment pads.

1.2 REFERENCES

A. ASTM International: (ASTM)
1. ASTM A123 – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM B633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
3. ASTM B695 - Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

B. Manufacturers Standardization Society: (MSS)
1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, and Manufacture.
2. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.

1.3 QUALITY ASSURANCE

A. Substitution of Materials: In accordance with Division 01- General Requirements.

1.4 DESCRIPTION

A. Provide supporting devices as required for installation of mechanical equipment and materials.

B. Supports and installation procedures shall conform to latest requirements of ANSI Code for building piping.

C. Do not hang any mechanical item directly from a metal deck or run piping so it rests on bottom chord of any truss or joist.

D. Fasteners depending on soft lead for holding power or requiring powder actuation shall not be accepted.

E. Support apparatus and material under conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.

F. Protect insulation at all hanger points.

1.5 SUBMITTALS

A. Division 01 – General Requirements - Submittal Procedures: Requirements for submittals.

B. Submit manufacturer's installation instructions.

1.6 DESIGN CRITERIA

A. Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 and SP-69 unless noted otherwise.

B. Piping connected to pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from equipment, whichever is greater.

C. Standard pipe hangers and supports as specified in this section are required beyond 100 pipe diameter divided by 3 for support distance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
1. Anvil.
2. B-Line.
3. Pate.
4. Piping Technology.
5. Roof Products & Systems.
6. Or approved equal.

2.2 STRUCTURAL SUPPORTS

A. Provide supporting steel required for installation of mechanical equipment and materials, including angles, channels, and beams, to suspended or floor supported tanks and equipment.

B. Supporting steel not be specifically indicated on Drawings, shall be used as required by governing code.

2.3 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2-Inch through 2-Inch:
1. Carbon steel, adjustable swivel ring. B-Line B3170NF, Anvil 69 or 70.
2. Carbon steel, adjustable clevis, standard. B-Line B3100, Anvil 260.

B. Hangers for Pipe Sizes 2-Inch and Larger:
   1. Carbon steel, adjustable clevis, standard. B-Line B3100, Anvil 260.

C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

D. Wall Support:
   1. Carbon steel welded bracket with hanger. B-Line 3068 Series, Anvil 194 Series.
   2. Perforated, epoxy painted finish, 16-12 gauge minimum, steel channels securely anchored to wall structure, with interlocking, split-type, bolt secured, galvanized pipe and tubing clamps.
   3. B-Line type S channel with B-2000 series clamps or Anvil type PS 200 H with PS 1200 clamps.
   4. When copper piping is being supported, provide flexible elastomeric and thermoplastic isolation cushion material to completely encircle piping and avoid contact with channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Anvil PS 1400 series.

E. Vertical Support: Carbon steel riser clamp. B-Line B3373, Anvil 261 for above floor use.

F. Floor Support: Carbon steel pipe saddle, stand and bolted floor flange, B-Line B3088T/B3093.

G. Copper Pipe Supports: Supports, fasteners and clamps directly connected to copper piping shall be copper plated or polyvinyl chloride coated. Where steel channels are used, provide isolation collar between supports, clamps, fasteners and copper piping.

2.4 PIPE HANGER RODS

A. Steel Hanger Rods: Threaded both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.

B. Size rods for individual hangers and trapeze support as indicated in following schedule, total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed limits indicated in following schedule.

Maximum Load (Lbs.) (650°F Maximum Temp.)	Rod Diameter (inches)
610	3/8
1130	1/2
1810	5/8
2710	3/4
3770	7/8
4960	1
8000	1-1/4

2.5 BEAM CLAMPS

A. MSS SP-69 Types 19 or Type 23, malleable black iron clamp for attachment to beam flange to 0.62 inches thick with a retaining ring and threaded rod of 3/8, 1/2, and 5/8 inch diameter. Furnish with a hardened steel cup point set screw. B-Line B3036L/B3034, Anvil 86/92.

B. MSS SP-69 Type 28 or Type 29, forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2 inch diameter. B-Line B3054, Anvil 228.

2.6 CONCRETE INSERTS

A. Poured In Place:
1. MSS SP-69 Type 18 wedge type to be constructed of a black carbon steel body with a removable malleable iron nut that accepts threaded rod to 7/8-inch diameter. Wedge design to allow insert to be held by concrete in compression to maximize load carrying capacity. B-Line B2505, Anvil 281.
2. MSS SP-69 Type 18 universal type to be constructed of black malleable iron body with a removable malleable iron nut that accepts threaded rod to 7/8-inch diameter. B-Line B3014N, Anvil 282.

B. Drilled Fasteners: Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor. Hilti, Rawl, or Redhead.

2.7 CONTINUOUS CONCRETE INSERT CHANNELS

A. Steel inserts with an industry standard pre-galvanized finish, nominally 1-5/8-inch wide by 1-3/8 inch deep by length to suit application, designed to be nailed to concrete forms and provide a linear slot for attaching other support devices.

B. Installed channels to provide a load rating of 2000 pounds per foot in concrete.

C. Manufacturer's standard brackets, inserts, and accessories designed to be used with channel inserts may be used.

D. Select insert length to accommodate all pipe in area.

2.8 ANCHORS

A. Use welding steel shapes, plates, and bars to secure piping to structure.

2.9 EQUIPMENT STANDS

A. Use structural steel members welded to and supported by pipe supports.

B. Clean, prime and coat with three coat rust inhibiting alkyd paint or one coat epoxy mastic.

C. Where exposed to weather, treat with corrosive atmosphere coatings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Size, apply and install supports and anchors in compliance with manufacturer’s recommendations.

B. Install supports to provide for free expansion of piping system.

C. Support piping from structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands.

D. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

E. Coordinate hanger and support installation to properly group piping of all trades.

F. Where piping can be conveniently grouped to allow use of trapeze type supports, use standard structural shapes or continuous insert channels for supporting steel.

G. Where continuous insert channels are used, pipe supporting devices made specifically for use with channels may be substituted for specified supporting devices provided that similar types are used and all data is submitted for prior approval.

H. Size and install hangers and supports, except for riser clamps, for installation on exterior of piping insulation.

I. Where a vapor barrier is not required, hangers may be installed either on exterior of pipe insulation or directly on piping.

J. Perform welding in accordance with standards of American Welding Society.

3.2 HANGER AND SUPPORT SPACING

A. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.

B. Place a hanger within 12 inches of each horizontal elbow, valve, strainer, or similar piping specialty item.

C. Use hangers with 1-1/2-inch minimum vertical adjustment.

D. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

E. Support riser piping independently of connected horizontal piping.

F. Adjust hangers to obtain slope specified in piping section of these specifications.

G. Space hangers for pipe as follows:

Pipe Material	Pipe Size	Maximum Horizontal Spacing	Maximum Vertical Spacing
Cast Iron	2" and larger	5'-0"	15'-0"
Copper	1/2" through 3/4"	5'-0"	10'-0"
Copper	1" through 1-1/4"	6'-0"	10'-0"
Copper	1-1/2" through 2-1/2"	8'-0"	10'-0"
Copper	3"	10'-0"	10'-0"
Copper	4" and larger	12'-0"	10'-0"
Ductile Iron	All	10'-0"	20'-0"
Steel	1/2" through 1-1/4"	7'-0"	15'-0"
Steel	1-1/2" through 6"	10'-0"	15'-0"
Steel	8" through 12"	14'-0"	20'-0"
Steel	14" and over	20'-0"	20'-0"
Plastic	Drain and Vent	4'-0"	10'-0"
Plastic	1" or less	32"	4'-0"
Plastic	1-1/4" and over	4'-0"	6'-0"
Plastic	Pure Water 1-1/2" or less	Continuous	5’-0”

3.3 RISER CLAMPS

A. Support vertical piping with clamps secured to piping and resting on building structure or secured to building structure below at each floor.

3.4 CONCRETE INSERTS AND CONTINUOUS INSERT CHANNELS

A. Select size based on manufacturer's stated load capacity and weight of material that will be supported.

B. Locate continuous insert channels on 6'-0" maximum centers and 2'-0" from corners.

C. Furnish inserts to Contractor for placement in concrete formwork.

D. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

E. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inch size.

F. Where concrete slabs form finished ceiling, provide inserts that are flush with slab surface.

3.5 ANCHORS

A. Install where indicated on Drawings and details.

B. Where not specifically indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops.

C. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

END OF SECTION

SECTION 22 05 33

HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This section describes the requirement for supplying, installing, and testing of the electric heat tracing system of the plumbing piping.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all Work under this section.
2. Section 22 05 00 – Basic Plumbing Piping and Materials.
3. Section 22 07 00 – Plumbing Insulation: Pipe Insulation.

1.2 REFERENCES

A. International Code Council, (ICC):
1. IPC-06, (R 2007) - International Plumbing Code.

B. Institute of Electrical and Electronic Engineers (IEEE):
1. IEEE 515.1, (R 2007) - Recommended Practice for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Commercial Applications.

1.3 SUBMITTALS

A. Submit in accordance with Division 01 – General Requirements.

B. The following product data shall be submitted:
1. Rated capacity.
2. Length of cable.
3. Cable spacing.
4. Electrical power requirements.

C. Shop drawings shall include plans, sections, details, wiring diagrams, and attachments to other work. Wiring diagrams shall include power, signal, and control wiring.

D. Field quality control test reports shall be submitted.

E. Operation and Maintenance data shall be included.

1.4 RECORD DOCUMENTS

A. Electronic documentation and copies of the Operations and Maintenance Manual, approved submittals, shop drawings, and other closeout documentation shall be prepared.

B. Four (4) sets of manufacturer’s literature and data updated to include submittal review comments and any equipment substitutions.

C. Four (4) sets of operation and maintenance data updated to include submittal review comments shall be inserted into a three ring binder.
   1. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual.
   2. Operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations.
   3. Notes on all special systems or devices such as damper and door closure interlocks shall be included.
   4. List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished.
   5. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the as-built documentation.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Ten (10) years' experience in design, engineering, manufacture and support of specified system and components.

B. Product Requirements:
   1. Pipe or tank tracing cable assembly shall be factory assembled, immersed in water for a minimum of 12 hours, and then tested for insulation resistance, high potential breakdown and continuity before leaving the factory.
   2. Factory Mutual approved constant wattage cable.
   3. UL Listed, thermostat and contactor panel.
   4. UL Listed Control/Monitor Panel.

PART 2 - PRODUCTS

2.1 PLASTIC INSULATED SERIES RESISTANCE HEATING CABLES

A. Plastic insulated series resistance heating cables shall comply with IEEE 515.1.

B. Heating element shall be a single or dual strained resistor wire. Terminations shall be made with waterproof, factory assembled non heating leads with connectors at both ends.

C. Electrical insulated jacket shall be a minimum 0.10 millimeter (4.0 mil) Kapton with silicone jacket or Tefzel. Cable cover shall be aluminum braid.

D. Maximum operating temperature shall be 150 degrees C (300 degrees F).

E. Capacities and characteristics shall be:
   1. Maximum Heat Output: 24.6 W/m (7.5 W/foot).
   2. Pipe Diameter: 6 inches.
   3. Number of parallel cables: 2.
   4. Volts: 230
   5. Phase: 3.
   6. Hertz: 60.

7. Full load amps: 60.
8. Minimum Circuit Ampacity: 60.
9. Maximum Over Current Protection: 80.

2.2 CONTROLS

A. Pipe mounting thermostats for Freeze protection shall have be a remote bulb unit with adjustable temperature range from minus 1 to 10 degrees C (30 to 50 degrees F).

B. Thermostat shall be snap action, open-on-rise, single pole switch with minimum current rating adequate for the connected cable.

C. Thermostat shall be remote bulb on capillary, resistance temperature device, or thermistor for direct sensing of pipe wall temperature.

D. Control enclosure shall be corrosion resistant and waterproof.

E. Precipitation and temperature sensor for snow melting on roofs and in gutters shall be automatic based control with manual on, automatic, and standby/reset switches.

F. Precipitation and temperature sensors shall sense the surface conditions of roof and/or gutters and shall be programmed to energize the cable as follows:
1. Temperature span between 1 to 7 degrees C (34 to 44 degrees F).
2. Adjustable delay off span between 30 and 90 minutes.
3. Following a two minute delay, the cables shall be energized if ambient temperature is below set-point and precipitation is detected.
4. Cables shall be de-energized upon detection of a dry surface plus a time delay of 15 minutes.

G. Enclosure shall be corrosion resistant and waterproof suitable for outdoor mounted.

H. Minimum 30 amp contactor shall be provided to indicate operational status, on/off control, and for interface with central energy management and control system.

I. A programmable timer for domestic hot water temperature maintenance shall have the following features:
1. Micro-processor based.
2. Capable of four separate operation schedules.
3. On/off/Auto switch.
4. A 365 day calendar with 20 programmable holidays.
5. Relays with contacts to indicate operational status, on/off status, and to interface with central energy management and control system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Electric heating cable shall be installed for the following applications:
1. Snow and ice melting on roofs, in gutters, roof drain bodies, and roof drain leaders.
2. Freeze protection of plumbing piping.

B. Electric heating cable shall be installed across expansion, construction, and control joints according to manufacturer's recommendations using cable protection conduit and slack cable to allow for movement without damage to cable.

C. Installation of electric heating cable for snow and ice melting on roofs, gutters, and roof drain leaders shall be provided with clips furnished by the manufacturer that is compatible.

D. Electric heating cable for pipe freeze protection shall be installed according to the following:
   1. Electric heating cables shall be installed after piping has been tested and before insulation is installed.
   2. Electric heat cables shall be installed according to IEEE 515.1.
   3. Insulation shall be installed or applied over piping with electric cables.
   4. Warning tape shall be installed on pipe insulation where piping is equipped with electric heating cables.

E. Electric heating cable for domestic hot water temperature maintenance shall be installed according to the following:
   1. Electric heating cables shall be installed after piping has been tested and before insulation is installed.
   2. Insulation shall be installed or applied over piping wit electric cables.
   3. Warning tape shall be installed on pipe insulation where piping is equipped with electric heating cables.

F. Field adjustable switches and circuit breaker trip ranges shall be set.

G. Heating cables including leads shall be protected from damage.

H. Equipment shall be grounded according to Division 26.

I. Wiring shall be connected according to Division 26.

3.2 TESTS

A. Tests shall be performed after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete. Cables shall be tested for electrical continuity and insulation integrity before energizing. Cables shall be tested to verify rating and power input.

B. Cables shall be energized and voltage and current measured simultaneously.

C. Test repeatedly after repairing heating cables with new products.

END OF SECTION

SECTION 22 08 00

COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Plumbing commissioning description.
2. Plumbing commissioning responsibilities.

B. Related Sections:
1. Applicable provisions of Section 22 05 00 – Basic Plumbing Requirements shall govern Work under this Section.
2. Section 22 05 00 – Basic Plumbing Materials and Methods.
3. Division 01 – General Requirements – General Commissioning Requirements.
4. Division 21 – Fire Suppression Systems: Fire suppression systems commissioning requirements.
5. Division 23 – Heating, Ventilating and Air Conditioning: For requirements and procedures concerning testing, adjusting, and balancing of mechanical systems.
6. Division 25 – Integrated Automation: Submittal, training, and programming requirements.
7. Division 26 – Electrical: Electrical systems commissioning requirements.

1.2 REFERENCES

A. Associated Air Balance Council: (AABC)
1. AABC - ACG Commissioning Guideline.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers: (ASHRAE)
1. ASHRAE Guideline 0 - The HVAC Commissioning Process.

C. BCA (Building Commissioning Association) Commissioning Handbook.

D. National Environmental Balancing Bureau: (NEBB)
1. NEBB - Procedural Standards for Building Systems Commissioning.

1.3 COMMISSIONING DESCRIPTION

A. Commissioning:
1. Commissioning is a quality-oriented process for achieving, verifying, and documenting that performance of facilities, systems, and assemblies meet defined objectives and criteria.
2. Commissioning process begins at project inception (during pre-design phase) and continues through the life of facility.
3. Commissioning process includes specific tasks to be conducted during each phase in order to verify that design, construction, and training meets Owner’s Project Requirements.

B. Commissioning Team:
1. Members of commissioning team consist of:
a. Commissioning Authority (CxA).

b. Owner's Representative/Construction Manager (CM).
c. General Contractor (GC).
d. Architect and Design Engineers.
e. Plumbing Contractor (PC).
f. Mechanical Contractor (MC).
g. Electrical Contractor (EC).
h. Testing and Balancing (TAB) Contractor.
i. Control Contractor (CC).
j. Facility Operating Staff
k. Other installing subcontractors or suppliers of equipment.

2. CxA directs and coordinates project commissioning activities and reports to Owner.
3. All team members work together to fulfill their contracted responsibilities and meet objectives of the Contract Documents.

C. Plumbing commissioning process includes the following tasks:
1. Testing and startup of plumbing equipment and systems.
2. Equipment and system verification checks.
3. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.
4. Provide qualified personnel to assist in commissioning tests.
5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
7. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.
8. Assist Commissioning Authority to develop, edit, and document system operation descriptions.
9. Provide training for systems specified in this Section with coordination by Commissioning Authority.

D. Equipment and Systems to be Commissioned:
1. Facility water distribution piping.
2. Domestic water pumps.
3. Pressure booster pumping system.
4. Sump pumps.
5. Facility sanitary waste piping.
6. Facility storm drainage piping.
7. General service compressed air system.
8. Domestic water softners.
9. Domestic water filtration equipment.
10. Electric domestic water heaters.
11. Fuel-fired domestic water heaters.
12. Domestic water heat exchangers.
13. Plumbing fixtures.
14. Emergency plumbing fixtures.
15. Drinking fountains and water coolers.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 - General Requirements: Execution and Closeout Submittal Procedures: Shop drawings, product data and samples.

B. Division 01 – General Requirements: Requirements for submittals.

C. Division 01 – General Requirements: Record revisions to equipment and system documentation necessitated by commissioning.

D. Division 01 – General Requirements: Submit revisions to operation and maintenance manuals for necessary revisions discovered during commissioning.

1.5 COMMISSIONING RESPONSIBILITIES

A. Equipment or System Installer Commissioning Responsibilities:
1. Attend commissioning meetings.
2. Ensure temperature controls installer performs assigned commissioning responsibilities as specified below.
3. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified.
4. Provide instructions and demonstrations for Owner's personnel.
5. Ensure subcontractors perform assigned commissioning responsibilities.
6. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
7. Develop startup and initial checkout plan using manufacturer’s startup procedures and functional performance checklists for commissioned equipment and systems.
8. During verification check and startup process, execute plumbing related portions of checklists for commissioned equipment and systems.
9. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
10. Provide manufacturer’s representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and attend for duration to complete tests, adjustments, and problem solving.
11. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
12. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
13. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits used during tests.
14. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan.
15. When deficient or incomplete work is discovered, ensure to take corrective action and re-check until equipment or system is ready for startup.
16. Coordinate work with manufacturer and Commissioning Authority.
17. Perform verification checks and startup on equipment and systems as specified.
18. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
19. Perform operation and maintenance training sessions scheduled by Commissioning Authority.

20. Conduct plumbing system orientation and inspection.

B. Temperature Controls Installer Commissioning Responsibilities:
   1. Attend commissioning meetings.
   2. Review design for ability of systems to be controlled including the following:
      a. Confirm proper hardware requirements exist to perform functional performance testing.
      b. Confirm proper safeties and interlocks are included in design.
      c. Confirm proper sizing of system control valves and actuators and control valve operation will result capacity control identified in Contract Documents.
      d. Confirm proper sizing of system control dampers and actuators and damper operation will result in proper damper positioning.
      e. Confirm sensors selected are within device ranges.
      f. Review sequences of operation and obtain clarification from Engineer.
      g. Indicate delineation of control between packaged controls and building automation system, listing BAS monitor points and BAS adjustable control points.
      h. Provide written sequences of operation for packaged controlled equipment. Equipment manufacturers' stock sequences may be included, when accompanied by additional narrative to reflect Project conditions.
   3. Inspect, check, and confirm proper operation and performance of control hardware and software provided in other plumbing sections.
   4. Inspect check and confirm correct installation and operation of automatic temperature control system input and output device operation through point-to-point checks.
   5. Perform training sessions to instruct Owner's personnel in hardware operation, software operation, programming, and application in accordance with commissioning plan and requirements.
   6. Demonstrate system performance and operation to Commissioning Authority during functional performance tests including each mode of operation.
   7. Provide control system technician to assist during Commissioning Authority verification check and functional performance testing.
   8. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.
   9. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

C. Testing, Adjusting, and Balancing Agency Commissioning Responsibilities:
   1. Attend commissioning meetings.
   2. Participate in verification of testing, adjusting, and balancing report for verification or diagnostic purposes. Repeat sample of 10 percent of measurements contained in testing, adjusting, and balancing report.
   3. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

1.6 COMMISSIONING MEETINGS

A. Division 01 – General Requirements: Requirements for commissioning meetings.

B. Attend initial commissioning meeting and progress commissioning meetings as required by Commissioning Authority.

1.7 SCHEDULING

A. Division 01 – General Requirements: Requirements for scheduling.

B. Prepare schedule indicating anticipated start dates for the following:
1. Piping system pressure testing.
2. Piping system flushing and cleaning.
3. Equipment and system startups.
4. Plumbing system orientation and inspections.
5. Operation and maintenance manual submittals.
6. Training sessions.

C. Schedule tests of equipment and systems during peak design conditions to observe full-load performance.

D. Schedule occupancy sensitive tests of equipment and systems during conditions of both minimum and maximum occupancy or use.

1.8 COORDINATION

A. Division 01 – General Requirements: Requirements for coordination.

B. Notify Commissioning Authority minimum of four (4) weeks in advance of the following:
1. Scheduled equipment and system startups.
2. Scheduled start of testing, adjusting, and balancing work.

C. Coordinate programming of automatic lawn irrigation system with construction and commissioning schedules.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 FUNCTIONAL TESTING

A. Place plumbing systems and equipment into full operation and continue operation during each working day of commissioning.

3.2 COMMISSIONING

A. Seasonal Sensitive Functional Performance Tests:
1. Test domestic water heating equipment at design temperatures.
2. Participate in testing delayed beyond Final Completion to test performance at peak seasonal conditions.

B. Be responsible to participate in initial and alternate peak season test of systems required to demonstrate performance.

C. Occupancy Sensitive Functional Performance Tests:
   1. Test equipment and systems affected by occupancy variations at minimum and peak loads to observe system performance.
   2. Participate in testing delayed beyond Final Completion to test performance with actual occupancy conditions.

3.3 CONSTRUCTION VERIFICATION CHECKLISTS

A. Complete the following construction verification checklists for this project. Submit to CxA for review and approval.
   1. CV-22 05 14: Backflow Preventers.
   2. CV-22 05 14: Trap Primer Valves.
   3. CV-22 07 00: Plumbing Insulation.
   4. CV-22 10 13: Facilities Fuel Piping.
   5. CV-22 11 00: Facilities Water Distribution.
   6. CV-22 13 00: Facilities Sanitary Sewage.
   7. CV-22 14 00: Facilities Storm Drainage.
   8. CV-22 15 13: General Service Compressed Air Piping.
   9. CV-22 30 00: Acid Neutralization Tanks.
   10. CV-22 30 00: Domestic Booster Pumps.
   11. CV-22 30 00: Expansion Tanks.
   12. CV-22 30 00: In-Line Centrifugal Pumps.
   13. CV-22 30 00: Sewage Ejectors.
   14. CV-22 30 00: Storage Tanks.
   15. CV-22 30 00: Sump Pumps.
   16. CV-22 30 00: Electric Water Heaters.
   17. CV-22 30 00: Gas Water Heaters.
   18. CV-22 30 00: Steam Water Heaters.
   19. CV-22 30 00: Water Softeners.
   20. CV-22 42 00: Commercial Plumbing Fixtures.
   21. CV-22 30 00: Electric Water Coolers.
   22. CV-22 50 00: Pool Aquarium and Fountain Piping.
   23. CV-22 60 00: Air Compressors.
   24. CV-22 60 00: Laboratory and Medical Gas and Vacuum Piping.
   25. CV-22 60 00: Refrigerated Air Driers.
   26. CV-22 60 00: Vacuum Pumps.
   27. CV-22 67 00: Laboratory and Medical Process Water Piping.

3.4 FUNCTIONAL PERFORMANCE TESTS

A. Complete the following functional performance tests;
   1. FPT-22 30 00: Domestic Booster Pumps.
   2. FPT-22 30 00: In-Line Centrifugal Pumps.
   3. FPT-22 30 00: Sewage Ejector Pumps.
   4. FPT-22 30 00: Sump Pumps.
   5. FPT-22 30 00: Water Heaters.

END OF SECTION

SECTION 22 11 00

FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Potable water pipe and pipe fittings.

B. Related Sections
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 22 05 00 - Basic Plumbing Materials and Methods.
3. Section 22 05 14 - Plumbing Specialties.
4. Section 22 05 29 - Hangers and Supports for Plumbing.

1.2 REFERENCES

A. American Society of Mechanical Engineers: (ASME)
1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.4 - Cast Iron Threaded Fittings.
3. ASME B16.5 - Pipe Flanges and Flanged Fittings.
4. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
5. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
6. ASME B16.22 - Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
7. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
8. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings – DWV.

B. ASTM International: (ASTM)
1. ASTM A53 – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
2. ASTM A105 - Specification for Forgings, Carbon Steel, for Piping Components.
3. ASTM A126 - Specification for Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
4. ASTM A234 - Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
5. ASTM B32 - Specification for Solder Metal.
6. ASTM B88 - Specification for Seamless Copper Water Tube.
7. ASTM B280 - Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
8. ASTM B813 - Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
9. ASTM D1785 - Specification for Poly Vinyl Chloride (PVC) Plastic Pipe.
10. ASTM D2241 - Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).

11. ASTM D2464 - Specification for Threaded Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
12. ASTM D2466 - Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
13. ASTM D2513 - Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
14. ASTM D2564 - Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
15. ASTM D2657 –Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
16. ASTM D2774 - Practice for Underground Installation of Thermoplastic Pressure Piping.
17. ASTM D2855 – Practice for Making Solvent Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
18. ASTM D3139 - Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
19. ASTM D3222 - Specification for Unmodified Poly Vinylidene Fluoride (PVDF) Molding Extrusion and Coating Materials.
20. ASTM D4101 - Specification for Propylene Plastic Injection and Extrusion Materials.
21. ASTM F437 - Specification for Threaded Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80.
22. ASTM F438 - Specification for Socket Type Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40.
23. ASTM F441 - Specification for Chlorinated Poly Vinyl Chloride (CPVC Plastic Pipe, Schedules 40 and 80.
24. ASTM F493 - Specification for Solvent Cements for Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe and Fittings.
25. ASTM F656 - Specification for Primers for Use in Solvent Cement Joints of Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.

C. American Welding Society: (AWS)
   1. AWS A5.8 - Brazing Filler Metal

D. American Water Works Association: (AWWA)
   1. AWWA C104 - Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water.
   2. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water.
   3. AWWA C110 - Ductile Iron and Gray Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids.
   4. AWWA C111 - Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
   5. AWWA C151 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
   6. AWWA C153 - Ductile Iron Compact Fittings, 3 In. Through 48 In., for Water and Other Liquids.
   7. AWWA C600 - Installation of Ductile Iron Water Mains and Their Appurtenances.
   8. AWWA C651 - Disinfecting Water Mains.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Schedule from Contractor indicating ASTM or AWWA specification number of pipe being proposed along with its type and grade if known at time of submittal, and sufficient information to indicate type and rating of fittings for each service.

C. Statement from manufacturer on his letterhead that pipe furnished meets ASTM OR AWWA specification contained in this section.

1.4 QUALITY ASSURANCE

A. Substitution of Materials: In accordance with Division 01 – General Requirements.

B. Order all copper, cast iron, steel, PVC and polyethylene pipe with each length marked with name or trademark of manufacturer and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and name of supplier.

C. Any installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to insure that material is undamaged and complies with specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade.

C. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so caps remain in place.

D. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

E. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

F. Storage and protection methods must allow inspection to verify products.

1.6 DESIGN CRITERIA

A. Use only new material, free of defects, rust and scale, and meeting latest revision of ASTM or AWWA specifications as listed in this specification.

B. Construct all piping for highest pressures and temperatures in respective system.

C. Non-metallic piping will be acceptable only for services indicated. It will not be acceptable in ventilation plenum spaces, including plenum ceilings.

D. Weld fittings or mechanical grooved fittings shall only use long radius elbows having a centerline radius of 1.5 pipe diameters.

E. Where ASTM A53 type F pipe is specified, grade A, type E or S, or grade B, type E or S may be substituted at Contractor's option. Where grade or type is not specified, Contractor may choose from those commercially available.

F. Where ASTM B88, Type L, H58 drawn temper copper tubing is specified, ASTM B88, Type K, H58 drawn temper copper tubing may be substituted at Contractor's option.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER

A. Above Ground:
1. Type L, copper water tube, H58 drawn temper, ASTM B88; wrought copper pressure fittings, ASME B16.22; lead free, less than 0.2 percent solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BCuP.
2. Wrought copper ANSI B16.22 or cast bronze. ANSI B16.18 fittings, copper tube dimensioned grooved ends, joined with mechanical couplings, synthetic rubber gasket seals, Victaulic Style 606.
3. Copper press fittings, ASTM B16.18 or ASTM B16.22, EPDM O-ring by Viega.

B. Below Ground 2-1/2-Inch and Smaller: Type K copper water tube, O50 (annealed) temper, ASTM B88; with cast copper pressure fittings, ASME B16.18; wrought copper pressure fittings, ASME B16.22; lead free, less than 0.2 percent solder, ASTM B32; flux, ASTM B813; or cast copper flared pressure fittings, ASME B16.26.

C. Below Ground 3-Inch and Larger: Ductile iron pipe, mechanical or push on joint, thickness Class 52, AWWA C151; with standard thickness cement mortar lining, AWWA C104; ductile iron or gray iron mechanical joint cement mortar lined fittings, Class 250, AWWA C110; ductile iron mechanical joint compact fittings, Class 350, AWWA C153; rubber gasket joints with non-toxic gasket lubricant, AWWA C111.
1. Provide 8-mil tube or sheet polyethylene encasement of iron pipe and pipe fittings, AWWA C105.
2. PVC Pressure Pipe: DR 18, Class 150, AWWA C900 and C905; with integral bell and elastomeric gaskets, ASTM D3139. Fittings and fitting polyethylene encasement to be same as noted above for ductile iron.

2.2 DIELECTRIC UNIONS AND FLANGES

A. Dielectric unions 2-inch and smaller; dielectric flanges larger than 2-inch; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets, having a pressure rating of not less than 175 psig at 180 degrees.

B. Manufacturers:
1. Watts Regulator Company.
2. Lochinvar.
3. Wilkins.
4. EPCO Sales, Inc.
5. Or approved equal.

2.3 UNIONS AND FLANGES

A. Unions, flanges, and gasket materials to have a pressure rating of not less than 150 psig at 180 degrees. Gasket material for flanges and flanged fittings shall be teflon type. Treated paper gaskets are not acceptable.

B. 2-Inch and Smaller Steel:
   1. ASTM A197/ASME B16.3 malleable iron unions with brass seats.
   2. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping.

C. 2-Inch and Smaller Copper:
   1. ASME B16.18 cast bronze union coupling or ASME B15.24 Class 150 cast bronze flanges.

D. 2-1/2-Inch and Larger Steel:
   1. ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding neck, or slip-on pattern on black steel and threaded only on galvanized steel.
   2. Use raised face flanges ASME B16.5 for mating with other raised face flanges or equipment with flat ring or full face gaskets.
   3. Use ASME B16.1 flat face flanges with full face teflon gaskets for mating with other flat face flanges on equipment.
   4. Gaskets shall be teflon type.

E. 2-1/2-Inch and Larger Copper:
   1. ASME B15.24 Class 150 cast bronze flanges with full face teflon gaskets.

2.4 MECHANICAL GROOVED PIPE CONNECTIONS

A. Mechanical grooved pipe couplings and fittings, ASTM F1476, may be used with cut groove galvanized steel pipe, cut groove ductile iron pipe or roll groove copper pipe where noted. Mechanical grooved components and assemblies to be rated for minimum 250 psi working pressure.
   1. Manufacturers:
      a. Victaulic.
      b. Gruvlok.
      c. Gustin-Bacon.
      d. Or approved equal.

B. All mechanical grooved pipe material including gaskets, couplings, fittings, and flange adapters to be from same manufacturer.

C. Couplings to be malleable iron, ASTM A47, or ductile iron ASTM A536, with painted finish. Reducing couplings are not acceptable.

D. Fittings used on galvanized steel pipe to be malleable iron, ASTM A47, or ductile iron A536, with galvanized finish, ASTM A153. Fittings used on ductile iron pipe to be cement mortar lined ductile iron with coal tar coating, ASTM A536; conforming to requirements of AWWA C110/C153 and AWWA C606. Fittings used on copper pipe to be copper.

E. Gaskets to be EPDM, ASTM D2000. Gaskets for hot water systems and dry pipe systems to be flush seal design. Heat-treated carbon steel oval neck track bolts and nuts, ASTM A183, with zinc electroplated finish ASTM B633.

PART 3 - EXECUTION

3.1 GENERAL

A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.

3.2 PREPARATION

A. Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

3.3 ERECTION

A. Install piping parallel to building walls and ceilings and at heights not obstructing any portion of a window, doorway, stairway, or passageway.

B. Where interferences develop in field, offset or reroute piping as required to clear such interferences.

C. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances.

D. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

E. Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve covering of elastomeric pipe insulation.

F. Maintain piping in clean condition internally during construction.

G. Provide clearance for installation of insulation, access to valves and piping specialties.

H. Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.

I. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment

J. Install all valves and piping specialties, including items furnished by others, as specified or detailed. Provide access to valves and specialties for maintenance.

K. Make connections to all equipment, fixtures and systems installed by others where same requires piping services indicated in this section.

3.4 PIPE JOINTS

A. Copper Pipe Joints: Comply with following installation requirements.
   1. Remove slivers and burrs remaining from cutting operation by reaming and filing both pipe surfaces.
   2. Clean fitting and tube with metal brush, emery cloth or sandpaper.
   3. Remove residue from cleaning operation, apply flux and assemble joint to socket stop.
   4. Apply flame to fitting until solder melts when placed at joint.
   5. Remove flame and feed solder into joint until full penetration of cup and ring of solder appears.
   6. Wipe excess solder and flux from joint.

B. Threaded Pipe Joints: Comply with following installation requirements.
   1. Use a thread lubricant or teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

C. Mechanical Hubless Pipe Connections**:** Comply with following installation requirements.
   1. Place gasket on end of one pipe or fitting and clamp assembly on end of other pipe or fitting.
   2. Firmly seat pipe or fitting ends against integrally molded shoulder inside neoprene gasket.
   3. Slide clamp assembly into position over gasket.
   4. Tighten fasteners to manufacturers recommended torque.

D. Mechanical Joint Pipe Connections: Comply with following installation requirements.
   1. Comply with AWWA C600 and C605 installation requirements.
   2. Clean pipe end and socket.
   3. Clean and lubricate pipe end, socket and gasket with soapy water or gasket lubricant.
   4. Place gland and gasket, properly oriented, on pipe end.
   5. Insert pipe end fully into socket and press gasket evenly into recess keeping joint straight.
   6. Press gland evenly against gasket, insert bolts and hand tighten nuts.
   7. Make joint deflection prior to tightening bolts.
   8. Evenly tighten bolts in sequence to recommended torque.

E. Push-On Gasketed Pipe Connections: Comply with following installation requirements.
   1. Clean pipe end, bell, gasket seat and gasket of dirt or debris.
   2. Coat end of pipe and gasket with gasket lubricant.
   3. Insure pipe is supported off-ground so lubricant does not pick up dirt.
   4. Push spigot end into gasket bell with levered pipe joining tool recommended by pipe manufacturer.
   5. Large diameter exterior mains may be joined by pushing end of pipe section with backhoe against wood blocking over pipe end.
   6. Insert to fully seated position or to reference mark on pipe.

F. Mechanical Grooved Pipe Connections: Comply with following installation requirements.
   1. Use pipe factory grooved in accordance with coupling manufacturer's specifications or field grooved pipe in accordance with same specifications using specially designed tools specially designed for application.
   2. Lubricate pipe and coupling gasket, align pipe, and secure joint in accordance with coupling manufacturer's specifications.

3.5 DOMESTIC WATER

A. Maintain piping system in clean condition during installation.

B. Remove dirt and debris from assembly of piping as work progresses.

C. Cap open pipe ends where left unattended or subject to contamination.

D. Install exterior water piping below predicted frost level in accordance with authority having jurisdiction, but in no case less than 6-foot bury depth to top of pipe.

E. Maintain minimum of 8-foot horizontal distance between 2-1/2-inch and larger water piping and sanitary sewer piping.

F. Maintain minimum of 30-inch horizontal and 12-inch vertical distance, water on top, between 2-inch and smaller water piping and sanitary sewer piping.

G. Where water piping crosses a sanitary sewer, provide minimum 18-inch vertical clearance and waterproof PVC water pipe sleeve (reference sanitary sewer materials) sealed at both ends for distance of 10 feet from sewer in both directions.

H. Provide thrust restraints for 3-inch and larger exterior water piping joints, hydrants, caps, plugs, fittings and bends of 22-1/2 degrees or more.

I. Field apply continuous anti-corrosion coating to rodded restraint components.

J. Protect mechanical joints, nuts and bolts from concrete cover.

K. Cover with 8-mil sheet or tube polyethylene material sleeve.

L. Install interior water piping with drain valves where indicated and at low points of system to allow complete drainage.

M. Install shutoff valves where indicated and at base of risers to allow isolation of portions of system for repair. Do not install water piping within exterior walls.

N. Prior to use, isolate and fill system with potable water. Allow to stand 24 hours.

O. Flush each outlet proceeding from service entrance to furthest outlet for minimum of one minute and until water appears clear.

P. Fill system with a solution of water and chlorine containing at least 50 parts per million of chlorine and allow to stand for 24 hours. Alternately, a solution containing at least 200 parts per million of chlorine may be used and allowed to stand for 3 hours.

Q. Flush system with potable water until chlorine concentration is no higher than source water level.

R. Wait 24 hours after final flushing. Take samples of water for lab testing.

S. Number and location of samples shall be representative of system size and configuration and are subject to approval by Engineer/Architect.

T. Test shall show absence of coliform bacteria. If test fails, repeat disinfection and testing procedures until no coliform bacteria are detected. Submit test report indicating date and time of test along with test results.

3.6 UNDERGROUND PIPE WRAP

A. Use for steel piping encased in concrete or underground which is not in a conduit.

B. Remove dirt and other foreign material from exterior of pipe.

C. Apply primer as recommended by manufacturer.

D. Use a spiral wrap process for applying tape to pipe.

E. Repair any breaks in tape coating caused by installation process.

3.7 DIELECTRIC UNIONS AND FLANGES

A. Install dielectric unions or flanges at each point where a copper-to-steel pipe connection is required in domestic water systems.

3.8 UNIONS AND FLANGES

A. Install a union or flange at each connection to each piece of equipment and at other items which may require removal for maintenance, repair, or replacement.

B. Where a valve is located at a piece of equipment, locate flange or union connection on equipment side of valve. Concealed unions or flanges are not acceptable.

3.9 PIPING SYSTEM LEAK TESTS

A. Isolate or remove components from system which are not rated for test pressure.

B. Test piping in sections or entire system as required by sequence of construction.

C. Do not insulate or conceal pipe until it has been successfully tested.

D. If required for additional pressure load under test, provide temporary restraints at fittings or expansion joints.

E. Backfill underground water mains prior to testing with exception of thrust restrained valves which may be exposed to isolate potential leaks.

F. For hydrostatic tests, use clean water and remove all air from piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at high point in system.

G. Inspect system for leaks. Where leaks occur, repair area with new materials and repeat test. Caulking will not be acceptable.

H. Testing with air will not be allowed.

System	Medium	Test Pressure	Test Duration
*Below Ground Domestic Water	Water	200 psig	2 hour
Above Ground Domestic Water	Water	150 psig	4 hour
Above Ground Non-potable Water	Water	150 psig	4 hour
Below Ground Non-potable Water	Water	200 psig	2 hour

* Leakage on exterior mains 3-inch and larger may not exceed leakage calculated as follows: GPH Allowable Leakage = (Feet of Pipe) (Inches Dia. of Pipe) $(\text{Test Pressure})^2 = 133{,}200$

I. Below Ground Domestic Water test pressure of 200 psig is required by NFPA 24 for private fire service mains. Small diameter piping not serving hydrants or buildings with fire protection systems may be tested at 150 psig.

END OF SECTION

SECTION 22 13 00

FACILITY SANITARY SEWERAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Sanitary sewer pipe and pipe fittings.

B. Related Sections:
1. Applicable provisions of Division 01 shall govern all work under this Section.
2. Section 22 05 00 – Basic Plumbing Materials and Methods.
3. Section 22 05 14 - Plumbing Specialties.
4. Section 22 05 29 - Hangers and Supports for Plumbing.

1.2 REFERENCES

A. American Society of Mechanical Engineers: (ASME)
1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.4 - Cast Iron Threaded Fittings.
3. ASME B16.5 - Pipe Flanges and Flanged Fittings.
4. ASME B16.22 - Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
5. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings – DWV.

B. ASTM International: (ASTM)
1. ASTM A53 – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
2. ASTM A74 - Specification for Cast Iron Soil Pipe and Fittings.
3. ASTM A105 - Specification for Forgings, Carbon Steel, for Piping Components.
4. ASTM A126 - Specification for Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
5. ASTM A234 - Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
6. ASTM A861 - Specification for High Silicon Iron Pipe and Fittings.
7. ASTM A888 - Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
8. ASTM B32 - Specification for Solder Metal.
9. ASTM B306 - Specification for Copper Drainage Tube (DWV).
10. ASTM B813 - Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
11. ASTM C76 - Specification for Reinforced Concrete Culvert, Storm Drain and Sanitary Pipe.
12. ASTM C564 - Standard Specifications for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
13. ASTM C1540 - Standard Specifications for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
14. ASTM D1785 - Specification for Poly Vinyl Chloride (PVC) Plastic Pipe.

15. ASTM D2241 - Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
16. ASTM D2466 - Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
17. ASTM D2564 - Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
18. ASTM D2665 - Specification for Poly Vinyl Chloride (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.
19. ASTM D2729 - Specification for Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
20. ASTM D2774 - Practice for Underground Installation of Thermoplastic Pressure Piping.
21. ASTM D2855 – Practice for Making Solvent Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
22. ASTM D3034 - Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
23. ASTM D3139 - Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
24. ASTM D3212 - Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
25. ASTM D3222 - Specification for Unmodified Poly Vinylidene Fluoride (PVDF) Molding Extrusion and Coating Materials.
26. ASTM D3311 - Specification for Drain, Waste and Vent (DWV) Plastic Fitting Patterns.

C. American Welding Society: (AWS)
   1. AWS A5.8 - Brazing Filler Metal.

D. Cast Iron Soil Pipe Institute: (CISPI)
   1. CISPI 301 - Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
   2. CISPI 310 - Couplings For Use In Connection With Hubless Cast Iron Soil Pipe And Fittings For Sanitary And Storm Drain, Waste And Vent Piping Applications.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Schedule from Contractor indicating ASTM or CISPI specification number of pipe being proposed along with its type and grade if known at time of submittal, and sufficient information to indicate type and rating of fittings for each service.

C. Statement from manufacturer on his letterhead that pipe furnished meets ASTM or CISPI specification contained in this section.

1.4 QUALITY ASSURANCE

A. Substitution of Materials: In accordance with Division 01 – General Requirements.

B. Order copper, cast iron, steel, PVC and polyethylene pipe with each length marked with name or trademark of manufacturer and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and name of supplier.

C. Any installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to insure that material is undamaged and complies with specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation.

C. Do not store materials directly on grade.

D. Protect pipe, tube, and fitting ends so they are not damaged.

E. Where end caps are provided or specified, take precautions so caps remain in place.

F. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

G. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

H. Storage and protection methods must allow inspection to verify products.

1.6 DESIGN CRITERIA

A. Use only new material, free of defects, rust and scale, and meeting latest revision of ASTM or CISPI specifications as listed in this specification.

B. Construct all piping for highest pressures and temperatures in respective system.

C. Non-metallic piping will be acceptable only for services indicated. It will not be acceptable in ventilation plenum spaces, including plenum ceilings.

D. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.

E. Where ASTM A53, Type F pipe is specified, Grade A, Type E or S, or Grade B, Type E or S may be substituted at Contractor's option. Where grade or type is not specified, Contractor may choose from those commercially available.

F. Where ASTM B88, Type L, H58 drawn temper copper tubing is specified, ASTM B88, Type K, H58 drawn temper copper tubing may be substituted at Contractor's option.

PART 2 - PRODUCTS

2.1 SANITARY WASTE AND VENT

A. Interior Above Ground:

1. Hubless cast iron soil pipe and fittings, ASTM A888; with no-hub couplings, CISPI 310, CISPI 310, ASTM A74.
2. Pipe and fittings shall be marked with collective trademark of Cast Iron Pipe Institute or receive prior approval of Engineer.
3. Type M copper water tube, H (drawn) temper, ASTM B88; with cast copper drainage fittings (DWV), ASME16.23; wrought copper drainage fittings (DWV), ASME16.29; lead free, less than 0.2 percent solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BCuP.
4. PVC Plastic Pipe: Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.
5. Galvanized Steel Pipe: Schedule 40, Type F, Grade A, ASTM A53; with cast iron threaded drainage fittings, ASTM B16.12.

B. Pressurized Interior Above Ground:
1. Type L, Copper water tube, H58 drawn temper, ASTM B88; with cast copper drainage fittings (DWV), ASME B16.23; wrought copper drainage fittings (DWV), ASME 16.29; lead free, less than 0.2 percent solder, ASTM B32; flux, ASTM B813.
2. Galvanized steel pipe, Schedule 40, Type F, Grade A, ASTM A53; with cast iron threaded drainage fittings, ASTM B16.12.

C. Interior Below Ground:
1. Cast iron soil pipe and fittings, hub and spigot, service weight, ASTM A74, with neoprene rubber compression gaskets, ASTM C564, CISPI 301, and CISPI HSN 85.
2. Pipe and fittings shall be marked with collective trademark of Cast Iron Pipe Institute.
3. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

D. Exterior Below Ground 15-Inch and Smaller:
1. Cast iron soil pipe and fittings, CISPI 301, ASTM A74 or ASTM A888 with neoprene rubber compression gaskets, ASTM C564 and CISPI HSN 85. Pipe and fittings shall be marked with collective trademark of Cast Iron Pipe Institute.
2. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.
3. Type PSM PVC sewer pipe and socket fittings, SDR 35, Class 12454-B (PVC 1120), ASTM D3034; primer, ASTM F656; solvent cement, ASTM 2564; or integral bell and flexible elastomeric seal, ASTM D3212.
4. Corrugated PVC pipe and fittings with smooth interior, ASTM F949; gasketed joint, ASTM D3212; elastomeric gasket, ASTM F477.

PART 3 - EXECUTION

3.1 GENERAL

A. Install pipe and fittings in accordance with reference standards, manufacturers' recommendations and recognized industry practices.

3.2 PREPARATION

A. Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

3.3 ERECTION

A. Install piping parallel to building walls and ceilings and at heights not obstructing any portion of a window, doorway, stairway, or passageway.

B. Where interferences develop in field, offset or reroute piping as required to clear such interferences.

C. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances.

D. In all cases, consult Drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

E. Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve of elastomeric pipe insulation.

F. Install underground warning tape 6-12 inches below finished grade above all exterior below ground piping. Where existing underground warning tape is encountered, repair and replace.

G. Maintain piping in clean condition internally during construction.

H. Provide clearance for installation of insulation, access to valves, and piping specialties.

I. Provide anchors, expansion joints, swing joints, or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.

J. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.

K. Install all valves and piping specialties, including items furnished by others, as specified and detailed.

L. Provide access to valves and specialties for maintenance. Make connections to all equipment, fixtures and systems installed by others where same requires piping services indicated in this section.

3.4 PIPE JOINTS

A. Copper Pipe Joints:
   1. Remove slivers and burrs remaining from cutting operation by reaming and filing both pipe surfaces.
   2. Clean fitting and tube with metal brush, emery cloth, or sandpaper.
   3. Remove residue from cleaning operation, apply flux, and assemble joint to socket stop.

4. Apply flame to fitting until solder melts when placed at joint.
5. Remove flame and feed solder into joint until full penetration of cup and ring of solder appears. Wipe excess solder and flux from joint.

B. Welded Pipe Joints:
1. Make welded joints by fusion welding in accordance with ASME Codes, ASMR B31, and state Codes where applicable. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) diameter of main.

C. Threaded Pipe Joints:
1. Use a thread lubricant or teflon tape when making joints. No hard setting pipe thread cement or caulking will be allowed.

D. Solvent Welded Pipe Joints:
1. Install in accordance with ASTM D2855.
2. Saw cut piping square and smooth.
3. Tube cutters may be used if they are fitted with wheels designed for use with PVC/CPVC pipe that do not leave a raised bead on pipe exterior.
4. Support and restrain pipe during cutting to prevent nicks and scratches.
5. Bevel ends 10-15 degrees and deburr interior.
6. Remove dust, drips, moisture, grease, and other superfluous materials from pipe interior and exterior.
7. Check dry fit of pipe and fittings.
8. Reject materials which are out of round or do not fit within close tolerance.
9. Use heavy body solvent cement for large diameter fittings.
10. Maintain pipe, fittings, primer, and cement between 40 and 100 degrees F during application and curing.
11. Apply primer and solvent using separate daubers (3-inch and smaller piping only) or clean natural bristle brushes about 1/2 size of pipe diameter.
12. Apply primer to fitting socket and pipe surface with a scrubbing motion.
13. Check for penetration and reapply as needed to dissolve surface to a depth of 4-5 thousandths.
14. Apply solvent cement to fitting socket and pipe in an amount greater than needed to fill any gap.
15. While both surfaces are wet, insert pipe into socket fitting with a quarter turn to bottom of socket.
16. Solvent cement application and insertion must be completed in less than one minute.
17. Minimum of 2 installers is required on piping 4-inch and larger.
18. Hold joint for 30 seconds or until set.
19. Reference manufacturers' recommendations for initial set time before handling and for full curing time before pressure testing.
20. Cold weather solvent/cement may be utilized only under unusual circumstances and when specifically approved by Engineer/Architect.

3.5 PIPE CONNECTIONS

A. Mechanical Hubless Pipe Connections:
1. Place gasket on end of one pipe or fitting and clamp assembly on end of other pipe or fitting.
2. Firmly seat pipe or fitting ends against integrally molded shoulder inside neoprene gasket.
3. Slide clamp assembly into position over gasket.

4. Tighten fasteners to manufacturers recommended torque.

B. Mechanical Joint Pipe Connections:
1. Comply with AWWA C600/C605 installation requirements.
2. Clean pipe end and socket.
3. Clean and lubricate pipe end, socket and gasket with soapy water or gasket lubricant.
4. Place gland and gasket, properly oriented, on pipe end.
5. Insert pipe end fully into socket and press gasket evenly into recess keeping joint straight.
6. Press gland evenly against gasket, insert bolts and hand tighten nuts.
7. Make joint deflection prior to tightening bolts.
8. Evenly tighten bolts in sequence to recommended torque.

C. Push-On Gasketed Pipe Connections:
1. Clean pipe end, bell, gasket seat and gasket of dirt or debris.
2. Coat end of pipe and gasket with gasket lubricant.
3. Insure pipe is supported off ground so lubricant does not pick up dirt.
4. Push spigot end into gasket bell with levered pipe joining tool recommended by pipe manufacturer.
5. Large diameter exterior mains may be joined by pushing end of pipe section with backhoe against wood blocking over pipe end.
6. Insert to fully seated position or to reference mark on pipe.

D. Mechanical Grooved Pipe Connections:
1. Use pipe factory grooved in accordance with coupling manufacturer's specifications or field grooved pipe in accordance with same specifications using specially designed tools specially designed for application.
2. Lubricate pipe and coupling gasket, align pipe, and secure joint in accordance with coupling manufacturer's specifications.

3.6 MECHANICALLY FORMED TEE FITTINGS

A. Form mechanically extracted collars in a continuous operation, consisting of drilling a pilot hole and drawing out tube surface to form a collar having a height of not less than three times thickness of tube wall.

B. Use an adjustable collaring device. Notch and dimple branch tube.

C. Braze joint with neutral flame oxy-acetylene torch, applying heat properly so that pipe and tee do not distort; remove distorted connections.

3.7 SANITARY WASTE AND VENT

A. Verify invert elevations and building elevations prior to installation.

B. Install exterior piping pitched to drain at indicated elevations and slope.

C. Install interior piping pitched to drain at minimum slope of 1/4-inch per foot where possible and in no case less than 1/8-inch per foot for piping 3-inch and larger.

D. Install exterior piping below predicted frost level and shall maintain not less than 5-foot of bury depth to top of pipe wherever possible.

E. Where piping is located above predicted frost level, provide frost protection as required.

F. Flush piping inlets including floor drains, hub drains, mop basins, and fixtures, with high flow of water at completion of project to demonstrate full flow capacity.

G. Remove blockages and make necessary repairs wherever flow is impeded.

3.8 PIPING SYSTEM LEAK TESTS

A. Isolate or remove components not rated for test pressure from system.

B. Perform final testing for medical and lab gas with all system components in place.

C. Test piping in sections or entire system as required by sequence of construction.

D. Do not insulate or conceal pipe until it has been successfully tested.

E. If required for additional pressure load under test, provide temporary restraints at fittings or expansion joints.

F. Backfill underground water mains prior to testing with exception of thrust restrained valves which may be exposed to isolate potential leaks.

G. For hydrostatic tests, use clean water and remove all air from piping being tested by means of air vents or loosening of flanges and unions.

H. Measure and record test pressure at high point in system.

I. For air or nitrogen tests, gradually increase pressure to not more than one half of test pressure; then increase pressure in steps of approximately one-tenth of test pressure until required test pressure is reached.

J. Examine joints and connections with soap bubble solution or equivalent method. System will not be approved until it can be demonstrated that there is no measurable loss of test pressure during test period.

K. Inspect system for leaks. Where leaks occur, repair area with new materials and repeat test; caulking will not be acceptable.

System	Medium	Test Pressure	Test Duration
Sanitary Waste and Vent	Water	10-foot water	2 hour

END OF SECTION

SECTION 22 14 00

FACILITY STORM DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Plumbing pipe and pipe fittings.

B. Related Sections:
1. Applicable provisions of Division 01 shall govern all work under this Section.
2. Section 22 05 00 – Basic Plumbing Materials and Methods.
3. Section 22 05 14 - Plumbing Specialties.
4. Section 22 05 29 - Hangers and Supports for Plumbing.

1.2 REFERENCES

A. American Society of Mechanical Engineers: (ASME)
1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.4 - Cast Iron Threaded Fittings.
3. ASME B16.5 - Pipe Flanges and Flanged Fittings.
4. ASME B16.22 - Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
5. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings – DWV.

B. American Water Works Association: (AWWA)
1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. AWWA C105- - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings for Water.
4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
6. AWWA C153 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
7. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 Inch - 12 Inch, for Water Distribution.

C. ASTM International: (ASTM)
1. ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
2. ASTM A74 - Specification for Cast Iron Soil Pipe and Fittings.
3. ASTM A105 - Specification for Forgings, Carbon Steel, for Piping Components.
4. ASTM A126 - Specification for Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
5. ASTM A234 - Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
6. ASTM A861 - Specification for High Silicon Iron Pipe and Fittings.
7. ASTM A888 - Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

8. ASTM B32 - Specification for Solder Metal.
9. ASTM B88 - Specification for Seamless Copper Water Tube.
10. ASTM B306 - Specification for Copper Drainage Tube (DWV).
11. ASTM B813 - Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
12. ASTM C76 - Specification for Reinforced Concrete Culvert, Storm Drain and Sanitary Pipe.
13. ASTM C443 - Specification for Joints for Circular Concrete Pipe Sewer and Culvert Pipe Using Rubber Gaskets.
14. ASTM C564 - Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
15. ASTM C1540 - Specification for Heavy Duty Shielded Couplings for Joining Hubless Cast Iron Soil Pipe and Fittings.
16. ASTM D1785 - Specification for Poly Vinyl Chloride (PVC) Plastic Pipe.
17. ASTM D2321 - Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
18. ASTM D2241 - Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
19. ASTM D2464 - Specification for Threaded Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
20. ASTM D2466 - Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
21. ASTM D2513 - Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
22. ASTM D2564 - Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
23. ASTM D2657 - Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
24. ASTM D2665 - Specification for Poly Vinyl Chloride (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.
25. ASTM D2729 - Specification for Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
26. ASTM D2774 - Practice for Underground Installation of Thermoplastic Pressure Piping.
27. ASTM D2855 - Practice for Making Solvent Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
28. ASTM D3034 - Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
29. ASTM D3139 - Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
30. ASTM D3212 - Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
31. ASTM D3311 - Specification for Drain, Waste and Vent (DWV) Plastic Fitting Patterns.
32. ASTM D4101 - Specification for Propylene Plastic Injection and Extrusion Materials.
33. ASTM F405 - Specification for Corrugated Polyethylene (PE) Tubing and Fittings.
34. ASTM F437 - Specification for Threaded Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80.
35. ASTM F438 - Specification for Socket Type Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40.
36. ASTM F441 - Specification for Chlorinated Poly Vinyl Chloride (CPVC Plastic Pipe, Schedules 40 and 80.
37. ASTM F656 - Specification for Primers for Use in Solvent Cement Joints of Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.

D. Cast Iron Soil Pipe Institute: (CISPI)

1. CISPI 301 - Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
2. CISPI 310 - Couplings For Use In Connection With Hubless Cast Iron Soil Pipe And Fittings For Sanitary And Storm Drain, Waste And Vent Piping Applications.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Statement from manufacturer on his letterhead that pipe furnished meets ASTM, AWWA, or CISPI specification contained in this section.

1.4 QUALITY ASSURANCE

A. Substitution of Materials: In accordance with Division 01 – General Requirements.

B. Order copper, cast iron, steel, PVC and polyethylene pipe with each length marked with name or trademark of manufacturer and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and name of supplier.

C. Any installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to insure that the material is undamaged and complies with specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation.

C. Do not store materials directly on grade.

D. Protect pipe, tube, and fitting ends so they are not damaged.

E. Where end caps are provided or specified, take precautions so caps remain in place.

F. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

G. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

H. Storage and protection methods must allow inspection to verify products.

1.6 DESIGN CRITERIA

A. Use only new material, free of defects, rust and scale, and meeting latest revision of ASTM, AWWA, or CISPI specifications as listed in this specification.

B. Construct all piping for highest pressures and temperatures in respective system.

C. Non-metallic piping will be acceptable only for services indicated. It will not be acceptable in ventilation plenum spaces, including plenum ceilings.

D. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.

E. Where ASTM A53, Type F pipe is specified, Grade A, Type E or S, or Grade B, Type E or S may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.

F. Where ASTM B88, Type L, H58 drawn temper copper tubing is specified, ASTM B88, type K, H58 drawn temper copper tubing may be substituted at Contractor's option.

PART 2 - PRODUCTS

2.1 STORM AND CLEARWATER WASTE AND VENT

A. Interior Above Ground:
1. Hubless cast iron soil pipe and fittings, ASTM A888; with no-hub couplings, CISPI 301, CISPI 310, ASTM A74.
2. Pipe and fittings shall be marked with collective trademark of Cast Iron Pipe Institute.
3. Type M, copper water tube, H58 drawn temper, ASTM B88; with cast copper drainage fittings (DWV), ASME B16.23; wrought copper drainage fittings (DWV), ASME B16.29; lead free, less than 0.2 percent solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BCuP.
4. Mechanically formed brazed tee connections may be used in lieu of specified tee fittings for clearwater waste vent branch takeoffs up to one-half (1/2) diameter of main.
5. Copper drainage tube (DWV), ASTM B306; with cast copper drainage fittings (DWV), ASME B16.23; wrought copper drainage fittings (DWV), ASME B16.29; lead free, less than 0.2 percent solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BCuP.
6. Mechanically formed brazed tee connections may be used in lieu of specified tee fittings for clearwater waste vent branch takeoffs up to one-half (1/2) diameter of main.
7. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

B. Interior Below Ground 15-Inch and Smaller:
1. Cast iron soil pipe and fittings, hub and spigot, service weight, CISPI 301, ASTM A74; ASTM A888 with neoprene rubber compression gaskets, ASTM C564 and CISPI HSN 85. Pipe and fittings shall be marked with collective trademark of Cast Iron Pipe Institute.
2. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

C. Exterior Below Ground 15-Inch and Smaller:
1. Cast iron soil pipe and fittings, hub and spigot, service weight, CISPI 301, ASTM A74; ASTM A888 with neoprene compression rubber gaskets, ASTM C564 and CISPI HSN 85. Pipe and fittings shall be marked with collective trademark of Cast Iron Pipe Institute.

2. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM 2564.
3. Type PSM PVC sewer pipe and fittings, SDR 35, Class 12454-B (PVC 1120), ASTM D3034; primer, ASTM F656; solvent cement, ASTM 2564; or integral bell and flexible elastomeric seal, ASTM D3212.
4. Corrugated PVC pipe and fittings with smooth interior, ASTM F949; gasketed joint, ASTM D3212; elastomeric gasket, ASTM F477.
5. Corrugated polyethylene pipe with smooth interior and minimum pipe stiffness of 50 psi, ASTM F-405/ASTM F-667, AASHTO M-252/AASHTO M-294 Type S; PVC gasketed fittings, ASTM F1336; elastomeric gasket, ASTM F477.

D. Exterior Below Ground 12-Inch and Larger:
1. Reinforced concrete culvert, storm drain and sewer pipe, Class III, ASTM C76; rubber gasket joints, ASTM C443; bell and spigot or tongue and groove ends.

2.2 SUBSOIL DRAIN

A. Corrugated polyethylene tubing and fittings, standard tubing, perforated, ASTM F405; with polypropylene fabric filter cover.

B. PVC sewer pipe and fittings, perforated, Class 12454-B (PVC 1120), ASTM D2729; primer, ASTM F656; solvent cement, ASTM 2564; with polypropylene fabric filter cover.

PART 3 - EXECUTION

3.1 GENERAL

A. Install pipe and fittings in accordance with reference standards, manufacturers' recommendations and recognized industry practices.

3.2 PREPARATION

A. Cut pipe ends square. Ream ends of piping to remove burrs.

B. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

3.3 ERECTION

A. Install piping parallel to building walls and ceilings and at heights not obstructing any portion of a window, doorway, stairway, or passageway.

B. Where interferences develop in field, offset or reroute piping as required to clear such interferences.

C. Coordinate locations of plumbing piping with piping, ductwork, conduit, and equipment of other trades to allow sufficient clearances.

D. In all cases, consult Drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

E. Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve of elastomeric pipe insulation.

F. Maintain piping in clean condition internally during construction.

G. Provide clearance for installation of insulation, access to valves and piping specialties.

H. Provide anchors, expansion joints, swing joints, or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.

I. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.

J. Install valves and piping specialties, including items furnished by others, as specified and detailed.

K. Provide access to valves and specialties for maintenance.

L. Make connections to equipment, fixtures, and systems installed by others where same requires piping services indicated in this section.

3.4 PIPE JOINTS

A. Copper Pipe Joints:
1. Remove all slivers and burrs remaining from cutting operation by reaming and filing both pipe surfaces.
2. Clean fitting and tube with metal brush, emery cloth or sandpaper.
3. Remove residue from cleaning operation, apply flux, and assemble joint to socket stop.
4. Apply flame to fitting until solder melts when placed at joint.
5. Remove flame and feed solder into joint until full penetration of cup and ring of solder appears.
6. Wipe excess solder and flux from joint.

B. Threaded Pipe Joints:
1. Use a thread lubricant or teflon tape when making joints.
2. No hard setting pipe thread cement or caulking will be allowed.

C. Solvent Welded Pipe Joints:
1. Install in accordance with ASTM D2855.
2. Saw cut piping square and smooth.
3. Tube cutters may be used if they are fitted with wheels designed for use with PVC/CPVC pipe that do not leave a raised bead on pipe exterior.
4. Support and restrain pipe during cutting to prevent nicks and scratches.
5. Bevel ends 10-15 degrees and deburr interior.
6. Remove dust, drips, moisture, grease, and other superfluous materials from pipe interior and exterior.

7. Check dry fit of pipe and fittings.
8. Reject materials which are out of round or do not fit within close tolerance.
9. Use heavy body solvent cement for large diameter fittings.
10. Maintain pipe, fittings, primer, and cement between 40 and 100 degrees F during application and curing.
11. Apply primer and solvent using separate daubers (3-inch and smaller piping only) or clean natural bristle brushes about 1/2 size of pipe diameter.
12. Apply primer to fitting socket and pipe surface with a scrubbing motion.
13. Check for penetration and reapply as needed to dissolve surface to a depth of 4-5 thousandths.
14. Apply solvent cement to fitting socket and pipe in an amount greater than needed to fill any gap.
15. While both surfaces are wet, insert pipe into socket fitting with a quarter turn to bottom of socket.
16. Solvent cement application and insertion must be completed in less than 1 minute.
17. Minimum of 2 installers is required on piping 4-inch and larger.
18. Hold joint for 30 seconds or until set.
19. Reference manufacturers' recommendations for initial set time before handling and for full curing time before pressure testing.
20. Cold weather solvent and cement may be utilized only under unusual circumstances and when specifically approved by Engineer/Architect.

3.5 PIPE CONNECTIONS

A. Mechanical Hubless Pipe Connections:
1. Place gasket on end of one pipe or fitting and clamp assembly on end of other pipe or fitting.
2. Firmly seat pipe or fitting ends against integrally molded shoulder inside neoprene gasket.
3. Slide clamp assembly into position over gasket.
4. Tighten fasteners to manufacturers recommended torque.

B. Mechanical Joint Pipe Connections:
1. Comply with AWWA C600/C605 installation requirements.
2. Clean pipe end and socket.
3. Clean and lubricate pipe end, socket, and gasket with soapy water or gasket lubricant.
4. Place gland and gasket, properly oriented, on pipe end.
5. Insert pipe end fully into socket and press gasket evenly into recess keeping joint straight.
6. Press gland evenly against gasket, insert bolts, and hand tighten nuts.
7. Make joint deflection prior to tightening bolts.
8. Evenly tighten bolts in sequence to recommended torque.

C. Push-On Gasketed Pipe Connections:
1. Clean pipe end, bell, gasket seat, and gasket of dirt or debris.
2. Coat end of pipe and gasket with gasket lubricant.
3. Insure pipe is supported off ground so lubricant does not pick up dirt.
4. Push spigot end into gasket bell with levered pipe joining tool recommended by pipe manufacturer.
5. Large diameter exterior mains may be joined by pushing end of pipe section with backhoe against wood blocking over pipe end.
6. Insert to fully seated position or to reference mark on pipe.

D. Mechanical Grooved Pipe Connections:
   1. Use pipe factory grooved in accordance with coupling manufacturer's specifications or field grooved pipe in accordance with same specifications using tools specially designed for application.
   2. Lubricate pipe and coupling gasket, align pipe, and secure joint in accordance with coupling manufacturer's specifications.

3.6 MECHANICALLY FORMED TEE FITTINGS

A. Form mechanically extracted collars in a continuous operation, consisting of drilling a pilot hole and drawing out tube surface to form a collar having a height of not less than three times thickness of tube wall.

B. Use an adjustable collaring device. Notch and dimple branch tube.

C. Braze joint with neutral flame oxy-acetylene torch, applying heat properly so that pipe and tee do not distort; remove distorted connections.

3.7 STORM AND CLEARWATER WASTE AND VENT

A. Verify invert elevations and building elevations prior to installation.

B. Install exterior piping pitched to drain at indicated elevations and slope.

C. Install interior piping pitched to drain at minimum slope of 1/8-inch per foot where possible and in no case less than 1/16-inch per foot for piping 3-inch and larger.

D. Install exterior piping below predicted frost level and not less than 5-foot bury depth to top of pipe wherever possible.

E. Where piping is located above predicted frost level, provide frost protection in accordance with local building code requirements.

3.8 SUBSOIL DRAIN

A. Verify invert elevations and building elevations prior to installation.

B. Install piping sloped to drain to locations indicated.

C. Where subsoil drains are required to penetrate foundation work, sleeve subsoil drains or use non-perforated sections of piping and place prior to foundation work.

D. Secure joints and piping where corrugated polyethylene is used to prevent movement during laying and backfill.

E. Route piping in straight lines. Plug dead ends of pipe with pipe caps or concrete plugs.

F. Extend filter fabric cover over all piping and fittings with fabric cover joints overlapping and banded.

G. Bed piping on and backfill around subsoil drains with clear draining stone material to a level 12 inches above or as indicated.

3.9 PIPING SYSTEM LEAK TESTS

A. Isolate or remove components not rated for test pressure from system.

B. Perform final testing for medical and lab gas with all system components in place.

C. Test piping in sections or entire system as required by sequence of construction.

D. Do not insulate or conceal pipe until it has been successfully tested.

E. If required for additional pressure load under test, provide temporary restraints at fittings or expansion joints.

F. Backfill underground water mains prior to testing with exception of thrust restrained valves which may be exposed to isolate potential leaks.

G. For hydrostatic tests, use clean water and remove all air from piping being tested by means of air vents or loosening of flanges and unions. Measure and record test pressure at high point in system.

H. For air or nitrogen tests, gradually increase pressure to not more than one half of test pressure; then increase pressure in steps of approximately one-tenth of test pressure until required test pressure is reached.

I. Examine all joints and connections with a soap bubble solution or equivalent method.

J. System will not be approved until it can be demonstrated that there is no measurable loss of test pressure during test period.

K. Inspect system for leaks. Where leaks occur, repair area with new materials and repeat test. Caulking will not be acceptable.

System	Medium	Test Pressure	Test Duration
Clearwater Waste and Vent	Water	10' water	2 hours
Storm and Clearwater Waste	Water	10' water	2 hours

END OF SECTION

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SECTION 22 42 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Plumbing fixtures.
2. Faucets.
3. Trim.

B. Related Sections:
1. Applicable provisions of Division 01 shall govern all work under this Section.
2. Section 22 05 00 – Basic Plumbing Materials and Methods.
3. Section 22 05 14 - Plumbing Specialties.
4. Section 22 05 29 – Hangers and Supports for Plumbing.
5. Section 22 11 00 - Facility Water Distribution.
6. Section 22 13 00 - Facility Sanitary Sewerage.
7. Section 22 14 00 - Facility Storm Drainage.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute: (ARI)
1. ARI-1010-94 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.

B. American National Standards Institute: (ANSI)
1. ANSI Z124.1 - Plastic Bathtub Units.
2. ANSI Z124.2 - Plastic Shower Receptors and Shower Stalls.

C. American Society of Mechanical Engineers: (ASME)
1. ASME A112.6.1M - Supports for Off Floor Plumbing Fixtures for Public Use.
2. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
3. ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures.
4. ASME A112.19.2M - Vitreous China Plumbing Fixtures.
5. ASME A112.19.5 - Trim for Water Closet Bowls, Tanks and Urinals.

D. American Society of Safety Engineers: (ASSE)
1. ASSE 1011-93 - Hose Connection Vacuum Breakers.
2. ASSE 1014-90 - Handheld Showers.
3. ASSE 1035-93 - Laboratory Faucet Backflow Preventers.

1.3 QUALITY ASSURANCE

A. Substitution of Materials: In accordance with Division 01 – General Requirements.

B. Plumbing products requiring approval by code authority having jurisdiction, must be approved or have pending approval at time of Shop Drawing submission.

1.4 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Submit data concerning sizes, utility sizes, rough in-dimensions, capacities, materials of construction, ratings, weights, trim, finishes, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

1.5 ENERGY EFFICIENCY REQUIREMENTS

A. Plumbing fixtures must meet the following maximum water usage requirements based upon Federal Energy Management Program (FEMP) performance requirements.
1. Lavatory Faucets, flow of 2 gpm or less and .25 gallon per cycle or less (based on inlet pressure of 60 psi).
2. Showerheads, flow of 2.2 gpm or less (based on inlet pressure of 80 psi).
3. Urinal Flush Valves, 1.0 gallon per flush or less.
4. Water Closet Flush Valves, 1.6 gallon per flush or less.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

A. See Fixture Schedule on P-020.

B. Manufacturers: Fixture descriptions establish fixture type, quality, materials, features and size. Products of the following manufacturers determined to be equal by Engineer will be accepted.
1. Water Closets - American Standard, Kohler, and Zurn.
2. Water Closet Seats - Bemis, Beneke, Centoco, and Olsonite Sperzel.
3. Lavatories – American Standard, Kohler, and Zurn.
4. Faucets - Chicago Faucet, Kohler, Speakman, Symmons, T&S Brass, and Zurn.
5. Drains - Chicago Faucet, Engineered Brass Co., Kohler, and McGuire.
6. Stops and Supplies - Chicago Faucet Co., T&S Brass, and McGuire. (Heavy-Duty Type Only)
7. Flush Valves - Coyne & Delany, Sloan Royal, and Zurn AV.
8. Traps - Kohler, McGuire, Dearborn, and Engineered Brass Co. (17-gauge minimum)
9. Carriers and Supports - Josam, Smith, Wade, Watts Drainage, and Zurn.
10. Sinks - American Standard, Elkay, Just, and Kohler.
11. Mop Basins - Fiat, Mustee, and Stern-Williams.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install plumbing fixtures in accordance with manufacturer’s instructions.

B. Set level and plumb. Secure in place to counters, floors and walls providing solid bearing and secure mounting.

C. Bolt fixture carriers to floor and wall. Secure rough-in fixture piping to prevent movement of exposed piping.

D. Install each fixture with trap easily removable for servicing and cleaning. Install fixture stops in readily accessible location for servicing.

E. Install barrier free fixtures in compliance with IBC 1108 and 3408, code authority having jurisdiction and Federal ADA Accessibility Guidelines.

F. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to 27 inches above floor to avoid contact by wheelchair users.

G. Provide unions at water connections to drinking fountains and electric water coolers.

H. Each fixture shall have a stop valve installation to control fixture. Stop valves shall be heavy-duty type with brass stems and screwed or sweat inlet connections. Compression type inlets are not acceptable.

I. Cover pipe penetrations with escutcheons. Exposed traps, stops, piping, and escutcheons to be chrome-plated brass. Same items in concealed locations may be of rough brass finish.

J. Set floor mounted water closets, floor mounted service sinks, counter mounted lavs and sinks; lav and sink faucets and drains with full setting bed of flexible non-staining plumber's putty. Cover exposed water closet bolts with bolt covers.

K. Set mop basins to floor and wall with grout or silicone sealant.

L. Seal openings between walls, floors, and fixtures with mildew-resistant silicone sealant same color as fixture.

M. Test fixtures to demonstrate proper operation. Replace malfunctioning units or components. Adjust valves for intended water flow rate to fixtures without splashing, noise, or overflow. Adjust self-closing lavatory faucets to 15 second cycle. Adjust shower valve temperature limit stops to 110 degrees F maximum outlet temperature.

N. Protect fixtures during construction. At completion, clean plumbing fixtures and trim using manufacturer's recommended cleaning methods and materials.

END OF SECTION

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SECTION 23 05 00

BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Reference Standards.
2. References.
3. Regulatory Requirements.
4. Quality Assurance.
5. Drawings.
6. Protection of Products and Finished Surfaces.
7. Sleeves and Openings.
8. Sealing and Firestopping.
9. Product Substitution Procedures.
10. Submittals.
11. Off Site Storage.
12. Request and Certification for Payment.
13. Certificates and Inspections.
14. Operating and Maintenance Instructions.
15. Training of Owner Personnel.
16. Record Drawings.
17. Manufacturer's Field Services and Reports.
18. Identification.
19. Concrete Work.
20. Cutting and Patching.
21. Building Access.
22. Equipment Access.
23. Coordination.
24. Lubrication.
25. HVAC Painting.

B. Related Sections:
1. Applicable provisions of Section 23 05 00 - Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
2. Section 23 05 13 - Motor Requirements for HVAC Equipment.

1.2 REFERENCE STANDARDS

A. Abbreviations of standards organizations referenced in other sections are as follows:

1.	AABC	Associated Air Balance Council.
2.	ABMA	American Boiler Manufacturers Association.
3.	ADC	Air Diffusion Council.
4.	AGA	American Gas Association.
5.	AMCA	Air Movement and Control Association.
6.	ANSI	American National Standards Institute.

7. ARI Air-Conditioning and Refrigeration Institute.
8. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
9. ASME American Society of Mechanical Engineers.
10. ASTM American Society for Testing and Materials.
11. AWWA American Water Works Association.
12. AWS American Welding Society.
13. CGA Compressed Gas Association.
14. CTI Cooling Tower Institute.
15. EPA Environmental Protection Agency.
16. GAMA Gas Appliance Manufacturers Association.
17. IEEE Institute of Electrical and Electronics Engineers.
18. ISA Instrument Society of America.
19. MCA Mechanical Contractors Association.
20. MICA Midwest Insulation Contractors Association.
21. MSS Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
22. NBS National Bureau of Standards.
23. NEBB National Environmental Balancing Bureau.
24. NEC National Electric Code.
25. NEMA National Electrical Manufacturers Association.
26. NFPA National Fire Protection Association.
27. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Inc.
28. UL Underwriters Laboratories Inc.

1.3 REFERENCES

A. ASTM International
   1. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
   2. ASTM E814 - Test Method for Fire Tests of Through-Penetration Fire Stops.

B. Underwriters Laboratories, Inc. (UL)
   1. UL 1479 - Fire Tests of Through-Penetration Firestops.
   2. UL 723 - Surface Burning Characteristics of Building Materials.

C. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA)
   1. SMACNA – IAQ Guidelines for Occupied Buildings Under Construction.

1.4 REGULATORY REQUIREMENTS

A. Specified systems shall be installed in compliance with federal, state and local codes and regulations.

B. Contractor shall secure and pay for permits, licenses and certificates of inspection applicable to this work.

C. Contractor shall pay taxes applicable to this work.

1.5 QUALITY ASSURANCE

A. Substitution of Materials: In accordance with Division 01 – General Requirements.

B. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated in the Contract Documents, Contractor is responsible for all costs involved in integrating equipment or accessories into system and for obtaining performance from system into which these items are placed. This may include changes found necessary during testing, adjusting, and balancing phase of project.

C. System design is based on manufacturer indicated on drawing schedules. Additional listed manufacturers may be used in base bid provided that this Division of work assumes responsibility for correct size and capacity, space limitations and plumbing, mechanical and electrical deviations. This responsibility also includes any redesign of structure, foundations, utilities, piping, HVAC, wiring or any other part of structural, mechanical, sanitary or electrical work. Cost of redesign, drawings, detailing and accompanying additional costs of items of work shall be paid by this Division of work, and redesign shall be subject to approval of Engineer.

1.6 DRAWINGS

A. Drawings show general arrangement of piping, equipment and appurtenances and shall be followed as close as possible actual building construction and work of other Contractors.

B. Work shall conform to requirements indicated on Drawings. Architectural and structural Drawings shall take precedence.

C. Due to scale of Drawings, it is not possible to indicate all offsets, fittings and accessories that may be required.

D. Investigate architectural and structural conditions affecting work and arrange work accordingly, providing offsets, fittings and accessories as may be required to meet constructed design.

E. HVAC equipment and systems, including piping and ductwork shall also be installed to maintain required operation and maintenance clearances.

F. Work shall conform to requirements indicated on the Drawings

1.7 PROTECTION OF PRODUCTS AND FINISHED SURFACES

A. Division 01 – General Requirements: Protection of finished surfaces.

1.8 SLEEVES AND OPENINGS

A. Division 01 – General Requirements: Sleeves and openings.

1.9 SEALING AND FIRESTOPPING

A. Sealing and firestopping of sleeves/openings between ductwork, piping, and sleeves, structural or partition opening shall be responsibility of Contractor whose work penetrates an opening.

B. Responsible Contractor shall hire individuals skilled in such work, such as sealing and fireproofing. These individuals hired shall normally and routinely be employed in sealing and fireproofing occupation.

1.10 PRODUCT SUBSTITUTION PROCEDURES

A. Division 01 – General Requirements: Product Substitution Procedures.

1.11 SUBMITTALS

A. Division 01 - Submittal Procedures: Requirements for submittals.

B. Submit for equipment and systems as indicated in respective specification sections, marking each submittal with that specification section number.

C. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in Contract Documents.

D. Before submitting electrically powered equipment, verify that electrical power and control requirements for equipment are in agreement with motor starter schedule on electrical Drawings.

E. Contractor shall include statement on Shop Drawing transmittal to Engineer that equipment submitted and motor starter schedule are in agreement or indicate any discrepancies.

F. Include wiring diagrams of electrically powered equipment.

G. Submit sufficient quantities of Shop Drawings to allow the following distribution:
1. Operating and Maintenance Manuals: Three (3) copies.
2. Testing, Adjusting and Balancing Contractor: One (1) copy.
3. Engineer: One (1) copy each.
4. Contractor and Manufacturer: As required.

H. Shop Drawings Submittal Procedures:
1. Incomplete submittals shall not be reviewed and Contractor will be held responsible for correction of work not having final approval.
2. Engineer will review or take other appropriate action on Contractor submittals, such as certified shop drawings, product data, samples and other data, which Contractor is required to submit, but only for limited purpose of checking for conformance with design concept and Contract Documents.
3. This review shall not include review of accuracy or completeness of details, such as quantities, dimensions, capacities, weights or gauges, fabrication processes, construction means or methods, coordination of work with other trades or construction safety precautions, all of which are sole responsibility of Contractor.
4. Engineer’s review will be conducted with reasonable promptness while allowing sufficient time in Engineer’s judgment to permit adequate review.
5. Review of specific items shall not indicate that Engineer has reviewed entire assembly of which said item is a component.
6. Engineer will not be responsible for any deviations from Contract Documents not submitted to Engineer in writing by Contractor.
7. Engineer will not be required to review partial submissions or those for which submissions of correlated items have not been received.
8. Review of certified drawings does not relieve Contractor of responsibility of furnishing and installing all system components, as per drawings and specifications for proper system operation with particular respect to BTU outputs, water and air flow capacities, minimum

noise requirements and space limitations, nor from responsibility for errors or omissions of any sort in submittal drawings.

9. Engineer assumes no responsibility for Contractor calculated dimensions or exact quantities of materials on shop drawings.
10. Reviews by Engineer are subject to limitations of general conditions of the contract for construction.
11. Contractor shall thoroughly check all shop drawings prepared by subcontractors for materials or equipment suppliers with regard to measurements, size of members, materials and details to satisfy specifications and drawings.
12. Each drawing shall have date of approval and signature of Contractor's reviewer.
13. If Contractor's shop drawings have been submitted and reviewed by Engineer for particular product and Engineer has stamped "rejected", "revised and resubmit" or "submit specified items" after two reviews, any further review by Engineer for that particular product will require contractor to compensate Engineer for time spent for further review of that product at rate of One Hundred Fifty Dollars ($150.00) per hour.
14. Furnish approved and corrected shop drawings to all other Contractors whose work is affected.

1.12 OFF SITE STORAGE

A. Prior approval by Owner's Representative is required.

B. Ductwork and metal for making ductwork, duct lining, sleeves, pipe/pipe fittings and similar rough-in material will not be accepted for offsite storage.

C. For pipe material that can be stored off site, no material will be accepted for off-site storage unless Shop Drawings for that material have been approved.

D. Provide off-site storage and protection when site does not permit on-site storage or protection.

E. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

F. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.13 CERTIFICATES AND INSPECTIONS

A. Obtain and pay for Authorities Having Jurisdiction required inspections except those provided by Engineer in accordance with governing building code.

B. Deliver originals of these certificates to Engineer.

C. Include copies of certificates in Operating and Maintenance Manuals.

1.14 OPERATING AND MAINTENANCE MANUALS

A. Division 01 – General Requirements: Operating and Maintenance Data.

1.15 TRAINING OF OWNER PERSONNEL

A. Instruct Owner's personnel in proper operation and maintenance of systems and equipment provided as part of this project.

B. Include not less than 4 hours of instruction, over total of 2 training sessions, using Operating and Maintenance manuals during this instruction.

C. Demonstrate startup and shutdown procedures for all equipment. All training to be during normal working hours.

D. Coordinate with Owner at least two weeks prior to scheduling training sessions.

1.16 RECORD DRAWINGS

A. Division 01 – General Requirements: Record Drawings.

1.17 MANUFACTURERS' FIELD SERVICES AND REPORTS

A. When specified in individual specification Sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance of equipment as applicable, and to initiate instructions when necessary.

B. Submit qualifications of observer to Engineer 30 days in advance of required observations. Observer is subject to approval of Engineer and Owner.

C. Individuals are to report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

D. Submit report in duplicate within (15) fifteen days of observation to Engineer for review.

1.18 WARRANTIES

A. Division 01 – General Requirements: Warranties.

B. Contractor warrants to Owner that all materials and supplies used in Work are free from all liens, claims or encumbrances, and good title to materials and supplies is retained by Contractor and shall be conveyed to Owner on or before date of Substantial Completion.

C. Contractor warrants to Owner that all materials and equipment furnished under Contract will be of good quality and new, unless otherwise required or permitted by Contract Documents, that Work will be free from defects not inherent in quality required or permitted, and that Work will strictly conform with requirements of Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective.

D. Printed, signed copies of Manufacturer's warranties which are required by Contract Documents shall be presented to Architect/Engineer prior to approval of final payment.

E. All warranties, including manufacturer's warranties and Contractor warranties shall take effect on date of Substantial Completion and shall remain in effect for period of one year (1) year thereafter, unless Contract Documents specifically require different warranty period.

F. If any part of Work is declared Substantially Complete by Architect/Engineer, and Owner/Users take possession of that portion of Work before completion of entire Project, warranty for that portion of Work shall continue for period of one (1) year from date of Substantial Completion for that portion of Work, unless Contract Documents specifically require different warranty period.

G. Contractor shall remedy at Contractor's expense, any defect in Work. In addition, Contractor shall remedy at Contractor's expense, any damage to City owned or controlled real or personal property, when damage is result of:
   1. Contractor's failure to conform to Contract Document requirements; or
   2. Any defect in equipment, material, Workmanship or design furnished by Contractor or Subcontractor or supplier, regardless of tier.

H. Contractor shall warrant any Work restored or replaced due to damage caused in fulfilling terms and conditions of this Article, or during performance of any Work required by Contract Documents. Contractor's warranty with respect to Work repaired or replaced will run for one (1) year from date of Substantial Completion of said repair or replacement.

I. Owner or Owner's representative shall notify Contractor, in writing, within reasonable time after discovery of any failure, defect, or damage.

J. If, after receipt of Notice of claim under this warranty, Contractor fails to remedy any failure, defect or damage within time judged reasonable by Architect/Engineer, Owner shall have right to replace, repair, or otherwise remedy failure, defect, or damage, at Contractor's expense.

PART 2 - PRODUCTS

2.1 IDENTIFICATION

A. Stencils: With clean cut symbols and letters of following size:
   1. Up to 2 inch Outside Diameter of Insulation or Pipe: ½ inch high letters.
   2. Equipment: 1-3/4 inch high letters.
   3. Stencil Paint: As specified in Article 9, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

B. Engraved Name Plates: White letters on black background, 1/16-inch thick plastic laminate, beveled edges, screw mounting.
   1. Setonply Style 2060 by Seton Name Plate Company.
   2. Emedolite- Style EIP by EMED Co.
   3. Marking Services.
   4. W. H. Brady.
   5. Equivalent as acceptable to Engineer.

C. Valve Tags: Round brass tags with 1/2-inch numbers, 1/4-inch system identification abbreviation, 1-1/4-inch minimum diameter, with brass jack chains or brass "S" hooks around valve stem.
   1. EMED Co.

2. Seton Name Plate Company.
3. Marking Services.
4. W. H. Brady.
5. Equivalent as acceptable to Engineer.

D. Information Tags:
1. Clear plastic with printed “Danger,” “Caution,” or “Warning” and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.

E. Plastic Tags:
1. Laminated three layer plastic with engraved black letters on white contrasting background color. Tag size minimum 1-1/2 inches diameter.

2.2 NON-RATED PENETRATIONS

A. Pipe Penetrations: At pipe penetrations of non-rated interior partitions, floors, and exterior walls above grade, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required use urethane caulk in annular space between pipe insulation and wall material.

PART 3 - EXECUTION

3.1 CONCRETE WORK

A. Division 03 – Concrete: Contractor shall provide cast-in-place concrete, unless otherwise noted.

B. Provide layout drawings, anchor bolts, metal shapes, and templates to be cast into concrete or used to form concrete for support of mechanical equipment.

3.2 CUTTING AND PATCHING

A. Contractor shall perform cutting and patching of existing general construction as required accommodating new systems.

B. Before cutting or drilling, he must obtain permission from Engineer, and he shall repair any damage to Owner's Representative satisfaction.

C. In event holes must be cut through reinforced concrete, drill carefully so as to avoid spalling and unnecessary damage or weakening of structural members.

D. No chopping or breaking will be permitted.

E. Repair surfaces damaged during installation of new system to complete satisfaction of Owner and Engineer.

F. Do not cut through any building structural members without prior approval from Engineer.

G. Openings in general construction shall be neatly cut with smooth edges and opening shall be made only large enough to accommodate new system.

H. Pipe openings through reinforced concrete construction shall be core drilled.

I. Other openings shall be machine sawed.

J. Breaking or chopping out will not be permitted.

3.3 BUILDING ACCESS

A. Arrange for necessary openings in building to allow for admittance of all apparatus.

B. When building access was not previously arranged and must be provided by this Contractor, restore any opening to its original condition after apparatus has been brought into building.

3.4 EQUIPMENT ACCESS

A. Install piping, conduit, ductwork, and accessories to permit access to equipment for maintenance and service.

B. Coordinate exact location of wall and ceiling access panels and doors with General Contractor, making sure that access is available for all equipment and specialties.

C. Where access is required in plaster walls or ceilings, furnish access doors to General Contractor.

D. Provide color-coded thumb tacks or screws, depending on surface, for use in accessible ceilings which do not require access panels.

3.5 COORDINATION

A. Verify that devices are compatible for surfaces on which they will be used including, but not limited to, diffusers, register, grilles, and recessed or semi-recessed heating and cooling terminal units installed in or on architectural surfaces.

B. Coordinate work with other contractors prior to installation.

C. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at installing contractor's expense.

3.6 IDENTIFICATION

A. Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against dark background.

B. Install identifying devices after completion of coverings and paint.

C. Use primer where necessary for proper paint adhesion.

D. Do not label equipment such as cabinet heaters and ceiling fans in occupied spaces.

E. Where stenciling is not appropriate for equipment identification, engraved nameplates may be used.

F. Identify concealed or exposed piping not less than once every 30 feet including risers and drops, not less than once in each room, adjacent to each access door or panel, and on both side of partition where piping passes through walls, floors, or roofs.
   1. Identify service, pressure and flow direction at each pipe identification location.
   2. Install in clear view and align with axis of pipe.

G. Identify valves with brass tags bearing system identification and valve sequence number. Install tags using corrosion resistant chain, number tags consecutively.

H. Valve tags are not required at terminal device unless valves are greater than ten feet from device or located in another room not visible from terminal unit.

I. Provide typewritten valve schedule indicating valve number and equipment or areas supplied by each valve.
   1. Locate schedules in each mechanical room.
   2. Under clear plastic frame provide in each Operating and Maintenance manual.

J. Use engraved nameplates to identify control equipment, air handling units, pumps, VFD’s, heat transfer equipment, tanks and water treatment devices.
   1. Install nameplates with corrosive resistant mechanical fasteners or adhesive.

K. Small devices such as in-line pumps may be identified with tags.

3.7 LUBRICATION

A. Lubricate bearings with lubricant as instructed by manufacturer before equipment is operated for any reason.

B. Once equipment has been run, maintain lubrication in accordance with manufacturer's instructions until work is accepted by Engineer.

C. Maintain log of lubricants used and frequency of lubrication and include this information in Operating and Maintenance Manuals at completion of project.

3.8 SLEEVES

A. Pipe Sleeves:
   1. Provide galvanized sheet metal sleeves for pipe penetrations through interior and exterior walls to provide a backing for sealant or firestopping.
   2. Patch wall around sleeve to match adjacent wall construction and finish.
   3. Grout area around sleeve in masonry construction.
   4. In finished spaces where pipe penetration through wall is exposed to view, sheet metal sleeve shall be installed flush with face of wall.
   5. Pipe sleeves are not required in interior non-rated drywall, plaster, or wood partitions and sleeves are not required in existing poured concrete walls where penetrations are core drilled.

6. Pipe sleeves in new poured concrete construction shall be schedule 40 steel pipe, sized to allow insulated pipe to run through sleeve, cast in place.
7. Extend top of sleeve one-inch above adjacent floor in piping floor penetrations located in mechanical rooms. In finished areas, sleeves shall be flush with rough floor.
8. For floor pipe penetrations through existing floors in mechanical rooms, core drill opening and provide 1-1/2 x 1-1/2 x 1/8-inch galvanized steel angles fastened to floor surrounding penetration or group of penetrations to prevent water from getting to penetration.
9. Place urethane sealant between angles and floor and fasten angles to floor minimum 8 inches on center.
10. Seal corners water tight with urethane sealant or core drill sleeve opening large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting, non-shrink grout.
11. If pipe penetrating sleeve is supported by pipe clamp resting on sleeve, weld collar or struts to sleeve that will transfer weight to existing floor structure.
12. Pipe sleeves are not required in cored floor pipe penetrations through existing floors that are not located in mechanical rooms.

3.9 SEALING AND FIRESTOPPING

A. Fire and Smoke Rated Penetrations:
   1. Install approved product in accordance with manufacturer's instructions where pipes penetrate fire and smoke rated surface.
   2. Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming.
   3. Firestop mortar alone is not adequate to support any substantial weight.
   4. Reference Division 07 – Firestopping.

B. Non-Rated Partitions:
   1. At interior partitions and exterior walls, pipe penetrations are required to be sealed.
   2. Apply sealant to both sides of penetration in such a manner that annular space between pipe sleeve or cored opening and pipe or insulation is completely blocked.

3.10 PROJECT CLOSEOUT

A. Division 01 – General Requirements: Closeout Procedures:

B. Contractor shall provide the following submittal data prior to final site walk-through review.

C. Closeout Data Submittals:
   1. Record Drawing submission.
   2. Operating and maintenance manuals.
   3. Instructional walk-through and training.
   4. Piping and valve charts.
   5. Inspector’s test reports as follows:
      a. Fire department inspector.
      b. HVAC inspector.
   6. Pipe Pressure test reports as follows:
      a. Gas piping leak test.
      b. Refrigerant leak test.
   7. Closeout statements:

a. Work completion.
b. Warranty statements.
c. Punch list completion.

3.11 HVAC PAINTING

A. Reference Division 09 – Finishes for paint and coating application requirements.

B. All exposed steel support structures including all metal surfaces located inside and outside building, shall be painted after installation with one coat of compatible metal primer coat and two finish coat applications. Color shall be gray unless specified.

C. All exposed piping, including uninsulated piping located inside building, exposed to weather shall be painted after installation with one coat of compatible metal primer and two finish coat applications.

D. Paint piping in accordance with the following color charts:
1. Natural Gas – Yellow

E. Piping systems shall be clearly identified after painting with pipe markings as specified.

END OF SECTION

SECTION 23 05 10

HVAC ELECTRICAL CONNECTIONS AND MOTOR STARTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all starting equipment including push button and pilot light stations, selector switches, motor starters and relays.

B. Furnish components to Electrical Contractor with complete installation instructions and wiring diagrams required for a complete installation.

C. Provide all low voltage wiring (less than 110 volts) required by the HVAC system.

D. Provide complete installation instructions and wiring diagrams for all HVAC equipment requiring electrical wiring.

E. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
2. Section 23 05 13 – Common Motor Requirements for HVAC Equipment.
3. Division 26 – Electrical.

1.2 ABBREVIATIONS

Man. Str.	Manual Starter
Man. Str. W/P.L.	Manual Starter with Pilot Light
Comb. Starter	Combination Magnetic Starter
Mag. Str.	Magnetic Starter
P.E. Sw.	Pneumatic-Electric Switch
E.P. Sw.	Electric-Pneumatic Switch
SAV	Solenoid Air Valve
Stat.	Thermostat
Sel. Sw.	Manual Selector Switch
P.B.-P.L.	Remote Push Button and Pilot Light Station
T.C.	Temperature Control subcontractor
HVAC	Heating, Ventilating & Air Conditioning Contractor
E.C.	Electrical Contractor
Disc. Sw.	Disconnect Switch
M.C.C.	Motor Control Center
O.H.P.	Over Heat Protection
VSD	Variable Speed Drive

1.3 REFERENCES

A. The Institute of Electrical and Electronics Engineers, Inc (IEEE):
   1. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.

B. Association of Electrical and Medical Imaging Equipment Manufacturers (NEMA):
   1. ANSI/NEMA MG-1 – Motors and Generators.
   2. ANSI/NEMA MG1-Part 31 - Application of Induction Motors with Variable Frequency Drives .

C. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories, Inc. (UL).

1.4 ELECTRICAL REQUIREMENTS

A. Line voltage wiring is required to temperature control panel.

1.5 SUBMITTALS

A. Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements: Requirements for submittals.

B. Submit shop drawings for motor starters. Include information with motor starter submittals on identification of motor starters as specified.

C. Motor starter submittals shall indicate starter features and options, auxiliary contactors and installation instructions.

D. For stand alone motors and equipment furnished with motors, include with equipment which motor drives, the following motor information:
   1. Motor manufacturer.
   2. Horsepower.
   3. Voltage,
   4. Phase,
   5. Hertz,
   6. RPM.
   7. Full load efficiency.
   8. Related power factor.
   9. Installation and Maintenance Instructions.

E. Submit wiring diagrams for motor starters and HVAC equipment requiring wiring by Electrical Contractor for this project.

F. Include manufacturer’s instructions in the manuals with specific equipment to which they apply. Also include following information, if not previously documented on shop drawings:
   1. Full load power factor.
   2. Service factor.

3. NEMA design designation.
4. Insulation class.
5. Frame type.

1.6 ELECTRICAL COORDINATION AND GENERAL REQUIREMENTS

A. Starters, overload relay heater coils, disconnect switches and fuses, relays, wire, conduit, push-buttons, pilot lights, and other devices required for control of motors or electrical equipment shall be furnished by HVAC Contractor and turned over for installation by Electrical Contractor, unless stated otherwise.

B. Drawings and specifications show number and horsepower rating of motors furnished by Contractor, together with their actuating devices, if devices are furnished by HVAC Contractor.

C. Discrepancies in size, horsepower rating, electrical characteristics, or means of control be found for motors or other electrical equipment after contracts are awarded, Contractor shall immediately notify Engineer of discrepancy.

D. Costs involved in changes required due to equipment substitutions initiated by Contractor shall be responsibility of Contractor.

E. Electrical Contractor shall provide line voltage power wiring.

F. HVAC Contractor shall be responsible for providing control wiring (line and low voltage) for project, including installation of interlock wiring of line and low voltage motorized automatic dampers in power roof exhaust and supply fans, sidewall centrifugal exhaust fans and propeller exhaust and supply fans to power supply wiring serving respective fan.

G. Furnish project specific wiring diagrams to Electrical Contractor for equipment, starters and devices furnished by Contractor and indicated to be wired by Electrical Contractor.

H. Provide on front enclosure face of starting equipment, selector switches and push-button stations, a securely mounted, laminated plastic engraved name plate which shall identify motorized equipment served by respective starter.

I. Name tags shall be constructed of black and white plastic (black face and white lettering) with 1/4-inch high lettering. Lettering shall identify unit served by plan identification mark (example: “Exhaust Fan EF-1”).

1.7 PRODUCT REQUIREMENTS

A. Motor starters to conform to applicable requirements of NEMA, IEEE, ANSI, and NEC standards and shall be listed by UL for service specified.

B. Flush mounting manual starters, selector switches and push-button stations shall be provided at locations in finished areas. Flush mounting units shall be equivalent to surface mounted type units as specified herein. Flush mounting equipment shall include switch box and flush plate.

PART 2 - PRODUCTS

2.1 MOTOR STARTERS

A. Manufacturers:
1. Models specified are based on Allen-Bradley Starters and Accessories.
2. Equivalent units as manufactured by:
   a. Square D.
   b. General Electric
   c. Cutler Hammer/Westinghouse.
   d. Cerus Industrial.

2.2 MANUAL STARTERS

A. Manual starters shall be two-pole type, compatible for use with single-phase motors and include overload protection, general purpose (NEMA 1) enclosure and toggle operation.

B. Units shall have neon or L.E.D. type pilot lights and “On-Off” or “Hand-Off-Auto” selector switches as specified on plan schedule. In automatic mode, the starter shall be capable of integrating with building automatic control system.

C. Manual Starter Types:
1. Manual starters: Bulletin 600-TAX5 or Cerus Model BAS-1P.
2. Manual starters with pilot light: Bulletin 600-TAX109.
3. Manual starters with “Hand-Off-Auto” selector switch: Bulletin 600-TAX9.
4. Manual starters with “Hand-Off-Auto” selector switch and pilot light: Bulletin 600-TAX142.

PART 3 - EXECUTION

3.1 SCHEDULE

A. Reference Drawings for electrical connection schedule.

3.2 MOTOR STARTER INSTALLATION

A. Motor starting equipment shall be delivered to selected location on job site by Contractor furnishing starters and turned over to installing Contractor.

B. Provide coordination, supervision and instructions to installing Contractor.

C. Motor starting equipment shall be clearly tagged and identified with respect to motor which it serves. Hand marking or “magic-marker” type method is not acceptable.

D. Motor starters shall be installed in strict accordance with manufacturer’s instructions and recommendations.

END OF SECTION

SECTION 23 05 13

MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Three Phase, Single Speed Motors.
2. Single Phase, Single Speed Motors.

B. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
2. Division 26 - Electrical.

1.2 REFERENCES

A. American National Standards Institute (ANSI):
1. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
2. ANSI/NEMA MG-1 - Motors and Generators.
3. ANSI/NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Division 01 – General Requirements and Section 23 05 00 – Basic HVAC Requirements: Requirements for submittals.

B. Include with equipment which motor drives, the following motor information:
1. Motor manufacturer.
2. Horsepower.
3. Voltage.
4. Phase.
5. Hertz.
6. RPM.
7. Full load efficiency.
8. Include project wiring diagrams prepared by Contractor specifically for this work.

1.4 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Include manufacturer’s instructions in manuals with specific equipment to which they apply. Also include the following information if not previously documented on shop drawings:
1. Full Load Power Factor.
2. Service Factor.
3. NEMA Design Designation.
4. Insulation Class.
5. Frame Type.

1.5 ELECTRICAL COORDINATION

A. All starters, overload relay heater coils, control relays, pushbuttons, pilot lights, and other devices required for control of motors or HVAC equipment are furnished by HVAC Contractor and installed by Electrical Contractor, except as specifically noted.

B. Mechanical drawings or specifications show number and horsepower rating of all motors furnished by this Contractor, together with their actuating devices if these devices are furnished by Electrical Contractor.

C. Should discrepancy in size, horsepower rating, electrical characteristics or means of control be found for any motor or other electrical equipment after contracts are awarded, Contractor is to immediately notify Engineer of such discrepancy.

D. Costs involved in any changes required due to equipment substitutions initiated by this Contractor will be responsibility of this Contractor.

E. Electrical Contractor will provide power wiring, except temperature control wiring.

F. Furnish project specific wiring diagrams to Electrical Contractor for equipment and devices furnished by this Contractor and indicated to be wired by Electrical Contractor.

1.6 PRODUCT CRITERIA

A. Motors to conform to applicable requirements of NEMA, IEEE, ANSI, and NEC standards and shall be listed by U.L. for service specified.

B. Select motors for conditions in which they will be required to perform such as general purpose, splashproof, explosion proof, standard duty, high torque or any other special type as required by equipment or motor manufacturer's recommendations.

C. Furnish motors for starting in accordance with utility requirements and compatible with starters as specified.

PART 2 - PRODUCTS

2.1 THREE PHASE, SINGLE SPEED MOTORS

A. Use NEMA rated 200 volt, three phase, 60 hertz motors for motors 1/2 HP and larger unless specifically indicated.

B. Use NEMA General Purpose, Continuous Duty, Design B, Normal Starting Torque, T-frame or U-frame motors with Class B or better insulation unless manufacturer of equipment on which motor is being used has different requirements.

C. Use open drip-proof motors unless totally enclosed fan-cooled, totally enclosed non-ventilated, explosion-proof, or encapsulated motors are specified in equipment sections.

D. Use grease lubricated anti-friction ball bearings with housings equipped with plugged and capped provision for re-lubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours.

E. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

F. Open drip-proof motors to have a 1.15 service factor. Other motor types may have minimum 1.0 service factors.

G. Motors 1 HP and larger, except specially wound motors and inline pump motors 56 frame and smaller, to be high efficiency design with full load efficiencies which meet or exceed values listed below when tested in accordance with NEMA MG 1.

Table 1

Full Load Nominal Motor Efficiency by Motor Size and Speed

(Open Drip-Proof Motors)

MOTOR HP	Nominal Motor Speed 1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	77.0
1-1/2	86.5	86.5	84.0
2	87.5	86.5	85.5
3	88.5	89.5	85.5
5	89.5	89.5	86.5
7-1/2	90.2	91.0	88.5
10	91.7	91.7	89.5

Table 2

Full Load Nominal Motor Efficiency by Motor Size and Speed

(Totally Enclosed Fan-Cooled)

MOTOR HP	Nominal Motor Speed 1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	77.0
1-1/2	87.5	86.5	84.0
2	88.5	86.5	85.5
3	89.5	89.5	86.5
5	89.5	89.5	88.5
7-1/2	91.0	91.7	89.5
10	91.0	91.7	90.2

2.2 SINGLE PHASE, SINGLE SPEED MOTORS

A. Use NEMA rated 115 volt, single phase, 60 hertz motors for motors 1/3 HP and smaller.

B. Use permanent split capacitor or capacitor start, induction run motors equipped with permanently lubricated and sealed ball or sleeve bearings and Class A insulation. Service factor to be not less than 1.35.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount motors on a rigid base designed to accept a motor, using shims if required under each mounting foot to get a secure installation.

B. When motor will be flexible coupled to driven device, mount coupling to shafts in accordance with coupling manufacturer's recommendations.

C. Using a dial indicator, check angular misalignment of two shafts; adjust motor position as necessary so that angular misalignment of shafts does not exceed 0.002 inches per inch diameter of coupling hub.

D. Using dial indicator, check shaft for run-out to assure concentricity of shafts; adjust as necessary so that run-out does not exceed 0.002 inch.

E. When motor will be connected to driven device by means of a belt drive, mount sheaves on appropriate shafts in accordance with manufacturer's instructions.

F. Use a straight edge to check alignment of sheaves; reposition sheaves as necessary so that straight edge contacts both sheave faces squarely.

G. After sheaves are aligned, loosen adjustable motor base so that belt(s) can be added and tighten base so that belt tension is in accordance with drive manufacturer's recommendations.

H. Frequently re-check belt tension and adjust if necessary during first day of operation and again after 80 hours of operation.

I. Verify proper rotation of each three-phase motor as it is being wired or before motor is energized for any reason.

J. Lubricate motors requiring lubrication. Record lubrication material used and frequency of use. Include this information in maintenance manuals.

END OF SECTION

SECTION 23 05 23

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Natural gas system valves.

B. Related Sections:
   1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
   2. Section 23 05 15 - Piping Specialties.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. ASME B16.4 - Gray Iron Threaded Fittings.

B. ASTM International (ASTM):
   1. ASTM A105 - Specification for Carbon Steel Forgings for Piping Applications.
   2. ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   3. ASTM A216 – Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.

C. National Fire Protection Association (NFPA):
   1. NFPA 30 - Flammable and Combustible Liquids Code.

1.3 SUBMITTALS

A. Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements: Requirements for submittals.

B. Contractor shall submit a schedule of valves indicating type of service, dimensions, materials of construction, and pressure/temperature ratings for valves used on project. Temperature ratings specified are for continuous operation.

1.4 DESIGN CRITERIA

A. Where valves are specified for individual mechanical services (such as hot water heating, steam) and valves shall be of same manufacturer unless prior written approval is obtained from Engineer.

PART 2 - PRODUCTS

2.1 NATURAL GAS SYSTEMS

A. Shut Off Valves:

1. 2-Inch and Smaller: Ball valve, bronze body, threaded ends, stainless steel ball, full or conventional port, teflon seat, blowout-proof stem, two-piece construction, suitable for 150 psig working pressure, UL listed for use as natural gas shut-off.
2. Manufacturers:
   a. DeZurik.
   b. Homestead.
   c. Rockwell.
   d. Walworth.
   e. Equivalent as acceptable to Engineer.

B. Gas Pressure Regulators:
1. 2-Inch and Smaller: Cast iron body, aluminum spring and diaphragm, Nitrile diaphragm, threaded ends, 150 psi WOG, -20 to 150 degrees F.

PART 3 - EXECUTION

3.1 GENERAL

A. Properly align piping before installation of valves in an upright position; operators installed below valves will not be accepted.

B. Install valves in strict accordance with valve manufacturer's installation recommendations. Do not support weight of piping system on valve ends.

C. Install valves with stem in upright position.

D. Contractor may install valves with stem in horizontal position only where space limitations do not allow installation in an upright position or where providing large valves with chain wheel operators.

E. Prior to flushing of piping systems, place valves in full-open position.

3.2 SHUT-OFF VALVES

A. Install shut-off valves at equipment, at each branch take-off from mains, and at each automatic valve for isolation or repair.

3.3 GAS PRESSURE REGULATORS

A. When gas pressure regulator is equipped with a vent connection, run a connection size vent to outside air in accordance with codes.

B. Use larger size vent when required by manufacturer's installation instructions.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Structural supports.
2. Pipe hangers and supports.
3. Beam clamps.
4. Concrete inserts.
5. Roof-mounted supports.
6. Equipment curbs.
7. Pipe penetrations through roof.
8. Corrosive atmosphere coatings.

B. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern Work under this Section.

1.2 REFERENCES

A. ASTM International (ASTM):
1. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM B633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
3. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

B. Manufacturers Standardization Society (MSS):
1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
2. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.

1.3 DESCRIPTION

A. Provide supporting devices as required for installation of mechanical equipment and materials.

B. Supports and installation procedures are to conform to latest requirements of ANSI Code for pressure piping.

C. Do not hang any mechanical item directly from a metal deck or run piping so it rests on bottom chord of any truss or joist.

D. Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.

E. Protect insulation at all hanger points.

1.4 SUBMITTALS

A. Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements: Requirements for submittals.

B. Submit schedule of all hanger and support devices indicating shields, attachment methods, and type of device for each pipe size and type of service. Reference Section 23 05 00 – Basic HVAC Requirements.

1.5 DESIGN CRITERIA

A. Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 and SP-69 unless noted otherwise.

B. Piping connected to base mounted pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from equipment, whichever is greater.

C. Standard pipe hangers and supports as specified in this section are required beyond 100 pipe diameter/3 support distance.

D. Standard pipe hangers/supports as specified in this section are required when there are no vibration isolation devices in piping and beyond 100 pipe diameter/3 support distance.

E. Piping supported by laying on bottom chord of joists or trusses will not be accepted.

F. Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.

G. Allow sufficient space between adjacent pipes and ducts for insulation, valve operation, routine maintenance, and the like.

PART 2 - PRODUCTS

2.1 PIPE HANGER AND SUPPORT MANUFACTURERS

A. Manufacturers:
1. B-Line.
2. Fee and Mason.
3. Anvil.
4. Kindorf.
5. Michigan Hanger.
6. Unistrut.
7. Equivalent as acceptable to Engineer.

B. Anvil figure numbers are listed below; equivalent material by other manufacturers is acceptable.

2.2 STRUCTURAL SUPPORTS

A. Provide all supporting steel required for installation of mechanical equipment and materials, whether or not it is specifically indicated or sized, including angles, channels, beams, etc. to suspend or floor support tanks and equipment.

2.3 PIPE HANGERS AND SUPPORTS

A. Hangers for Steel Pipe Sizes 1/2-Inch through 2-Inch:
   1. Carbon steel, adjustable, clevis, black finish.
   2. Provide Anvil Figure 65 or 260.

B. Multiple or Trapeze Hangers:
   1. Steel channels with welded spacers and hanger rods if calculations are submitted.

C. Wall Support:
   1. Welded steel bracket with hanger. B-Line 3068 Series, Anvil 194 Series or equivalent as acceptable to Engineer.
   2. Perforated epoxy painted finish, 16-12-gauge minimum, steel channels securely anchored to wall structure with interlocking, split type, bolt secured, galvanized pipe/tubing clamps.
   3. B-Line Type S channel with B-2000 Series clamps, Anvil Type PS200 H with PS 1200 clamps or equivalent as acceptable to Engineer.
   4. When copper piping is being supported, provide flexible elastomeric / thermoplastic isolation cushion material to completely encircle piping and avoid contact with channel or clamp, B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT Series, Anvil Cushion clamp assembly.

D. Vertical Riser Support:
   1. Carbon steel riser clamp, copper plated when used with copper pipe.
   2. Anvil Figure 261 for steel pipe, Figure CT121 for copper pipe.

E. Steel Hanger Rods:
   1. Threaded both ends, threaded one end, or continuous threaded, black finish.
   2. Size rods for individual hangers and trapeze support as indicated in the following schedule.
   3. Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed limits indicated.

Maximum Load (Lbs.) (650 Degrees F Maximum Temp.)	Rod Diameter (inches)
610	3/8
1130	1/2
1810	5/8
2710	3/4
3770	7/8
4960	1
8000	1-1/4

   4. Provide rods complete with adjusting and lock nuts.

2.4 BEAM CLAMPS

A. MSS SP-69 Type 23 malleable black iron clamp for attachment to beam flange to 0.62 inches thick for single threaded rods of 3/8, 1/2, and 5/8-inch diameter, for use with pipe sizes 4-inch and less. Furnish with a hardened steel cup point set screw. Anvil Figure 86.

B. MSS SP-69 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2-inch diameter but limited in application to pipe sizes 8-inch and less without prior approval. Anvil Figure 228.

2.5 CONCRETE INSERTS

A. Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating.

B. Use drill bit of same manufacturer as anchor; manufacturer: Hilti, Rawl, or Redhead.

2.6 ROOF-MOUNTED SUPPORTS

A. Manufacturers:
1. Custom Curb.
2. Pate.
3. Roof Products and Systems.
4. ThyCurb.
5. Vent Products.
6. Equivalent as acceptable to Engineer.

B. Height of Supports: Based on length of main support member, height of support member above roof deck to be as follows:

Length of Support Member (inches)	Minimum Height of Support Above Deck
Up to 36	18
37 and over	36

C. Supports 18-Inch or Less in Height:
1. Constructed of not less than 18-gauge galvanized steel reinforced so it is structurally capable of supporting intended load with no penetrations through curb flashing, inside and outside corner sections that are mitered and continuously welded, filled with 3 pound density rigid fiberglass insulation, integral deck mounting flange, nominal two inch wood nailer, galvanized steel counterflashing with attached galvanized steel channel track for securing pipe or duct roller and roller support.
2. Do not use built-in metal base flashings or cants.

2.7 EQUIPMENT CURBS

A. Manufacturers:
1. Custom Curb.
2. Pate.

3. Roof Products and Systems.
4. ThyCurb.
5. Vent Products.
6. Equivalent as acceptable to Engineer.

B. Constructed of not less than 18-gauge galvanized steel reinforced so it is structurally capable of supporting intended load with no penetrations through curb flashing, inside and outside corner sections that are mitered and continuously welded, filled with 3 pound density rigid fiberglass insulation, integral deck mounting flange, nominal 2-inch wood nailer, galvanized steel counterflashing.

C. Do not use built-in metal base flashings or cants. Use 18-inch high equipment curbs where curb completely surrounds perimeter of equipment and there is no roof exposed to weather.

2.8 PIPE PENETRATIONS THROUGH ROOF

A. Manufacturers:
1. Custom Curb.
2. Pate.
3. Roof Products and Systems.
4. ThyCurb.
5. Vent Products.
6. Equivalent as acceptable to Engineer.

B. Curb assembly constructed of not less than 18-gauge galvanized steel reinforced so it is structurally capable of supporting intended load, inside and outside corner sections that are mitered and continuously welded, filled with 3 pound density rigid fiberglass insulation, integral deck mounting flange, nominal 2-inch wood nailer, laminated acrylic clad thermoplastic cover with graduated step boots to accommodate various size pipes, fastening screws for cover, and stainless steel clamps for securing boots around pipe.

C. Do not use built-in metal base flashings or cants. Height of curb assembly shall be minimum of 12 inches.

D. A stack flashing penetration may be utilized for single pipe penetrations through built-up roofs and single ply membrane roofs. Utilize high temperature sealant for all high temperature applications. This includes but is not limited to steam condensate vent piping, steam safety relief piping, and flues.

E. A single pre-manufactured boot may be utilized for single pipe penetrations through single ply membrane roofs only.

2.9 CORROSIVE ATMOSPHERE COATINGS

A. Factory coat supports and anchors used in corrosive atmospheres with hot dip galvanizing after fabrication, ASTM A123, 1.5 ounces/square foot of surface, each side.

B. Mechanically galvanize threaded products, ASTM B695 Class 150, 2.0 mil coating.

C. Field cuts and damaged finishes shall be field coated with zinc rich paint of comparable thickness of factory coating.

D. Corrosive atmospheres include the following locations:
   1. Exterior locations.
   2. Parking ramps.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supports to provide for free expansion of piping and duct system.

B. Support piping from structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands.

C. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

D. Coordinate hanger and support installation to properly group piping of all trades.

E. Where piping can be conveniently grouped to allow use of trapeze type supports, use standard structural shapes or continuous insert channels for supporting steel.

F. Perform welding in accordance with standards of American Welding Society.

G. Clean surfaces of loose scale, rust, paint, or other foreign matter and properly align before welding.

H. Use wire brush on welds after welding.

I. Welds shall show uniform section, smoothness of weld metal, and freedom from porosity and clinkers.

J. Where necessary to achieve smooth connections, joints shall be dressed smooth.

3.2 HANGER AND SUPPORT SPACING

A. Place a hanger within 12 inches of each horizontal elbow, valve, strainer, or similar piping specialty item.

B. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

C. Support riser piping independently of connected horizontal piping.

D. Adjust hangers to obtain slope specified in piping section of this specification.

E. Space hangers for pipe as follows:

Pipe Material	Pipe Size (inches)	Maximum Spacing
Steel	1/2 through 1-1/4	6'-6"
Steel	1-1/2 through 6	10'-0"

3.3 VERTICAL RISER CLAMPS

A. Support vertical piping with clamps secured to piping and resting on building structure or secured to building structure below at each floor.

B. Additionally support piping 5-inch and above, of lengths exceeding 30 feet, on base elbows secured to building structure, with flexible supporting hangers provided at top of riser to allow for pipe expansion.

3.4 CONCRETE INSERTS

A. Select size based on manufacturer's stated load capacity and weight of material that will be supported.

3.5 ROOF MOUNTED SUPPORTS

A. Use for all pipe on roof.

B. Secure bottom of support flat on roof deck.

C. Apply two coats of zinc rich paint to cut edges of all galvanized steel elements.

D. Flashing and counter-flashing shall be provided and installed by General Contractor.

3.6 EQUIPMENT CURBS

A. Secure bottom of support flat on roof deck. Secure equipment to curb in accordance with equipment manufacturer's instructions.

B. Flashing and counter-flashing shall be provided and installed by General Contractor.

3.7 PIPE PENETRATION THROUGH ROOF

A. Install at points where pipes penetrate roof.

B. Install as indicated on approved Shop Drawings, as detailed, and according to manufacturer's installation instructions.

C. Flashing and counter-flashing shall be provided and installed by General Contractor.

END OF SECTION

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SECTION 23 07 00
HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulation for heating, ventilating and air conditioning piping, ductwork and equipment.

B. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
3. Section 23 24 00 - Internal-Combustion Engine Piping.
4. Section 23 31 00 - HVAC Ducts and Casings.

1.2 REFERENCES

A. ASTM International (ASTM):
1. ASTM B209 - Specification for Aluminum and Aluminum Alloy Sheet and Plate.
2. ASTM C165 - Test Method for Compressive Properties of Thermal Insulations.
3. ASTM C177 – Test Method for Heat Flux and Thermal Transmission Properties.
4. ASTM C195 - Specification for Mineral Fiber Thermal Insulation Cement.
5. ASTM C240 - Specification for Cellular Glass Insulation Block.
6. ASTM C302 - Test Method for Density of Preformed Pipe Insulation.
7. ASTM C303 - Test Method for Density of Preformed Block Insulation.
8. ASTM C411 – Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
9. ASTM C449 - Specification for Mineral Fiber Hydraulic Setting Thermal Insulation Cement.
10. ASTM C518 - Test Method for Heat Flux and Thermal Transmission Properties.
11. ASTM C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
12. ASTM C534 - Specification for Preformed Flexible Elastomeric Thermal Insulation.
13. ASTM C547 - Specification for Mineral Fiber Preformed Pipe Insulation.
14. ASTM C552 - Specification for Cellular Glass Block and Pipe Thermal Insulation.
15. ASTM C553 - Specification for Mineral Fiber Blanket and Felt Insulation.
16. ASTM C578 - Specification for Preformed, Block Type Cellular Polystyrene Thermal Insulation.
17. ASTM C591 - Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
18. ASTM C610 - Specification for Expanded Perlite Block and Thermal Pipe Insulation.
19. ASTM C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.
20. ASTM C916 - Specification for Adhesives for Duct Thermal Insulation.
21. ASTM C921 – Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
22. ASTM C1071 – Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material.

23. ASTM C1136 - Specification for Flexible Low Permeance Vapor Retarders for Thermal Insulation.
24. ASTM C1338 – Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
25. ASTM D412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
26. ASTM D1000 – Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications.
27. ASTM D1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
28. ASTM D1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics.
29. ASTM D1940 – Method of Test for Porosity of Rigid Cellular Plastics.
30. ASTM D2126 – Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
31. ASTM D2240 – Standard Test Method for Rubber Property-Durometer Hardness.
32. ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.
33. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
34. ASTM E814 – Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
35. ASTM E2336 – Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.
36. ASTM G21 - Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

B. Midwest Insulation Contractors Association (MICA):
   1. MICA - National Commercial & Industrial Insulation Standards.

C. National Fire Protection Association (NFPA):
   1. NFPA 225 - Surface Burning Characteristics of Building Materials.

D. Underwriters Laboratories, Inc. (UL):
   1. UL 723 - Surface Burning Characteristics of Building Materials.

1.3 QUALITY ASSURANCE

A. Substitutions: In accordance with Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements.

B. Label insulating products delivered to construction site with manufacturer's name and description of materials.

1.4 DESCRIPTION

A. Furnish and install insulating materials and accessories as specified or as required for a complete installation. Following types of insulation are specified in this section:
   1. Pipe insulation.
   2. Duct insulation.
   3. Equipment insulation.

B. Install insulation in accordance with latest edition of MICA standard and manufacturer's installation instructions.

C. Exceptions to these standards will only be accepted where specifically modified in these specifications, or where prior written approval has been obtained from Engineer.

1.5 DEFINITIONS

A. Concealed: Shafts, furred spaces, space above finished ceilings, utility tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

B. Exposed to Weather: Ducts located outdoors, either on grade, on a wall, or on a roof, in a location where sun, wind, rain snow, and other elements will come in contact with ductwork.

C. Unconditioned Spaces: Unheated or non-cooled attics, utility tunnels and crawl spaces where ambient temperatures may rise above 90 degrees F, or drop below 50 degrees F. Ducts in these instances are considered to be located outside of building thermal envelope.

1.6 SUBMITTALS

A. Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements: Requirements for submittals.

B. Submit a schedule of all insulating materials to be used on project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material.

C. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions.

D. Duct liner including data on thermal conductivity, air friction correction factor, and limitation on temperature and velocity.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not store insulation materials on grade or where they are at risk of becoming wet. Do not install insulation products that have been exposed to water.

B. Protect installed work with plastic sheeting to prevent water damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials or accessories containing asbestos will not be accepted.

B. Use composite insulation systems, including insulation, jackets, sealants, mastics, and adhesives that have flame spread rating of 25 or less and smoke developed rating of 50 or less, with following exceptions:
   1. Pipe insulation not located in an air plenum may have a flame spread rating not over 25 and a smoke developed rating no higher than 150.

2.2 INSULATION TYPES

A. Manufacturers:
1. Armacell.
2. Certainteed.
3. Manson.
4. Childers.
5. Dow.
6. Extol.
7. Fibrex.
8. H.B. Fuller.
9. Imcoa.
10. Johns Manville.
11. Knauf.
12. Owens-Corning.
13. Partek.
14. Pittsburgh Corning.
15. Rubatex.
16. Equivalent as acceptable to Engineer.

B. Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.

C. Flexible Fiberglass Insulation:
1. Minimum nominal density of 1.5 lbs. per cu. ft., and thermal conductivity of not more than 0.3 at 75 degrees F, rated for service to 250 degrees F.

D. Rigid Fiberglass Insulation:
1. Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F, minimum compressive strength of 25 psf at 10 percent deformation, rated for service to 450 degrees F.

E. Calcium Silicate Insulation:
1. Rigid hydrous calcium silicate, ASTM C533, Type II, minimum dry density of 12.5 lbs. per cu. ft., thermal conductivity of not more than 0.44 at 300 degrees F, maximum water absorption of 90 percent by volume, minimum compressive strength 140 psi at 5 percent deformation, rated for service range of 0 degrees F to 1,800 degrees F.
2. Material to be visually coded or marked to indicate it is asbestos free.

F. Elastomeric Insulation:
1. Flexible closed cell, minimum nominal density of 5.5 lbs. per cu. ft., thermal conductivity of not more than 0.27 at 75 degrees F, minimum compressive strength of 4.5 psi at 25 percent deformation, maximum water vapor permeability of 0.17 perm inch, maximum water absorption of 6 percent by weight, rated for service range of -20 degrees F to 220 degrees F on piping and 180 degrees F where adhered to equipment.

G. Polyolefin Insulation:
1. Flexible closed cell, minimum nominal density of 1.5 lbs. per cu. ft., thermal conductivity of not more than 0.24 at 75 degrees F, minimum compressive strength of 5 psi at 25 percent deformation, maximum water vapor permeability of 0.0 perm inch, maximum water

absorption of 0 percent by weight and volume, rated for service range of -165 degrees F to 210 degrees F.

H. Fireproofing Insulation:
1. Mineral fiber with nominal density of 8 lbs. per cu. ft., flame spread index of 25, fuel contribution index of 0, and smoke developed index of 0, thermal conductivity of not more than 0.23 at 75 degrees F, rated for service of -120 degrees F to 1200 degrees F.
2. Use rigid or semi-rigid board for duct insulations.
3. Foil-scrim-polyethylene vapor barrier jacket, factory applied to insulation, maximum permeance of 0.02 perms.

2.3 JACKETS

A. Foil Scrim All Service Jackets (FSJ):
1. Glass fiber reinforced foil kraft laminate, factory applied to insulation. Maximum permeance of .02 perms and minimum beach puncture resistance of 25 units.

B. Protective Metal Jackets (PMJ):
1. 0.016 inch thick aluminum with safety edge.

2.4 INSULATION INSERTS AND PIPE SHIELDS

A. Manufacturers:
1. B-Line.
2. Pipe Shields.
3. Value Engineered Products.
4. Equivalent as acceptable to Engineer.

B. Construct inserts with calcium silicate, or polyisocyanurate for service temperatures below 300 degrees F only, minimum 140 psi compressive strength.

C. Provide galvanized steel shield.

D. Insert and shield to be minimum 180-degree coverage on bottom supported piping and full 360-degree coverage on clamped piping.

E. On roller mounted piping and piping designed to slide on support, provide additional load distribution steel plate.

F. Where Contractor proposes shop and site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges, and lengths for each pipe size to demonstrate equivalency to pre-engineered/pre-manufactured product described above.

G. Pre-compressed 20 lb. density molded fiberglass blocks, Hamfab or an approved equal, of same thickness as adjacent insulation may be substituted for calcium silicate inserts with one 1 x 6-inch block for piping through 2-1/2-inch and three 1 x6-inch blocks for piping through 4-inch.

H. Submit shield schedule to demonstrate equivalency to pre-engineered/pre-manufactured product described above.

I. Wood blocks shall be prohibited.

2.5 DUCT LINING

A. Manufacturer:
1. Johns Manville - Linatex Series.
2. Owens-Corning - Quiet R.
3. Certainteed - Toughgard.
4. Equivalent as acceptable to Engineer.

B. Make 1-inch thick, 3 lbs./ft.^{3} density flexible, mat faced insulation from inorganic glass fibers bonded with a thermosetting resin with thermal conductivity of 0.25 BTU inch/hour sq.ft. degree F.

C. Meet erosion testing per UL 181 or ASTM C1071 for 5000 fpm maximum air velocity. ASTM C411 maximum operating temperature rating of 250 degrees F. ASTM E84 flame spread less than 25 and smoke developed less than 50.

D. Meet requirements of ASTM C1338 and ASTM G21 for fungi resistance.

E. Install liner using adhesive conforming to ASTM C916.

2.6 ACCESSORIES

A. Products shall be compatible with surfaces and materials on which they are applied, and be suitable for use at operating temperatures of systems to which they are applied.

B. Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.

C. Insulation bands to be 3/4-inch wide, constructed of aluminum or stainless steel. Minimum thickness to be 0.015-inch for aluminum and 0.010-inch for stainless steel.

D. Tack fasteners to be stainless steel ring grooved shank tacks.

E. Staples to be clinch style.

F. Insulating cement to be ASTM C195, hydraulic setting mineral wool.

G. Finishing cement to be ASTM C449.

H. Fibrous glass or canvas fabric reinforcing shall have a minimum untreated weight of 6 oz./sq. yd.

I. Bedding compounds to be non-shrinking and permanently flexible.

J. Vapor barrier coatings and tapes to have maximum applied water vapor permeance of 0.05 perms.

K. Fungicidal water base coating, Foster 40-20 or an approved equal, to be compatible with vapor barrier coating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install insulation, jackets and accessories in accordance with manufacturer's instructions and under ambient temperatures and conditions recommended by manufacturer.

B. Surfaces to be insulated must be clean and dry.

C. Do not insulate systems or equipment specified to be pressure tested or inspected, until testing, inspection, and any necessary repairs have been successfully completed.

D. Install insulation with smooth and even surfaces.

E. Poorly fitted joints or use of filler in voids will not be accepted.

F. Provide neatly beveled and coated terminations at nameplates, un-insulated fittings, or at other locations where insulation terminates.

G. Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2 inches.

H. Use full length material as delivered from manufacturer wherever possible.

I. Scrap piecing of insulation or pieces cut undersize and stretched to fit will not be accepted.

J. Insulation shall be continuous through sleeves and openings except where fire rated penetration materials require interruption of insulation.

K. Maintain vapor barriers continuous through all penetrations.

L. Provide a complete vapor barrier for insulation on following systems:
   1. Refrigerant.
   2. Insulated duct.
   3. Equipment or piping with a surface temperature below 65 degrees F.

3.2 PROTECTIVE JACKET INSTALLATION

A. Protective Metal Jacket (PMJ):
   1. Lap seams a minimum of 2 inches.
   2. Secure with metal bands for end to end joints, and rivets or sheet metal screws for longitudinal joints.
   3. Rivets, screws, and bands to be constructed of the same material as the jacket.
   4. Locate seams on bottom for exterior applications.

3.3 PIPING, VALVE, AND FITTING INSULATION

A. General:
   1. Install insulation with butt joints and longitudinal seams closed tightly.
   2. Provide minimum 2-inch lap on jacket seams and 2-inch tape on butt joints, firmly cemented with lap adhesive.

3. Additionally secure with staples along seams and butt joints.
4. Coat staples and longitudinal and transverse seams with vapor barrier mastic on systems requiring vapor barrier.
5. Install insulation continuous through pipe hangers and supports with hangers and supports on exterior of insulation.
6. Where a vapor barrier is not required or where roller hangers are not being used, hangers and supports may be attached directly to piping with insulation completely covering hanger or support and jacket sealed at support rod penetration.
7. Where riser clamps are required to be attached directly to piping requiring vapor barrier, extend insulation and vapor barrier jacketing/coating around riser clamp.
8. Where insulated piping is installed on hangers and supports, insulation shall be installed continuous through hangers and supports.
9. High density inserts shall be provided as required to prevent weight of piping from crushing insulation.
10. Pipe shields are required at all support locations.
11. Insulation shall not be notched or cut to accommodate supporting channels.

B. Insulated Inserts and Pipe Shields:
1. Provide insulation inserts and pipe shields at all hanger and support locations.
2. Inserts may be omitted on 3/4-inch and smaller copper piping provided 12-inch long 22-gauge pipe shields are used.
3. Provide pipe shields at all hanger and support locations.
4. Rigid insulation inserts shall be installed between pipe and insulation shields.
5. Quantity and placement of inserts shall be according to manufacturer's installation instructions; however, inserts shall be no less than 12 inches in length.
6. Inserts shall be of equal thickness to adjacent insulation and shall be vapor sealed as required for system.

C. Fittings and Valves:
1. Fittings, valves, unions, flanges, couplings and specialties may be insulated with factory molded or built up insulation of same thickness as adjoining insulation.
2. Cover insulation with fabric reinforcing and mastic or where temperatures do not exceed 150 degrees F, with PVC fitting covers.
3. Secure PVC fitting covers with tack fasteners and 1-1/2-inch band of mastic over ends, throat, seams and penetrations.
4. On systems requiring vapor barrier, use vapor barrier mastic.

D. Elastomeric and Polyolefin:
1. Where practical, slip insulation on piping during pipe installation when pipe ends are open.
2. Miter cut fittings allowing sufficient length to prevent stretching.
3. Completely seal seams and joints for vapor tight installation.
4. For elastomeric insulation, apply full bed of adhesive to both surfaces.
5. For polyolefin, seal factory preglued seams with roller and field seams and joints with full bed of hot melt polyolefin glue to both surfaces.
6. Cover elastomeric insulation on systems operating below 40 degrees F with vapor barrier mastic.

E. Pipe Insulation Schedule:
1. Provide insulation on new and existing remodeled piping as indicated in following schedule:

Service	Insulation Types	Jacket	Insulation Thickness in Inches by Pipe Size ≤ 1-1/4"	1-1/2"	2" to ≤ 4"	4" to 6"	8" and larger
Refrigerant	Elastomeric/Polyol	None	1	1-1/2	1-1/2	1-1/2	1-1/2
Cool. Coil Condensate	Rigid Fiberglass	ASJ	1/2	1/2	1	1	1

2. The following piping and fittings are not to be insulated:
   a. Piping unions for systems not requiring a vapor barrier.

3.4 DUCT INSULATION

A. General:
1. Secure flexible duct insulation on sides and bottom of ductwork over 24-inch wide and all rigid duct insulation with weld pins or speed clips.
2. Space fasteners 18-inches on center or less as required to prevent sagging for flexible duct insulation.
3. Space fasteners not less than 3 inches from edge or corner and 12 inches on center or less for rigid duct insulation.
4. Install weld pins without damage to interior galvanized surface of duct.
5. Clip pins back to washer and cover penetrations with tape of same material as jacket.
6. Firmly butt seams and joints and cover with 4-inch tape of same material as jacket.
7. Seal tape with plastic applicator and secure with staples.
8. Joints, seams, edges and penetrations shall be fully vapor sealed.
9. Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation or jacket material.
10. External supply duct insulation is not required where ductwork contains continuous 1-inch acoustical liner.
11. Provide 4-inch overlap of external insulation over ends of acoustically lined sections.
12. Where insulated ductwork is supported by trapeze hangers, insulation shall be installed continuous through the hangers. Drop support channels required to facilitate installation of insulation. Where rigid board or flexible insulation is specified, install high density inserts to prevent weight of ductwork from crushing insulation.
13. Where insulated duct risers are supported by steel channels secured directly to the duct, extend insulation and vapor barrier jacketing to encapsulate support channels.

B. Duct Insulation Schedule:
1. Provide duct insulation on ductwork in following schedule:

Service	Insulation Type	Jacket	Thickness (Inches)
Outside air ducts	Rigid Fiberglass	FSJ	2
Concealed supply ducts	Flexible Fiberglass	FSJ	1-1/2
Exhaust and relief ducts downstream of motorized backdraft dampers	Rigid Fiberglass	FSJ	2

3.5 DUCT LINING

A. Apply lining to the following ductwork:
   1. Return air ducts within 20 feet of air handling unit connection.
   2. Transfer air ducts.

B. Do not apply lining to the following ductwork:
   1. Outside air ductwork.

C. Install liner in compliance with latest edition of NAIMA's Fibrous Glass Duct Liner Standard. Locate longitudinal joints at corners of duct only.

D. Cut and fit to assure lapped, compressed joints. Coat all transverse and longitudinal joints and edges with adhesive.

E. Provide metal nosing on leading edge where lined duct is preceded by unlined duct. Adhere liner to duct with full coverage area of adhesive.

F. Additionally secure liner to duct using mechanical fasteners spaced as recommended by liner manufacturer without compressing liner more than 1/8 inch with fasteners.

G. Duct dimensions indicated on drawings are net dimensions required for air flow. Increase duct sizes to allow for liner thickness.

3.6 EQUIPMENT INSULATION

A. General:
   1. Do not insulate over equipment access manholes, fittings, nameplates, or ASME stamps. Bevel and seal insulation at these locations.

B. Protective Jackets:
   1. Provide a protective metal jacket (PMJ) for the following:
      a. Generator exhaust pipe that is not concealed in a shaft.
      b. Muffler.
   2. Lap seams a minimum of 2 inches.
   3. Secure with metal bands for end-to-end joints, and rivets or sheet metal screws for longitudinal joints.
   4. Rivets, screws, and bands to be constructed of same material as jacket. Locate seams on bottom for exterior applications.

C. Equipment Insulation Schedule:
   1. Provide equipment insulation as follows:

Equipment	Insulation Type	Jacket	Thickness (Inches)
Generator exhaust pipe and muffler	Calcium Silicate/Fireproofing	PMJ	3

END OF SECTION

SECTION 23 09 93

SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes control sequences for HVAC equipment as well as equipment furnished by others that may need monitoring or control. Included are the following control sequences:
   1. General Control.
   2. Exhaust fan control.
   3. Gas-fired heater control.
   4. Electric heat control.

B. Related Sections:
   1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
   2. Division 23 - HVAC - Equipment provided to be controlled or monitored.
   3. Section 26 05 03 – Wiring Connections.
   4. Section 26 05 19 – Building Wire and Cable

1.2 DESCRIPTION OF WORK

A. Control sequences are hereby defined as manner and method by which automatic controls function. Requirements for each type of operation are specified in this section.

B. Operation equipment, devices and system components required for automatic control systems are specified in other Division 23 control sections of these specifications.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL CONTROL

A. Setpoints:
   1. All setpoints indicated in control specification are to be adjustable.
   2. Setpoints shall be readily available to be modified in mechanical system software system summary (textual or graphic based) and under same software level as hardware points.
   3. Some less used setpoints may be provided on lower software level, if requested by user for clarity.
   4. Setpoints indicated are only specified as calculated starting point (or initial system operation). It is expected that setpoint adjustments and control loop tuning shall be required to provide optimum system operation based on requirements of building.

5. Control contractor shall work with balancing contractor and Owner's Representative to provide final system setpoint adjustments and control loop tuning after system is in operation and building is in use.
6. Document all final setpoints on record drawings. Any questions regarding intended operation of HVAC equipment and control systems shall be referred to HVAC design engineer through appropriate construction communication process.
7. The following setpoints should be used as initial setpoints unless otherwise specified in individual control sequences:
   a. Occupied Space Terminal Unit Heating: 70 degrees F
   b. Occupied Space Terminal Unit Cooling: 74 degrees F
   c. Entry Way Heating: 65 degrees F
   d. Mechanical or Unoccupied Space Ventilation: 82 degrees F
   e. Mechanical or Unoccupied Space Heating: 60 degrees F

B. Anti-cycling:
1. When HVAC equipment or sequence is specified to be started and stopped by temperature, humidity, pressure setpoint or any other controlled variable, there shall be adjustable differential setpoint that shall be set to prevent short cycling of systems and equipment due to minor changes in controlled variable.
2. Temperature differential setpoints shall be set at 2 degrees F and non-temperature setpoints shall be set at 10 percent of controlled range unless otherwise specified.
3. Setpoints shall indicate at when process should be turned on.
4. Heating and cooling differentials shall be set for above setpoint and will be used to turn process off.
5. For example, economizer sequence called to switch at 68 degrees F would turn on at 68 degrees F and off at 70 degrees F since it is cooling function.
6. Heating lockout setpoint of 50 degrees F would turn on heating control at 50 degrees F and off at 52 degrees F. Non-temperature differentials shall be set above setpoint if setpoint is indicating a minimum value or below setpoint if setpoint is indicating a maximum value.
7. Provide minimum runtime timers for loads that are cycled to prevent over-cycling.
8. Timers shall be set as specified or as needed to prevent damage or excessive wear to the equipment.
9. Unless otherwise specified in individual control sequences, fans and pumps shall have a minimum runtime on timers of 15 minutes (adjustable) and off timers of 5 minutes (adjustable). Safeties shall override runtime timers.

C. Deadbands:
1. Provide deadbands for all DDC control loops to prevent constant hunting of output signals to controlled devices.
2. Deadbands shall be set to provide adequate control around setpoint as follows unless otherwise specified in individual control sequences:
   a. Temperature Control: ±0.5 degrees F

D. Damper Interlocks for Fans with Starters:
1. For fan systems with magnetic starters and shutoff dampers specified with end switches, damper interlock shall be hardwired in such a way that damper shall open if fan starter Hand / Off / Auto switch is in hand or in auto position and being called to start.
2. After damper end switch has proven damper open, hardwire interlock from end switch to starter holding coil for fan shall cause fan to start.

3. For fan systems that are ducted in parallel, see specific sequence for fan system on interlock requirements.

3.2 FAN CONTROL

A. Toilet Exhaust Fan
   1. Exhaust fan shall be indexed to operate with light switch.
   2. When respective fan motor shall start. When respective light is off, exhaust fan motor shall stop.

B. Tunnel Ventilation Fan
   1. Fan servicing utility tunnel shall operate continuously.

3.3 GAS-FIRED HEATERS CONTROL

A. Gas-Fired Unit Heaters:
   1. For each unit, wire and install electric low voltage 24V room thermostat furnished by unit manufacturer.
   2. Provide all required control wiring for each unit heater as indicated on drawings. Room thermostats shall have 40 degrees F to 80 degrees F range. Provide heavy duty guards for all thermostats.
   3. On drop in space temperature below thermostat setpoint of 60 degrees F (adjustable), thermostat shall cycle unit on.
   4. On rise in space temperature above thermostat set point of 60 degrees F (adjustable), thermostat shall cycle unit off.

3.4 ELECTRIC HEAT CONTROL

A. Electric Wall Heaters:
   1. Electric wall heaters shall be controlled by integral thermostat provided with electric wall heater.

END OF SECTION

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SECTION 23 11 00
FACILITY FUEL PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Natural Gas and Propane Piping.
2. Vent and Relief Valve Piping.
3. Unions and Flanges.
4. Natural Gas Service.

B. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
2. Section 23 05 23 - General-Duty Valves for HVAC Piping.
3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME):
1. ASME 16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.3 - Malleable Iron Threaded Fittings.
3. ASME B16.5 – Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.
4. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings.
5. ASME B31.9 – Building Services Piping.
6. ASME BPVC Section IX - Welding and Brazing Qualifications.

B. ASTM International (ASTM):
1. ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
2. ASTM A105 – Specification for Carbon Steel Forgings for Piping Applications.
3. ASTM A181 – Specification for Carbon Steel Forgings, for General-Purpose Piping.
4. ASTM A197 – Specification for Cupola Malleable Iron.
5. ASTM A234 - Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
6. ASTM D2513 – Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings.

C. Code of Federal Regulations (CFR):
1. 48 CFR 192.285 - Plastic pipe: Qualifying persons to make joints.

D. National Fire Protection Association (NFPA):
1. NFPA 54 – National Fuel Gas Code, latest edition.

1.3 SUBMITTALS

A. Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements: Submittal Procedures: Shop Drawings, product data, and samples.

B. Contractor shall submit schedule indicating ASTM designation of pipe being proposed along with its type and grade and sufficient information to indicate type and rating of fittings for each service.

C. Type “E” or “S” Steel Pipe:
1. Mill certification papers, also known as material test reports, for pipe furnished for this project, in English.
2. Heat numbers on these papers to match heat numbers stenciled on pipe.
3. Chemical analysis indicated on mill certification papers to meet or exceed requirements of referenced ASTM specification.

D. Welder Qualifications:
1. Before any metallic welding is performed, Contractor shall submit his Standard Welding Procedure Specification together with Procedure Qualification Record as required by Section IX of ASME BPVC and National Certified Pipe Welding Bureau.
2. Engineer reserves right to test Work of any welder employed on Project, at Contractor's expense. If Work of welder is unsatisfactory, prevent welder from doing further welding on Project.

1.4 QUALITY ASSURANCE

A. Order Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on size of pipe, and in accordance with appropriate ASTM specification.

B. Contractor must replace any installed material not meeting Specification requirements with material that meets those requirements without additional cost to Owner.

C. All piping, tubing and fittings in a fuel gas system shall bear a manufacturer’s identification.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to insure that material is undamaged and complies with specifications.

B. Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation.

C. Do not store materials directly on grade.

D. Protect pipe, tube, and fitting ends from damage. Take precautions to keep provided or specified end caps in place.

E. Off-site storage agreements will not relieve Contractor from using proper storage techniques.

F. Storage and protection methods must allow inspection to verify products.

1.6 DESIGN CRITERIA

A. Use only new material, free of defects, rust, and scale, and meeting latest revision of ASTM specifications as listed in this Section.

B. Construct piping for highest pressures and temperatures in respective system in accordance with ASME B31.9, but not less than 125 psig unless specifically indicated otherwise.

C. Non-metallic piping will be acceptable only for services indicated. It shall not be acceptable in occupied spaces and ventilation plenum spaces, including plenum ceilings.

D. Where weld fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.

E. Where ASTM A53, Grade A pipe is specified, ASTM A53 Grade B pipe may be substituted at Contractor's option. Where no grade or type is specified, Contractor may choose from those commercially available.

F. Piping systems shall comply with NFPA 54, current edition.

1.7 NATURAL GAS SERVICE

A. Contactor shall pay charges for gas service as shown on Drawings, including connection from main in street or other location to gas meter, setting of gas meter(s), and work performed by gas utility.

PART 2 - PRODUCTS

2.1 NATURAL GAS AND PROPANE PIPING

A. 2-Inch and Smaller:
1. ASTM A53, Type E or S, Standard weight (Schedule 40) black steel pipe with ASTM A197/ASME B16.3 Class 150 black malleable iron threaded fittings or ASTM A234 Grade WPB/ASME B16.9 standard weight, seamless, carbon steel weld fittings.

2.2 VENT AND RELIEF VALVES

A. Use pipe and fittings specified for system to which relief valve or vent is connected.

2.3 UNIONS AND FLANGES

A. 2-Inch and Smaller:
1. ASTM A197/ASME B16.3 malleable iron unions with brass seats.
2. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping.
3. Use unions of pressure class equal to or higher than that specified for fittings of respective piping service but not less than 250 psi.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove foreign material from interior and exterior of pipe and fittings.

3.2 ERECTION

A. Install all piping parallel to building walls and ceilings and at heights not obstructing any portion of a window, doorway, stairway, or passageway.

B. Where interferences develop in field, offset or reroute piping as required to clear such interferences. In all cases, consult Drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

C. Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.

D. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) diameter of main.

E. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.

F. Install valves, and piping specialties, including items furnished by others, as specified and detailed.

G. Make connections to equipment installed by others where that equipment requires piping services indicated in this section.

3.3 WELDED PIPE JOINTS

A. Make welded joints by fusion welding in accordance with ASME B31, and State and local codes where applicable.

B. Electrodes shall be Lincoln, with coating and diameter as recommended by manufacturer for type and thickness of work performed.

3.4 THREADED PIPE JOINTS

A. Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.5 NATURAL GAS PIPING

A. Pitch horizontal piping down 1-inch in 60 feet in direction of flow. Install a 4-inch minimum depth dirt leg at bottom of each vertical run and at each appliance.

B. When installing mains and branches, cap gas tight each tee or pipe end which will not be immediately extended.

C. Branch connections to main shall be from top or side of main.

D. If an above ground vent terminates in an area subject to snow accumulation, terminate line at least five feet above grade.

E. Install a shut off valve at each appliance. Provide a valved connection at main for equipment and appliances furnished by others.

F. Run each gas pressure reducing valve vent and relief valve vent separately to a point outside of building. Terminate with a screened vent cap, and locate according to gas utility regulations.

G. Do not install gas pipe below a building or its foundation.

H. Exposed gas piping (exposed piping outside building) shall be painted after installation with a compatible metal primer coat and a finish coat of gray paint compatible for application. Gas piping shall be clearly identified with pipe markings as specified under Section 22 05 00.

3.6 VENTS AND RELIEF VALVES

A. Install vent and relief valve discharge lines as indicated on Drawings, as detailed, and as specified for each specific valve or piping specialty item.

B. In no event is a termination to occur less than six feet above a roof line.

3.7 UNIONS AND FLANGES

A. Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement.

B. Where a valve is located at a piece of equipment, locate flange or union connection on equipment side of valve. Concealed unions or flanges are not acceptable.

3.8 PIPING SYSTEM LEAK TESTS

A. Verify that piping system being tested is fully connected to components and that equipment is properly installed, wired, and ready for operation.

B. If required, for additional pressure load under test, provide temporary restraints at expansion joints or isolate them during test.

C. Verify that hangers can withstand any additional weight load imposed by test.

D. Provide all piping, fittings, blind flanges, and equipment to perform testing.

E. Conduct pressure test with test medium of air or water unless specifically indicated.

F. Minimum test time is indicated in table below; additional time may be necessary to conduct an examination for leakage. Engineer must witness each test.

G. If leaks are found, repair area with new materials and repeat test. Caulking will not be acceptable.

H. Do not insulate pipe until it has been successfully tested.

I. For air tests, gradually increase pressure to not more than one-half of test pressure; then increase pressure in steps of approximately one-tenth of test pressure until reaching required test pressure.

J. Examine all joints and connections with a soap bubble solution or equivalent method.

K. Piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking.

L. After testing is complete, slowly release pressure in a safe manner. Testing to conform to requirements of NFPA Chapter 54, latest edition.

M. Measure natural gas system test pressure with a water manometer or an equivalent device calibrated in increments not greater than 0.1 inch water column.

N. System will not be approved until demonstrating that there is no measurable loss of test pressure during test period.

O. Instead of a pressure test, suction lines may be tested under a vacuum of not less than 20 inches of mercury maintained for at least one hour.

System	Pressure	Medium	Duration
Natural gas	100 psig	Air	24 hours

P. Document all pressure tests on form included in this specification.

Q. On piping that cannot be tested because of connection to an active line, provide temporary blind flanges and hydrostatically test new section of piping.

R. After completion of test, remove temporary flanges and make final connections to piping.

END OF SECTION

PIPING SYSTEM TEST REPORT

Date Submitted: _____

Project Name: _____

Location: _____ **Project No:** _____

Contractor: _____

□ **HVAC** □ **Refrigeration** □ **Controls**
□ **Power Plant** □ **Plumbing** □ **Sprinkler**

Test Medium: □ **Air** □ **Water** □ **Other** _____

Test performed per Specification Section _____

Specified Test Duration _____ **Hours** **Specified Test Pressure** _____ **PSIG**

System Identification: _____

Describe Location: _____

_____

Test Date: _____

Start Test Time: _____ **Initial Pressure:** _____ **PSIG**

Stop Test Time: _____ **Final Pressure:** _____ **PSIG**

Tested By: _____ **Witnessed By:** _____

Title: _____ **Title:** _____

Signed: _____ **Signed:** _____

Date: _____ **Date:** _____

Comments: _____

_____

_____

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SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Refrigerant Piping.
2. Refrigerant Piping Accessories.

B. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
2. Section 23 05 00 – Basic HVAC Requirements.
3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME):
1. ASME B 16.22 - Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings

B. ASTM International (ASTM):
1. ASTM B88 – Specification for Seamless Copper Water Tube
2. ASTM B280 - Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

C. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
1. ASHRAE 15 - Safety Code for Mechanical Refrigeration

1.3 SUBMITTALS

A. Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements: Requirements for submittals. Shop drawings, product data and samples.

B. Contractor shall submit schedule indicating ASTM designation of proposed pipe along with its type, Grade, and sufficient information to indicate type and rating of fittings for each service.

C. Copper Tube:
1. Statement from manufacturer on his letterhead that pipe furnished meets ASTM specification contained in this section.

1.4 QUALITY ASSURANCE

A. Order copper refrigeration tube with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and name of supplier; with soft straight lengths or coils identified with a tag indicating that product was manufactured in accordance with ASTM B280 and with each hard temper straight length identified throughout its length by a blue colored

marking not less than 3/16 inch in height and a legend at intervals of not greater than three feet that includes designation "ACR" and pipe outside diameter.

B. Any installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to insure that material is undamaged and complies with specifications.

B. Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation.

C. Do not store materials directly on grade.

D. Protect pipe, tube, and fitting ends so they are not damaged.

E. Where end caps are provided or specified, take precautions so caps remain in place. If end caps are not present on tube bearing "ACR" designation, clean and re-cap in accordance with ASTM B280.

F. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

G. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

H. Storage and protection methods must allow inspection to verify products.

1.6 DESIGN CRITERIA

A. Use only new material, free of defects and scale, and meeting latest revision of ASTM specifications as listed in this Section.

B. Where ASTM B88, Type L hard temper copper tubing is specified, ASTM B88, Type K hard temper copper tubing may be substituted at Contractor's option.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING

A. ASTM B88, Type L, hard drawn copper tube, cleaned and capped in accordance with ASTM B280, and marked "ACR", with AS B16.22 wrought copper or forged brass solder-type fittings.

2.2 REFRIGERANT PIPING ACCESSORIES

A. Provide refrigerant piping specialties with a maximum working pressure of full vacuum to 450 psig and a maximum working temperature of 225 degree F.

B. For systems using R-410A, provide all refrigerant piping specialties with a maximum working pressure of full vacuum to 850 psig and a maximum working temperature of 225 degree F.

C. Flexible Pipe Connectors:
   1. Double braided bronze hose flexible pipe connectors with solder end connections.

D. Filter Dryers:
   1. For circuits 15 tons and over provide angle pattern filter dryers with replaceable core. For circuits below 15 tons provide straight pattern filter dryers without replaceable core.

E. Sight Glasses:
   1. Two piece brass construction with solder end connections. Include color indicator for sensing moisture.

F. Solenoid Valves:
   1. Two way normally closed with two piece brass body, full port, stainless steel plug, stainless steel spring, teflon diaphragm and solder end connections. Provide replaceable coil assembly.

G. Hot Gas Bypass Valves:
   1. Provide with integral solenoid valve, external equalizer connection and adjustable pilot assembly.

H. Thermostatic Expansion Valves:
   1. Brass body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.

I. Charging Valves:
   1. Provide 1/4 inch SAE brass male flare access ports with finger tight, quick seal caps. Provide 2-inch long copper extension sections.

J. Check Valves:
   1. Spring loaded type with bronze body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove foreign material from interior and exterior of pipe and fittings.

3.2 ERECTION

A. Install piping parallel to building walls and ceilings and at heights not obstructing any portion of a window, doorway, stairway, or passageway.

B. Where interferences develop in field, offset or reroute piping as required to clear such interferences.

C. Reference drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

D. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.

E. Install valves and piping specialties, including items furnished by others, as specified and detailed.

F. Make connections to equipment installed by others where that equipment requires piping services indicated in this section.

3.3 REFRIGERANT PIPING

A. Refrigeration piping to be installed by firms who are experienced in installation of such piping and in accordance with requirements of State of Wisconsin Code.

B. All brazing filler metals shall have melting temperature above 1400 degrees F and contain minimum of 6 percent silver.

C. Tubing shall be new and delivered to job site with original mill end caps in place. Clean and polish joints before brazing.

D. Avoid prolonged heating and burning during brazing. Purge lines with nitrogen during brazing.

E. Provide manual shut-off and check valves as shown and as required.

F. No refrigerant is to be vented directly to atmosphere except that which may escape through leaks in system during leak testing. During evacuation procedures, use equipment designed to recover and allow recycling of refrigerant.

G. Leak test system by charging system to a pressure of 10 psig with an HFC refrigerant, with compressor suction and discharge valves closed and with other system valves open. Increase pressure to 300 psig with dry nitrogen.

H. Rap all joints with a mallet and check for leaks with an electric leak detector having a certified sensitivity of at least one ounce per year. Seal any leaks that may be found and retest.

I. After completion of leak test, evacuate system with a vacuum pump to an absolute pressure not exceeding 1500 microns while system ambient temperature is above 60 degree F.

J. Break vacuum to 2 psig with refrigerant to be used in system. Repeat evacuation process, again breaking vacuum with refrigerant.

K. Install drier of required size in liquid line, open compressor suction and discharge valves, and evacuate to an absolute pressure not exceeding 500 microns.

L. Leave vacuum pump running for not less than two hours without interruption. Raise system pressure to 2 psig with refrigerant and remove vacuum pump.

M. Charge refrigerant directly from original drums through a combination filter-drier.

N. Each drier may be used for a maximum of three cylinders of refrigerant and then must be replaced with a fresh drier.

O. Charge system by means of a charging fitting in liquid line.

P. Weigh refrigerant drum before charging so that an accurate record can be kept of weight of refrigerant put in system.

Q. If refrigerant is added to system through suction side of compressor, charge in vapor form only.

3.4 REFRIGERANT PIPING ACCESSORIES

A. Install accessories in accordance with manufacturer's written instructions and recommendations.

END OF SECTION

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SECTION 23 24 00

INTERNAL-COMBUSTION ENGINE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Piping for internal combustion engines.

B. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
3. Section 23 07 00 - HVAC Insulation.

1.2 REFERENCES

A. American National Standards Institute (ANSI):
1. ANSI B16.3 - Malleable Iron Threaded Fittings
2. ANSI B16.4 - Cast Iron Threaded Fittings
3. ANSI B16.5 - Pipe Flanges and Flanged Fittings
4. ANSI B16.22 - Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings

B. ASTM International (ASTM):
1. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
2. ASTM A126 - Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
3. ASTM A181 - Forgings, Carbon Steel for General Purpose Piping.
4. ASTM A197 - Cupola Malleable Iron.
5. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
6. ASTM B88 - Seamless Copper Water Tube.

1.3 SHOP DRAWINGS

A. Refer to Division 01 – General Requirements and Section 23 05 00 – Basic HVAC Requirements – Submittal Procedures.

B. Contractor shall submit schedule indicating ASTM specification number of pipe being proposed along with its type and grade and sufficient information to indicate type and rating of fittings for each service.

C. Type F Steel Pipe:
1. Statement from manufacturer on his letterhead that pipe furnished meets ASTM specification contained in this section.

D. Copper Tube:
1. Statement from manufacturer on his letterhead that pipe furnished meets ASTM specification contained in this section.

1.4 QUALITY ASSURANCE

A. Order all copper water tube with each length marked with name or trademark of manufacturer and type of tube; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and name of supplier; all in accordance with ASTM B88.

B. Any installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to insure that material is undamaged and complies with specifications.

B. Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

C. Offsite storage agreements will not relieve contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

1.6 DESIGN CRITERIA

A. Use only new material, free of defects, rust and scale, and meeting latest revision of ASTM specifications as listed in this specification.

B. Construct all piping for highest pressures and temperatures in respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

C. Where weld fittings are used, use only long radius elbows having centerline radius of 1.5 pipe diameters.

D. Where ASTM A53 Type F pipe is specified, ASTM A53 Grade A, Type E or S, or ASTM A53 Grade B, Type E or S may be substituted at Contractor's option. Where ASTM A53 Grade A pipe is specified, ASTM A53 Grade B pipe may be substituted at Contractor's option. Where grade or type is not specified, Contractor may choose from those commercially available.

E. Where ASTM B88, type L hard temper copper tubing is specified, ASTM B88, type K hard temper copper tubing may be substituted at Contractor's option.

1.7 WELDER QUALIFICATIONS

A. Before any metallic welding is performed, Contractor to submit his Standard Welding Procedure Specification together with Procedure Qualification Record as required by Section IX of ASME Boiler and Pressure Vessel Code and/or National Certified Pipe Welding Bureau.

B. Engineer or Owner reserves right to test work of any welder employed on project, at Contractor's expense. If work of welder is found to be unsatisfactory, welder shall be prevented from doing further welding on project.

PART 2 - PRODUCTS

2.1 ENGINE EXHAUST

A. ASTM A53, standard weight, black steel pipe with ASTM A234 Grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

2.2 UNIONS AND FLANGES

A. ASTM A181 or A105, Grade 1 hot forged steel flanges of threaded, welding and of pressure class compatible with that specified for valves, piping specialties and fittings of respective piping service. Flanges smaller than 2-1/2 inches may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove all foreign material from interior and exterior of pipe and fittings.

3.2 ERECTION

A. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of window, doorway, stairway, or passageway. Where interferences develop in field, offset or reroute piping as required clearing such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

B. Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.

C. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.

3.3 WELDED PIPE JOINTS

A. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.

B. Electrodes shall be Lincoln, or equivalent as acceptable to Engineer, with coating and diameter as recommended by manufacturer for type and thickness of work being done.

3.4 ENGINE EXHAUST

A. Install engine exhaust lines where indicated on drawings, including mufflers, flexible connections, and other required exhaust line components furnished with engine. Pitch horizontal piping down and away from muffler to drain point where pipe rises. Install drain valve at this point, on muffler body if it has provision for drain connection, and at all low points in exhaust line where condensate may collect. Drain valves to be accessible without use of ladder.

B. Terminate exhaust piping with vent cap unless specifically detailed.

3.5 GASKETS

A. Store horizontally in cool, dry location and protect from sunlight, water and chemicals. Inspect flange surfaces for warping, radial scoring or heavy tool marks. Inspect fasteners, nuts and washers for burrs or cracks. Replace defective materials.

B. Align flanges parallel and perpendicular with bolt holes centered without using excessive force. Center gasket in opening. Lubricate fastener threads, nuts and washers with lubricant formulated for application.

C. Draw flanges together evenly to avoid pinching gasket. Tighten fasteners in cross pattern sequence (12 – 6 o'clock, 3 – 9 o'clock, etc.), one pass by hand and four passes by torque wrench at 30% full torque, 60% full torque and two passes at full torque per ASME B16.5.

END OF SECTION

SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Low pressure ductwork.
2. Duct sealant.
3. Pressure sensitive tapes.

B. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.

1.2 REFERENCES

A. American National Standards Institute (ANSI):
1. ANSI SS-EN 485-2 - Aluminum and Aluminum Alloys-Sheet, Strip and Plate-Part 2: Mechanical Properties.

B. ASTM International (ASTM):
1. ASTM A90 - Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
2. ASTM A167 - Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
3. ASTM A527 - Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality.
4. ASTM A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
5. ASTM A924 - Specification for General Requirements for Sheet Steel, Metallic-Coated by the Hot-Dip Method.
6. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
7. ASTM C411 - Test Method for Hot Surface Performance of High Temperature Thermal Insulation.
8. ASTM C916 - Specification for Adhesives for Duct Thermal Insulation.
9. ASTM C1071 - Specification for Fibrous Glass Duct Lining Insulation.
10. ASTM C1338 - Test Method for Determining Fungal Resistance of Insulation Materials and Facings.
11. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
12. ASTM G21 - Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

C. National Fire Protection Association (NFPA):
1. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
2. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

D. North American Insulation Manufacturers Association (NAIMA):
   1. NAIMA - Fibrous Glass Duct Liner Standard.

E. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

F. Underwriters Laboratories, Inc. (UL):
   1. UL 181 - Standard for Safety for Factory Made Air Ducts and Air Connectors.

1.3 SUBMITTALS

A. Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements: Requirements for submittals. Shop drawings, product data and samples.

B. Submit manufacturer's data and Contractor data for the following:
   1. Fabrication and installation drawings.
   2. Schedule of duct systems including material of construction, gauge, pressure class, system class, method of reinforcement, joint construction, fitting construction, and support methods, with details as appropriate.
   3. Duct sealant.
   4. Pressure sensitive tape.

1.4 DESIGN CRITERIA

A. Construct ductwork to be free from vibration, chatter, objectionable pulsations, and leakage under specified operating conditions.

B. Use material, weight, thickness, gauge, and construction and installation methods as outlined in the following Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA) publications, unless noted otherwise:
   1. HVAC Duct Construction Standards, Metal and Flexible, Latest Edition.
   2. HVAC Air Duct Leakage Test Manual, Latest Edition.
   3. HVAC Systems - Duct Design, Latest Edition.
   4. Rectangular Industrial Duct Construction Standard, Latest Edition.
   5. Round Industrial Duct Construction Standards, Latest Edition.
   6. Round Industrial Duct Construction Standards, Latest Edition.
   7. Rectangular Industrial Duct Construction Standards, Latest Edition.

C. Use products which conform to NFPA 90A, possessing a flame spread rating of not over 25 and a smoke developed rating no higher than 50.

1.5 DELIVERY, STORAGE AND HANDLING

A. Promptly inspect shipments to ensure that ductwork is undamaged and complies with specification.

B. Protect ductwork against damage.

C. Protect ductwork by storing inside or by durable, waterproof, above ground packaging.

D. Do not store material on grade. Protect ductwork from dirt, dust, construction debris, and foreign material.

E. Where end caps or packaging are provided, take precautions so caps or packaging remain in place and free from damage.

F. Offsite storage agreements do not relieve Contractor from using proper storage techniques.

G. Storage and protection methods must allow inspection to verify products.

PART 2 - PRODUCTS

2.1 GENERAL

A. Sheet metal used for construction of duct shall be 24-gauge or heavier except for round and spiral ductwork and spiral duct take-offs 12-inch and below may be 26-gauge where allowed in SMACNA HVAC Duct Construction Standards, Metal and Flexible, latest edition.

B. Duct sizes indicated on Drawings are net inside dimensions. Where duct liner is specified, dimensions are net, inside of liner.

2.2 DUCTWORK PRESSURE CLASS

A. Minimum acceptable duct pressure class, for ductwork except transfer ductwork, is 2-inch W.G. positive or negative, depending on application.

2.3 MATERIALS

A. Galvanized Steel Sheet:
   1. ASTM A653, galvanized steel sheet of lock forming quality.
   2. Galvanized coating to be 1.25 ounces per square foot, both sides of sheet, G90 in accordance with ASTM A90.

2.4 LOW PRESSURE DUCTWORK (MAXIMUM 3-INCH PRESSURE CLASS)

A. Fabricate and install ductwork in sizes indicated on Drawings and in accordance with SMACNA recommendations, except as modified below.

B. Construct so that interior surfaces are smooth.

C. Use slip and drive or flanged and bolted construction when fabricating rectangular ductwork.

D. Use spiral lock seam construction when fabricating round spiral ductwork.

E. Sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if screw does not extend more than 1/2-inch into duct.

F. Use elbows and tees with centerline radius to width or diameter ratio of 1.5 wherever space permits.

G. When a shorter radius must be used due to limited space, install single wall sheet metal splitter vanes in accordance with SMACNA, Type RE 3.

H. Square throat-radius heel elbows shall not be acceptable. Straight taps or bullhead tees are also not permitted.

I. Provide expanded take-offs or 45-degree entry fittings for branch duct connections with branch ductwork airflow velocities greater than 700 fpm. Square edge 90-degree take-off fittings or straight taps are unacceptable.

J. Button punch snaplock construction will not be accepted on aluminum ductwork.

K. Contractor may substitute round ducts for rectangular ducts if sized in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission of Engineer.

L. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

2.5 DUCT SEALANT

A. Manufacturers:
1. 3M 800.
2. 3M 900.
3. H.B. Fuller/Foster.
4. Hardcast.
5. Hardcast Peal & Seal.
6. Lockformer Cold Sealant.
7. Mon-Eco Industries.
8. United Sheet Metal.
9. Equivalent as acceptable to Engineer.

B. Silicone sealants will not be allowed in any type of ductwork installation.

C. Install sealants in strict accordance with manufacturer's recommendations, paying special attention to temperature limitations.

D. Allow sealant to fully cure before pressure testing of ductwork or startup of air handling systems.

2.6 PRESSURE SENSITIVE TAPES

A. Two-inch Pressure Class and Lower: UL-181A-P listed and labeled for rigid ductwork. UL-181B-FL listed and labeled for flexible duct applications.

B. Tape is not permitted on any hazardous ductwork including kitchen exhaust or fume exhaust ductwork.

C. Unlisted duct tape is not permitted as a sealant on any duct.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify dimensions at site, making field measurements and drawings necessary for fabrication and erection.

B. Check Drawings showing work of other trades and consult with Engineer in event of any interference.

C. Make allowances for beams, pipes, or other obstructions in building construction and for work of other contractors.

D. Transform, divide or offset ducts as required, in accordance with SMACNA HVAC Duct Construction Standards, Figure 2-7, except do not reduce duct to less than 6 inches in any dimension and do not exceed an 8:1 aspect ratio.

E. Where it is necessary to take pipes or similar obstructions through ducts, construct easement as indicated in SMACNA HVAC Duct Construction Standards, Figure 2-8, Fig. E.

F. In all cases, seal to prevent air leakage. Pipes or similar obstructions may not pass through high pressure or fume exhaust ductwork.

G. Provide frames constructed of angles or channels for coils, filters, dampers, or other devices installed in duct systems, and make connections to such equipment including equipment furnished by others. Secure frames with gaskets and screws or nut, bolts, and washers.

H. Install duct to pitch toward outside air intakes and drain to outside of building. Solder or seal seams to form watertight joints.

I. Where two different metal ducts meet, install joint in such a manner that metal ducts do not contact each other by using proper seal or compound.

J. Do not install ductwork through dedicated electrical rooms or spaces unless ductwork is serving this room or space.

K. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

L. Provide adequate access to ductwork for cleaning purposes.

M. Provide temporary capping of ductwork openings to prevent entry of dirt, dust, and foreign material.

N. Install prefabricated grease ductwork assemblies in accordance with manufacturer requirements and NFPA 96.

O. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

3.2 DUCTWORK SUPPORT

A. Support ductwork in accordance with SMACNA HVAC Duct Construction Standards, Figure 5.5, except supporting ductwork with secure wire method is not allowed.

B. Support with 3/32-inch, 7-inch x 7-inch, stainless steel air-craft cable, with matching fastener rated for 150 percent of actual load, will be allowed on round ductwork under 12 inches if installed as detailed, with cable double looped on duct and at point of support.

3.3 LOW PRESSURE DUCT (MAXIMUM 3-INCH PRESSURE CLASS)

A. Seal ducts, with exception of transfer ducts, in accordance with SMACNA seal class "A"; sealing transverse and longitudinal seams, joints, and penetrations.

B. Hangers must be wrapped around bottom edge of duct and securely fastened to duct with sheet metal screws or pop rivets. Trapeze hangers may be used at Contractor's option.

3.4 CLEANING

A. Remove dirt and foreign matter from entire duct system and clean diffusers, registers, grilles, and inside of air-handling units before operating fans.

B. Clean duct systems with high power vacuum machines where systems have been used for temporary heat, air-conditioning, or ventilation purposes during construction.

C. Protect equipment that may be harmed by excessive dirt with filters, or bypass during cleaning.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 GENERAL

A. SUMMARY

B. Section Includes:
1. Cabinet fans.
2. Ceiling exhaust fans.

C. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
2. Section 23 05 13 - Motor Requirements for HVAC Equipment.
3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

A. Air Movement and Control Association (AMCA):
1. AMCA 203 - AMCA Fan Application Manual - Troubleshooting
2. AMCA 210 - Laboratory Method of Testing Fans for Rating
3. AMCA 300 - Reverberant Room Method for Sound Testing of Fans

B. National Fire Protection Association (NFPA):
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems

1.3 SUBMITTALS

A. Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements: Requirements for submittals: Shop drawings, product data and samples.

B. Submit dimensions, capacities, fan curves, materials of construction, ratings, weights, motors and drives, sound power levels, appropriate identification, and vibration isolation for equipment.

C. Sound power levels to be based on tests performed in accordance with AMCA Standard 300.

D. Submit color selection charts for equipment where applicable.

E. Fan curves shall indicate relationship of CFM to static or total pressure for various fan speeds.

F. Indicate brake horsepower, recommended selection range, and limits of operation on curves.

G. Indicate operating point on fan curves at design air quantity and indicate manufacturer's recommended drive loss factor for specific application.

H. Tabular fan performance data is not acceptable.

1.4 DESIGN CRITERIA

A. Tested and certify fans in accordance with applicable AMCA test code.

B. Each fan and motor combination shall be capable of delivering 110 percent of schedules air quantity at scheduled static pressure.

C. Motor furnished with fan shall not operate into motor service factor when operating under these conditions.

D. Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA Publication 203, Appendix L.

E. Where inlet and outlet ductwork at any fan is changed from that shown on Drawings, provide any motor, drive, and wiring changes required due to increased static pressure or baffling necessary to prevent uneven airflow or improve mixing.

F. All internal insulation and other components exposed to air stream are to meet flame spread and smoke ratings contained in NFPA 90A.

PART 2 PRODUCTS

2.1 GENERAL

A. Use fan size, class, type, arrangement, and capacity as scheduled.

B. Furnish complete with motors, wheels, drive assemblies, bearings, vibration isolation devices, and accessories required for specified performance and proper operation. Single phase motors to have inherent thermal overload protection.

C. Reference Section 23 05 13 – Motor Requirements for HVAC Equipment for motor requirements.

D. Statically and dynamically balance fans so they operate without objectionable noise or vibration.

2.2 CABINET FANS

A. Manufacturers:
1. Acme Engineering & Manufacturing Corporation.
2. Broan.
3. Greenheck Fan Corporation.
4. Jenco Fan.
5. Loren Cook Company.
6. Equivalent as acceptable to Engineer.

B. Cabinet Fan Assembly:
1. Use double width, double inlet airfoil centrifugal fans unless scheduled otherwise.
2. Construct airtight casing and frame of galvanized or rust inhibited prime coated steel with removable panels to allow access to internal parts.
3. Thermally insulate casing with not less than 1-inch of glass fiber or other closed cell insulation secured to casing with waterproof adhesive or stick clips; coat exposed surface to minimize erosion.
4. Bearings to be self-aligning grease packed pillow block type with grease seal. Bearings rated for 200,000 hours average life.
5. Bearings may be mounted internally or externally but internally mounted bearings must be provided with extended grease lines to a point outside unit.
6. Provide filter section or a filter rack within fan cabinet suitable for installation of panel filters as scheduled or specified.

2.3 CEILING EXHAUST FANS

A. Manufacturers:
1. Acme Engineering & Manufacturing Corporation.
2. Broan.
3. Greenheck Fan Corporation.
4. Jenco Fan.
5. Loren Cook Company.
6. Equivalent as acceptable to Engineer.

B. Ceiling Exhaust Fan Assembly:
1. Centrifugal blower wheel, steel housing with acoustical lining, integral exhaust grille, adjustable mounting brackets to allow for any ceiling thickness, permanently lubricated motor and integral junction box.
2. Provide wall, eave, or roof discharge assembly, as indicated on Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install as shown on Drawings, as detailed, and according to manufacturer's installation instructions. On units provided with a drain connection, reduce drain connection down to 1/2-inch fitting and leave open.

B. Furnish wall and roof opening locations and dimensions to other sections of work requiring opening information.

C. Provide direct drive fans with variable fan speed controllers. Electrical Contractor will wire and install the fan speed controllers on the fans.

D. Balance fans to airflows indicated utilizing fan speed controllers. Generate balancing report certifying balanced airflow meets design airflow (within 10 percent).

3.2 CEILING EXHAUST FANS

A. Installation of fan speed controllers is provided by Electrical Contractor.

END OF SECTION

SECTION 23 54 00
GAS FIRED FURNACES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Gas fired furnaces.

B. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern Work under this Section.
2. Section 23 05 13 - Motor Requirements for HVAC Equipment.
3. Section 23 05 23 - General-Duty Valves for HVAC Piping.
4. Section 23 09 23 – Direct Digital Control System for HVAC.
5. Section 23 11 00 - Facility Fuel Piping.
6. Section 23 62 13 – Packaged Air Cooled Refrigerant Compressor Condensing Units

1.2 REFERENCES

A. American Gas Association (AGA):

B. American National Standards Institute (ANSI):
1. ANSI Z21.47 – Gas-Fired Central Furnaces.

C. ASTM International (ASTM):
1. ASTM D1785 – Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

D. Gas Appliance Manufacturers Association (GAMA).

E. National Fire Prevention Association (NFPA):
1. NFPA 70 - National Electrical Code (NEC).

1.3 ENERGY EFFICIENCY

A. Provide gas furnaces that bear ENERGY STAR label and meet ENERGY STAR specifications for energy efficiency.

1.4 SUBMITTALS

A. Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements: Requirements for submittals: Shop drawings, product data and samples.

B. Submit specific manufacturer and model numbers, equipment identification corresponding to Drawings and schedules, dimensions, capacities, materials of construction, ratings, weights, power requirements, and wiring diagrams, filter information, and information for accessories.

1.5 WARRANTY

A. Warrant furnace primary and secondary heat exchangers for 20 years under normal use and maintenance. Warrant remainder of furnace components for 1 year from date of start up.

PART 2 - PRODUCTS

2.1 FURNACES

A. Manufacturers:
1. American Standard - Trane.
2. Carrier Corporation.
3. Lennox International, Inc.
4. Bryant Heating & Cooling Systems, Inc.
5. York Division - Johnson Controls.
6. Equivalent as acceptable to Engineer.

B. Direct vent, sealed combustion, condensing type AGA certified for use with natural gas. Minimum annual fuel utilization efficiency (A.F.U.E.) of 91. Ratings shall be GAMA Certified. Wiring shall comply with National Electrical Code.

C. Furnace shall have 22 gauge steel casing with baked enamel finish or prepainted galvanized steel. Insulate casing back and side panels with foil faced fiberglass insulation.

D. Construct primary heat exchanger of aluminized steel. Construct secondary heat exchanger of stainless steel with aluminum fins or of polypropylene laminated steel.

E. Aluminized steel multi-port in-shot burner with hot surface or electronic spark ignition, approved for vertical or sidewall venting.

F. AGA listed gas controls including manual main shut-off valve, double automatic gas valves for redundancy and gas pressure regulator.

G. Centrifugal type blower fan statically and dynamically balanced with multiple speed, direct drive or belt drive fan motor.

H. Provide low energy induced draft blower for heat exchanger prepurge and combustion gas venting.

I. Provide unit with 2-inch thick 30 percent efficient disposable type panel air filter and filter holding rack with a maximum filter face velocity of 500 fpm.

J. Provide solid state integral control unit with necessary controls and relays including but not limited to:
1. Pressure switch for airflow of flue products through furnace and out vent system.
2. Rollout switch with manual reset to prevent over-temperature in burner area.
3. Electronic flame sensor.
4. Blower access safety interlock.
5. Timed blower start after main burners ignite.

6. Factory installed 24-Volt transformer for controls and thermostat.
7. LED's to indicate status and to aid in troubleshooting.

K. Provide unit with matching cased "A" configuration cooling coil for upflow units, "V" configuration cooling coil for downflow units, and vertical flat face configuration cooling coil for horizontal units.

L. Minimum 1/2-inch OD seamless copper tubing mechanically bonded to heavy ripple edged aluminum fins with thermal expansion valve, holding charge, and copper tube stubs for field piping.

M. Non-corrosive stainless steel or polymer drain pan with 3/4-inch NPT drain connection.

N. Provide 20-gauge steel coil casing with baked enamel finish and fiberglass insulation.

O. Provide 7-day programmable thermostat with 2 occupied periods per day, automatic changeover, and separate heating and cooling set points for both occupied and unoccupied modes. Provide auxiliary controls on subbase to open minimum outside air damper during occupied mode.
1. Manufacturer:
   a. Honeywell Model T7300 with Q7300 Sub-Base.
   b. Equivalent as acceptable to Engineer.

P. Provide lockable thermostat guards in public spaces.

Q. During occupied mode, run supply fan continuously, open outside air damper, and cycle cooling or heating as required to maintain occupied space temperature cooling or heating set point.

R. During unoccupied mode, close outside air damper and cycle supply fan and cooling or heating as required to maintain unoccupied cooling or heating space temperature set point.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as shown on Drawings, as detailed, and according to manufacturer's installation instructions.

B. Pipe vents from gas regulator to outside where regulators are provided.

C. Coordinate power wiring with electrical work. Coordinate temperature controls with temperature controls specifications. Clearly identify and coordinate which trade is providing various wiring.

3.2 FURNACES

A. Install on 3-1/2 inch high concrete housekeeping pad, steel stand, or suspend unit from structure as indicated on Drawings. Pipe condensate to floor drain.

B. Provide ASTM D1785, Schedule 40 PVC, combustion air and vent piping and fittings with solvent welded joints as indicated on Drawings. Terminate as recommended by furnace manufacturer.

C. Provide separate condensate drain lines from heat exchanger and from cooling coil condensate drain pans.

D. Provide flexible duct connections to furnaces.

E. Provide 1-inch thick neoprene pads at support points.

END OF SECTION

SECTION 23 55 00
FUEL-FIRED HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Gas Fired Unit Heaters.

B. Related Sections:
   1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
   2. Section 23 05 13 - Motor Requirements for HVAC Equipment.
   3. Section 23 05 23 - General-Duty Valves for HVAC Piping.
   4. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
   5. Section 23 09 93 – Sequence of Operation for HVAC Controls.
   6. Section 23 11 00 - Facility Fuel Piping.

1.2 REFERENCES

A. American Gas Association (AGA).

B. American National Standards Institute (ANSI):
   1. ANSI Z83.4 - Direct Gas Fired Makeup Air Heaters
   2. ANSI Z83.6 - Gas Fired Infrared Heaters

C. Gas Appliance Manufacturers Association (GAMA).

D. National Electrical Code (NEC).

1.3 SUBMITTALS

A. Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements: Requirements for submittals: Shop drawings, product data and samples.

B. Include specific manufacturer and model numbers, equipment identification corresponding to project drawings and schedules, dimensions, capacities, materials of construction, ratings, weights, power requirements, wiring diagrams, filter information, and information for all accessories.

1.4 OPERATION AND MAINTENANCE DATA

A. Operations and maintenance data shall comply with submission and content requirements specified under Division 01 – Operation and Maintenance Data.

1.5 WARRANTY

A. Warrant gas fired unit heaters heat exchangers for five years. Warrant remainder of unit heater components for 1 year from startup.

B. Warrant radiant heat tubes against internal corrosion for 10 years. Warrant remainder of infrared radiant heater components for 1 year from date of startup.

C. Warrant direct fired make-up air units for 12 months from date of startup.

D. Warrant indirect fired make-up air units for 12 months from date of startup.

PART 2 - PRODUCTS

2.1 GAS FIRED UNIT HEATERS

A. Manufacturers
1. Modine Manufacturing Company.
2. Reznor Division Thomas & Betts Corporation.
3. Sterling Gas Products.
4. Trane.
5. Equivalent as acceptable to Engineer.

B. Horizontal discharge, direct power vented type. AGA certified for use with natural gas.

C. Minimum annual fuel utilization efficiency (A.F.U.E.) of 80 percent.

D. Electrical wiring and installation shall comply with National Electrical Code.

E. Gas Fired Unit Heaters:
1. Construct casing of cold rolled steel with baked enamel finish.
2. Direct drive propeller type fan statically and dynamically balanced including fan safety guard and adjustable vertical and horizontal louvers for control of air diffusion on discharge of unit.
3. Aluminized steel burners, electronic spark ignition with electronic flame supervision, and timed lockout control.
4. Heavy gauge aluminized steel heat exchanger and factory installed induced draft blower for heat exchanger prepurge and combustion gas venting.
5. Provide hinged access panel on bottom of unit to access burner or provide side access (pull out drawer) to burner assembly. Single point power connection. Unit must be approved for vertical or side wall venting.

F. Provide spark ignited intermittent pilot system with electronic flame supervision

G. Provide integral power venter which allows venting vertically or horizontally.

H. AGA gas controls, including manual main shut-off valve, 24 volt redundant combination gas control valve with 100 percent safety shut-off valve and main gas pressure regulator.

I. Provide fan controls and limit safety controls including but not limited to:
   1. Pressure switch to verify combustion/exhaust gas airflow.
   2. High limit controls.
   3. Fan time delay to delay fan start until heat exchanger reaches predetermined temperature and to allow fan to operate, after burner shut down, to remove heat exchanger residual heat.

J. Provide factory installed 24-volt control transformer along with 24-volt wall mounted thermostat. Wiring shall be in conduit in accordance with Division 26 – Electrical, and comply with National Electrical Code.

K. Provide air inlet/vent termination assembly and threaded hanger connections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as shown on Drawings, as detailed, and according to manufacturer's installation instructions.

B. Pipe vents from gas regulator to outside where regulators are provided.

3.2 GAS FIRED UNIT HEATERS AND DUCT HEATERS

A. Install units and connect gas, combustion air, and vent piping as instructed by manufacture and in compliance with applicable code requirements.

B. Suspend from building structure to maintain headroom beneath units as indicated in Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

C. Connect combustion air and venting to outside of building as indicated on Drawings and terminate per manufacturer's instructions.

END OF SECTION

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SECTION 23 62 13

PACKAGED AIR-COOLED REFRIGERANT COMPRESSOR CONDENSING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Air cooled condensing units.
2. Refrigerant piping specialties.

B. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
2. Section 23 05 13 – Motor Requirements for HVAC Equipment.
3. Section 23 23 00 - Refrigerant Piping.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute (ARI):
1. ARI 210/240 - Unitary Air Conditioning and Heat Pump Equipment.
2. ARI 365 - Commercial and Industrial Unitary Air Conditioning Condensing Units.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
1. ASHRAE 15 - Safety Standard for Refrigeration Systems.
2. ASHRAE 90.1 – Current Edition - Energy Standard for Buildings Except Low Rise Residential Buildings.

C. ASTM International (ASTM):
1. ASTM B117 - Practice for Operating Salt Spray (Fog) Apparatus.

D. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code. (NEC)

E. Underwriters Laboratories, Inc. (UL).

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.

B. Unit Energy Efficiency Ratio (EER), Coefficient of Performance (COP) and Integrated Part Load Value (IPLV) shall meet minimum applicable requirements of ASHRAE 90.1. Units that are labeled Energy StaR® will be acceptable.

C. Rate unit performance in accordance with latest edition of ARI Standard 365 or ARI Standard 210/240, whichever is applicable for equipment.

D. Construct units in accordance with ASHRAE 15, UL standards, and NEC. Units shall carry UL label.

E. Factory run test units to see that each control device operates properly. Pressure test, evacuate, charge with holding charge of refrigerant, and full oil charge prior to shipping from factory.

1.4 SUBMITTALS

A. Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements - Requirements for submittals: Shop drawings, product data and samples.

B. Submit air cooled condensing unit Shop Drawings including the following information:
1. Specific manufacturer and model numbers.
2. Dimensional and weight data.
3. Required clearances.
4. Materials of construction.
5. Capacities and ratings.
6. Stages of unloading capacity achievable without hot gas bypass (and with hot gas bypass if applicable).
7. Refrigerant type and charge.
8. Component information.
9. Size and location of piping connections.
10. Electrical connections and wiring diagrams.
11. Refrigerant piping specialties.
12. Accessories.
13. Custom refrigerant piping diagrams.

C. Submit manufacturer's installation and start-up instructions, maintenance data, troubleshooting guide, parts lists, controls and accessories.

D. At substantial completion, submit warranty certificate and copy of start-up report.

E. Include cooling coil performance for matching condensing unit performance.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with manufacturer's instructions for storing, rigging, unloading, and transporting units. Protect units from physical damage.

B. Leave factory-shipping covers in place until installation.

C. Ship units to jobsite fully assembled.

1.6 WARRANTY

A. Provide one-year parts and labor warranty on entire unit beginning upon substantial completion of project.

B. Provide five-year parts warranty on compressor(s) beginning upon substantial completion of project.

PART 2 - PRODUCTS

2.1 PACKAGED UNITS (UP TO 5 TONS)

A. Manufacturers:
1. Trane.
2. Carrier Corporation.
3. McQuay International.
4. York.
5. Equivalent as acceptable to Engineer.

B. Cabinet:
1. Construct cabinet of heavy gauge, galvanized steel coated with weather resistant paint.
2. Provide removable access panels to facilitate full access to compressor, fan and control components.

C. Compressor:
1. Provide hermetic reciprocating or scroll type compressor with built in motor winding temperature and current protection, liquid and suction service valves, gage ports, sight glass, and liquid line filter dryer.
2. Provide crankcase heater with reciprocating type compressors.
3. Mount compressors on vibration isolators.

D. Condenser:
1. Provide condenser coils with aluminum alloy plate fins mechanically fastened to seamless copper tubing with integral subcooler.
2. Construct coils with design working pressure suitable for refrigerant.
3. Louvered condenser guard shall be provided.
4. Provide direct-drive statically and dynamically balanced propeller type fans with vertical or horizontal discharge as indicated on Drawings and guards constructed of heavy gage PVC coated wire or galvanized steel.
5. Provide permanent split capacitor fan motors with permanent lubrication.

E. Power Wiring:
1. Provide factory installed 24-volt control circuit with fusing; control power transformer and all associated internal wiring. Provide a single point power connection to unit(s). Provide factory installed magnetic contactors for compressor and condenser motors.
2. Electrical characteristics shall be as indicated in equipment schedule.

F. Controls:
1. Provide high/low refrigerant pressure cutouts with manual reset and anti-short cycle compressor timer.
2. Provide “low ambient” controls and accessories needed so that unit is capable of operating down to ambient temperature of 0 degrees F.

2.2 REFRIGERANT PIPING SIZING

A. Unit manufacturer shall verify final entire refrigeration pipe sizing system process to insure conformance to specific unit requirements such as maximum lengths, refrigerant velocities, unloading considerations, and proper oil return.

B. Contractor shall provide refrigeration piping drawings from field which detail way piping will actually be installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units, piping and accessories in accordance with manufacturer's written instructions and recommendations.

B. Mount unit(s) on level precast 3-1/2 inch high concrete pad on grade or on roof curbs as indicated on Drawings. This Contractor shall provide unit supports and concrete pad.

C. Maintain adequate service access and airflow clearances for all components as recommended by manufacturer and as indicated on Drawings.

D. Charge unit(s) with full oil charge and refrigerant charge based on entire refrigeration system pipe size and length.

E. Coordinate power wiring requirements with electrical trade.

3.2 STARTUP

A. Adjust units for maximum operating efficiency, adjust all controls to required final settings and demonstrate that all components are functioning properly.

B. Submit four copies of written startup report following initial startup.

C. Items required to be in report:
1. Work done to system.
2. Readings taken.
3. Statement certifying that refrigeration system(s) are leak free and statement certifying that unit(s) have been placed in proper running condition as recommended by manufacturer and as intended in Drawings and Specifications.

END OF SECTION

SECTION 23 81 28

DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Ductless split system air conditioning units for this project.

B. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements shall govern all work under this Section.
2. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.
3. Section 23 09 93 – Sequence of Operation for HVAC Controls.

1.2 REFERENCE STANDARDS

A. Air-Conditioning and Refrigeration Institute (ARI):
1. ARI 210 – Unitary Air-Conditioning and Air-Source Heat Pump Equipment

B. Underwriters Laboratories, Inc. (UL).

1.3 DESIGN CRITERIA

A. Units shall be certified in accordance with ARI Standard 210.

B. Units and remote electrically powered components shall contain unit mounted, factory prewired terminal block. Electrical components shall be UL tested, and UL labeled.

C. Units (except for power and control wiring to remote condensing units, thermostats and other specialty control interlocking) shall be factory prewired within unit cabinet and shall meet national, state and local codes.

D. Wiring shall be numbered and connected to numbered wiring terminal.

E. Entire split system heat pump VRF system shall be furnished and installed with components and accessories required for fully functional system. Verify field piping requirements with Manufacturer.

1.4 SHOP DRAWINGS

A. Submit shop drawings for equipment specified under this section.

B. Include data concerning sizes, dimensions, weights, heating capacities, materials of construction, ratings, electrical data, wiring diagrams, refrigerant piping diagrams, controls, options and manufacturers installation requirements, instructions and recommendations.

C. Manufacturer's shop drawing submittal shall include complete component descriptive literature, detailed electrical wiring and refrigerant piping diagrams and drawings that have been specifically prepared for this project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:
1. Mitsubishi.
2. Friedrich.
3. Carrier.
4. Equivalent as acceptable to Engineer.

2.2 INDOOR UNIT

A. Steel frame and cabinet with neutral color, furniture quality exposed exterior panels; removable exterior panels for access for servicing, and built-in air in intake and discharge louvers.

B. Unit shall include permanent, washable air filters. Filters shall be easily removable for cleaning.

C. Fans shall be vibration isolated, direct drive type.

D. Heating system shall consist of an electric resistance type heating coil with overload and thermal protection.

E. Unit evaporator coil shall have copper tubes, with aluminum fins, refrigerant distributor, and condensate drain pan with built-in condensate pump capable of providing 10-foot lift for condensate removal.

2.3 OUTDOOR UNIT

A. Air-cooled, remote mounting, compressor-condensing unit.

B. Unit cabinet shall be zinc, or similarly coated with corrosion resistant coating and have removable panels for service access.

C. Compressor shall be high efficiency, hermetic type with thermal overloads. Compressor shall have vibration isolators to keep sound to a minimum.

D. Condenser coil shall have copper tubes with aluminum fins.

E. Condenser fan shall be propeller type, with totally enclosed, direct drive fan motor.

F. Condenser low ambient capacity control shall be capable of providing continuous unit cooling and heating capability down to -15 degrees F ambient outside temperature.

G. Outdoor unit shall contain full charge of refrigerant and oil for entire system.

H. Refrigeration system shall include external service valves on outdoor unit for unit servicing, and factory supplied, pre-insulated liquid and suction line kit for field installation.

2.4 UNIT ELECTRICAL AND CONTROLS

A. Units shall be complete with motor starters, relays, and control thermostat. Indoor unit fan shall have fan speed controller to allow for fan speed selection from three speeds.

B. Units shall have single point electrical connection (on each section) with electrical characteristics as specified on equipment schedule, and shall allow aluminum or copper main conductors to be connected to terminal block power connections.

C. Control thermostat shall be electronic, seven day programmable type with LCD display, auto-changeover control, set-up and set-back schedules, built-in compressor time delay and battery back-up.

PART 3 - EXECUTION

3.1 GENERAL

A. Entire system and components shall be installed and operated in strict accordance with Manufacturer's instructions and recommendations.

B. Both indoor and outdoor sections shall be mounted level.
   1. Indoor Unit:
      a. Suspend indoor unit from building structure with hanger rods and spring vibration isolators.
      b. Extend cooling coil condensate drain line from unit condensate connection to nearest clear water waste drain location.
      c. Adjust unit fan speed to provide proper unit operation, or as specified.
   2. Outdoor Unit:
      a. Provide weatherproof fusible electrical disconnect switch with fuses to disconnect all electrical power to outside units.
      b. Outdoor units shall be mounted on concrete pad, secured to wall, on roof on roof rail supports as shown on Drawings.

C. Start-Up:
   1. Three (3) copies of written service report shall be submitted to Engineer following initial start-up.
   2. It shall be signed by serviceman responsible for performing startup and adjustment work.
   3. It shall indicate that installation is compete, indicate readings taken, and shall state that unit has been placed in proper running condition as recommended by unit manufacturer and within intent of Contract Documents.

END OF SECTION

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SECTION 23 82 01
ELECTRIC HEATING TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Electric Wall Heaters.

B. Related Sections:
1. Applicable provisions of Section 23 05 00 – Basic HVAC Requirements and Division 01- General Requirements shall govern all work under this Section.
2. Section 23 05 13 - Motor Requirements for HVAC Equipment.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute (ARI):
1. ARI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.

B. Underwriters Laboratories, Inc. (UL).

1.3 SUBMITTALS

A. Section 23 05 00 – Basic HVAC Requirements and Division 01 – General Requirements: Shop Drawings, product data, and samples.

B. Include dimensions, capacities, materials of construction, ratings, weights, wiring diagrams, and appropriate identification for all equipment in this section. Include color selection chart where applicable.

1.4 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with submission and content requirements specified in Division 01 – General Requirements.

1.5 DESIGN CRITERIA

A. Electrical Equipment and heaters shall be UL listed for service specified.

B. Electrical components and work must be in accordance with National Electrical Code.

PART 2 - PRODUCTS

2.1 ELECTRIC WALL HEATERS

A. Manufacturers:
1. Berko.

2. Q-Mark.
3. Markel Products Company.
4. Trane Division American Standard.
5. Equivalent as acceptable to Engineer.

B. Use corrosion resistant heating elements, designed and spaced for even distribution of air across heating element, and installed to prevent noise of expansion and contraction.

C. Provide units with necessary overheat protection, reset devices, air flow interlock switch, contactors, transformers, local non-fused disconnect switch that is prewired, integral concealed adjustable thermostat, and other controls as may be required by codes.

D. Fan powered units shall be provided with thermostat and controls to maintain fan operation until residual heat in heating elements has been dissipated. Fans and motors shall be balanced and mounted for vibration free operation.

E. Corrosion resistant 18 gauge steel for surface or recessed mounting as specified with louvered front panel with baked on enamel satin finish or anodized aluminum trim frame with anodized aluminum louvered front panel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units in accordance with manufacturer's installation instructions.

B. Protect finished surfaces from damages during construction.

C. Coordinate location of units with other trades to assure correct recess size for recessed units.

D. Provide required line and low voltage control wiring.

E. After installation, provide protective covers to prevent accumulation of dirt on units during balance of construction.

F. Power line voltage wiring will be by Electrical Contractor.

3.2 ELECTRIC WALL HEATERS

A. Install units at locations as specified on Drawings and as detailed.

B. Bottom of heaters shall be mounted approximately eight (8) inches above finished floor line.

C. Securely mount unit enclosure to wall at locations shown, except that due consideration and coordination shall be given to interferences with other construction.

D. Units shall be recessed or surface mounted as specified on Drawing schedule.

END OF SECTION

SECTION 26 00 00

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. General Electrical Requirements.
2. Work Included in Contract.
3. Definitions.
4. Dimensions and Equipment Location.
5. Owner Supplied Products.
6. Work by Owner.
7. Demonstration and Training Meetings.
8. Product Data.
9. Shop Drawings.
10. Test Reports.
11. Quality Assurance and Control of Installation.
12. Temporary Facilities and Controls.
13. Delivery, Storage, and Handling Requirements.
14. Product Options.
15. Product Substitution Procedures.
16. Final Cleaning and Painting.
17. Starting of Systems.
18. Demonstration and Instructions.
19. Project Record Documents.
20. Extra Material and Spare Parts.
21. Operation and Maintenance Manuals.

1.2 GENERAL ELECTRICAL REQUIREMENTS

A. Mention of any article, operation or method requires that Contractor shall provide same and perform each operation in complete accordance with conditions stated.

B. Contractor shall provide all material, labor, equipment and transportation as necessary to complete project in compliance with Contract Documents.

C. In general, this work includes everything essential for a complete electrical system in operating order as shown on drawings and indicated in specifications.

D. Work shall be installed in accordance with National, State, and Local codes, ordinances, laws, and regulations. Comply with all applicable OSHA regulations.

E. Materials shall have a UL or ETL label where a UL or ETL standard or testing requirement exists.

F. All work shall be installed in accordance with recommendations of manufacturer whose equipment is to be supplied and installed under this Contract.

G. Before submitting a bid, each bidder shall examine all specifications and drawings relating to their work and shall become fully informed as to extent and character of work required and its relation to other work within project area.

H. Contractor, in conjunction with Engineer's representative, shall establish exact locations of all materials and equipment to be installed. Consideration shall be given to construction features, equipment of other trades and requirements of equipment proper.

I. All materials shall be suitably stored and protected prior to installation and all work shall be protected after installation, during construction and prior to acceptance.

J. Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for delivery, erection and installation of all equipment and apparatus required to be installed by Contractor. All such equipment shall be removed by Contractor upon completion of project.

K. Refer to Division 01 – General Requirements for temporary electrical service.

1.3 WORK INCLUDED IN CONTRACT

A. Contractor shall provide auxiliary contacts, buttons, and switches on starters as required.

B. Contractor shall provide power wiring (120 V or greater) to control panels, motor starters, variable frequency drives, motors, electric actuators, electric devices and smoke detectors.

1.4 DEFINITIONS

A. Exposed: Exposed to view in any room, corridor, stairway, or from the building’s exterior.

B. Code: National, State and Local Electrical codes including OSHA requirements.

C. Provide, furnish, install, and wire ready for service.

D. Signal Voltage: NEC class 1, 2, or 3 remote control, signaling, or power limited circuits.

E. Low Voltage: 50 to 600 volts.

F. Electrical Ductbank: Assembly consisting of electrical conduits encased in concrete.

G. Substitution: Manufacturer or method other than those listed by name in these specifications, on the Drawings, or in an Addendum.

1.5 DIMENSIONS AND EQUIPMENT LOCATION

A. Drawings depicting electric work are diagrammatic and show, in their approximate location, symbols representing electrical equipment and devices.

B. Exact locations of such equipment and devices shall be established in field in accordance with instructions from Engineer/Architect as established by manufacturer's installation drawings and details.
   1. Contractor shall refer to shop drawings and submittal drawings for all equipment requiring electrical connections to verify rough-in and connection locations.
   2. Unless specifically stated, no measurement of an electric drawing derived by scaling shall be used as a dimension to work by.
   3. Dimensions noted on electric drawings are subject to measurements of adjacent and previously completed work.
   4. All measurements shall be performed prior to actual installation of equipment.

1.6 OWNER SUPPLIED PRODUCTS

A. Reference Division 01 – General Requirements for Owner supplied products.

1.7 WORK BY OWNER

A. Reference Division 01 – General Requirements for work by Owner.

1.8 DEMONSTRATION AND TRAINING MEETING

A. Contractor shall schedule and administer demonstration and training sessions for Owner for each portion of equipment and products that are required to have training in proper operation and maintenance.

B. Contractor shall schedule representatives of the equipment manufacturer to attend demonstration and training sessions to provide additional information as necessary.

1.9 PRODUCT DATA

A. Product Data: Submit to Engineer/Architect for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Provide copies and distribute in accordance with Submittal Procedures article in Division 01 – General Requirements and for record documents purposes described in Division 01 – General Requirements.

C. Submit number of copies Contractor requires, plus one copy Engineer/Architect will retain.

D. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

E. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

F. After review distribute in accordance with Submittal Procedures article in Division 01 – General Requirements and provide copies for record documents described in Division 01 – General Requirements.

1.10 SHOP DRAWINGS

A. Shop Drawings: Submit to Engineer/Architect for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. The following shop drawing submittals are required:
1. 26 05 73 Short Circuit/Coordination Studies
2. 26 07 00 Electrical Utility Services
3. 26 09 26 Lighting Control Panelboards
4. 26 24 13 Switchboards
5. 26 24 16 Panelboards
6. 26 27 26 Wiring Devices
7. 26 28 23 Enclosed Circuit Breakers
8. 26 28 26 Enclosed Transfer Switches
9. 26 28 19 Enclosed Switches
10. 26 32 13 Engine Generators
11. 26 35 53 Surge Protection Devices
12. 26 51 00 Interior Lighting

C. Produce copies and distribute in accordance with Submittal Procedures article in Division 01 – General Requirements and for record documents purposes described in Division 01 – General Requirements.

D. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. Shop drawings shall be submitted in advance of construction and installation so as to not cause delay in other Contractor's work.

F. Data submitted for Engineer's review shall be numbered consecutively, shall be noted to correlate with electrical drawings and shall bear:
1. Name and location of project.
2. Name of Contractor.
3. Date of submittal.
4. Date of drawings and date of each correction and revision.
5. If more than one type of lighting fixture (or other material) is on submitted sheet, proposed equipment shall be conspicuously checked with red pen by Electrical Contractor.

G. Shop drawings for different systems and equipment shall, be bound separately by specification section and not bound by manufacturer. Each separate submittal shall be sent under a separate transmittal.

H. Submittals which contain different specification section systems bound together shall be returned not reviewed and returned to Contractor for re-submittal.

I. Lighting Fixture shop drawings shall consist of single submittal with all project light fixtures included. Submittals grouped by manufacturer shall not be accepted. Contractor shall be responsible for coordinating drawings from his various suppliers in order to comply with this requirement.

J. Contractor shall examine shop drawings and equipment brochures prior to submission.

K. Contractor shall verify that materials and equipment depicted will properly fit into construction.

L. Contractor shall also review all previously completed work related to installation of equipment depicted to insure that it has been properly installed.

M. No materials or equipment subject to prior review by Engineer shall be fabricated or installed by Contractor, without approval.

N. Engineer's review of shop drawings shall not relieve Contractor of responsibility for deviations from requirements of drawings and specifications, unless prior approval for such deviations has been granted.

1.11 TEST REPORTS

A. Operation of equipment and electrical systems does not constitute an acceptance of work by Owner.

B. Final acceptance is to be made after Contractor has adjusted their equipment and demonstrated that it meets or exceeds requirements of drawings and specifications.

C. After work is completed and prior to acceptance, Contractor shall conduct following tests, tabulate data, date, sign and submit to Engineer:
   1. Standard megger insulation test on each feeder.
   2. Ground resistance test.
   3. Clamp ammeter test on each feeder conductor with all utilization equipment energized.
      a. Load current in each phase conductor of feeder or portion thereof supplying panel shall not differ from average connected load currents in feeder conductors by more than 7-1/2 percent.
      b. If load current does differ by more than 7-1/2 percent, Contractor shall change phase loading to same or receive written approval from Engineer that this is not required due to nature of load.

D. Upon completion of installation, Contractor shall furnish certificates of approval from authorities having jurisdiction.

E. Contractor shall demonstrate that all work is complete and is in specified operating condition, with raceway and conduit system properly grounded, wiring free from grounds, shorts, and entire installation is free from any physical defects.

F. In presence of Owner, Contractor shall demonstrate proper operation of all systems.

G. Perform other testing as specifically directed in other sections of specifications for specific equipment.

1.12 QUALITY ASSURANCE/CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship to produce Work of specified quality.

B. Comply fully with manufacturer's instructions, including each step in sequence.

C. Should manufacturer's instructions conflict with Contract Documents, request clarification from Engineer/Architect before proceeding.

D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce workmanship of specified quality.

F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

1.13 TEMPORARY FACILITIES AND CONTROLS

A. Reference Division 01 – General Requirements for temporary facilities and control requirements.

1.14 PRODUCT DELIVERY, STORAGE AND HANDLING REQUIREMENTS

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

D. Store and protect products in accordance with manufacturer's instructions.

E. Store with seals and labels intact and legible.

F. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

G. For exterior storage of fabricated products, place on sloped supports above ground.

H. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

I. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

J. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.15 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with following article.

C. Materials and equipment required shall be of new manufacture.

D. Items specified shall be of latest type or model produced by manufacturer specified. If model number is obsolete, substitute current manufacturer's product.

1.16 PRODUCT SUBSTITUTION PROCEDURES

A. Substitutions will not be allowed. Where the Contractor wishes to use equipment or methods other than those listed by name, that equipment must be approved by the Engineer. To gain approval for equipment not listed, the Contractor shall follow the substitution request procedures outlined in the following paragraphs.

B. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents, and specifically indicating where equipment differs from equipment specified.

D. A request constitutes a representation that Contractor:
1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
2. Will provide same warranty for Substitution as for specified product.
3. Will coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to Owner.
4. Waives claims for additional costs or time extension that may subsequently become apparent.
5. Will reimburse Owner and Engineer/Architect for review or redesign services associated with re-approval by authorities having jurisdiction.

E. Substitutions will not be considered when they are indicated or implied on shop drawings or product data submittals, without separate written request, or when acceptance will require revision to Contract Documents.

F. Substitution Submittal Procedure:
1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.
2. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
3. Lighting Fixtures: Request for substitutions shall include photometric test reports performed by an independent testing laboratory.

4. Contractor shall provide samples of proposed equipment for Engineer's review, if requested by Engineer.
5. Contractor shall furnish any other information or materials as requested by Engineer to establish equality.
6. Engineer will notify Contractor in writing of decision to accept or reject request.

G. Equipment and materials submitted without proper documentation shall be rejected without review.

H. Contractor's submitting equipment for approval as an equal, shall include in their bid all incidental costs that may result from use of approved equipment.

I. Such costs shall include, but not be limited to, additional costs that may be incurred by other contractors whose scope of work is affected by use of "equal" products.

J. Electrical Contractor shall be responsible for those costs even if they do not become evident until after bidding.

K. Only one request for substitution will be considered for each product.

L. When substitution is not accepted, provide specified product.

M. Submittals shall be received to allow for sufficient time to incorporate the acceptance into the bid documents through an addendum. Substitution submittals received after the issuance of the final addendum will not be considered.

1.17 FINAL CLEANING AND PAINTING

A. Rubbish resulting from work shall be removed and disposed of on a daily basis in such manner as to be acceptable to Architect.

B. Contractor shall clean all exposed iron work, interior and exterior of cabinets and pull boxes, etc., and remove rubbish and debris resulting from work.

C. Where painted surfaces of equipment have been damaged or rusted during construction, Contractor shall paint same to match final.

D. Clean other equipment as indicated in other sections of specification for specific equipment.

1.18 STARTING OF SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify Owner five days prior to start-up of each item.

C. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.

D. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.

E. Verify wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of applicable manufacturer's representative and/or Contractor's personnel in accordance with manufacturer's instructions.

G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

1.19 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of Substantial Completion.

1.20 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of following electrical record documents; record actual revisions to the Work:
   1. Locations of all buried conduit or similar items. Include buried depth.
   2. Changes made by field order or change order.
   3. Changes to circuit numbers.
   4. Locations of all feeders and pullboxes.
   5. Record documents include:
      a. Drawings.
      b. Specifications.
      c. Addenda.
      d. Change Orders and other modifications to the Contract.
      e. Reviewed Shop Drawings, Product Data, and Samples.
      f. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress, not less than weekly.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including following:
   1. Manufacturer's name and product model and serial number.
   2. Product substitutions or alternates utilized.
   3. Changes made by Addenda and modifications.

F. Record Drawings: Legibly mark each item to record actual construction including:
   1. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   2. Field changes of dimension and detail.

G. Submit documents to Engineer/Architect for review. Documents shall be submitted in both electronic and hard copy formats.

1.21 EXTRA MATERIAL AND SPARE PARTS

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual specification sections.

1.22 OPERATION AND MAINTENANCE MANUALS

A. Contractor shall assemble and submit to Architect for subsequent submission to Owner, three complete sets of Manual of Operation and Maintenance for each of electrical and communications systems.

B. Each manual shall consist of a 3-ring binder volume instructing Owner's personnel in operation and maintenance of system in question.

C. All information shall be bound and secured in manual.

D. Manual shall cover all phases of operation of equipment and shall be illustrated with photographs, drawings, and wiring diagrams.

E. Manuals shall accurately describe operation, construction and adjustable features of complete system and its component parts.

F. Manual shall be complete with an equipment parts listing to facilitate ordering of spare and replacement parts.

G. Each manual shall contain two sets of final shop drawings depicting equipment as installed.

PART 2 - PRODUCTS

2.1 FIRESTOPPING

A. Firestopping materials shall include, but not be limited to, mortars, sealants and caulks, putties, collars, intumescent wrap strips mastics, and firestop pillows. Materials and methods used shall be recognized by an independent testing agency and shall have flame and temperature ratings assigned by specific agency.

B. Materials using solvents or those requiring hazardous waste disposal shall not be used.

C. Firestop assemblies shall meet fire test and hose stream test requirements of independent testing agency. Acceptable Manufacturers:
1. 3M Corporation.
2. Rectorseal Corporation.

2.2 SLEEVES

A. Sleeves: ASTM A53, Schedule 40 galvanized steel pipe.

2.3 ACCESS PANELS

A. Access panels required by code or otherwise to electrical service equipment shall be supplied and installed by Electrical Contractor.

PART 3 - EXECUTION

3.1 FIRESTOPPING

A. Openings in fire rated construction and annular spaces around conduits, cable trays, and other penetrating items shall be protected in accordance with NEC Article 300.21 and in accordance with Wisconsin Administrative Code, Department of Commerce Chapter 51.049. Fire rating of protective seal shall be at least that of floor or wall into which it is installed, so that original fire rating of construction is maintained.

B. Wall or floor penetration openings shall be as small as possible.

C. Openings and annular spaces required by code to be protected, shall be protected.

D. Installation of materials and assemblies shall be in strict accordance with manufacturer's instructions.

3.2 SLEEVES

A. Where conduits, cables trays, or other electrical raceways must pass through floors or walls that are to be constructed of poured in place concrete, contractor shall provide sleeves in formwork prior to concrete pour. It shall be Electrical Contractor's responsibility to provide all sleeves for his work unless specifically indicated otherwise on drawings. Prior to installing sleeves, contractor shall prepare drawings indicating locations, quantities, sizes, and spacings of all sleeves anticipated. Drawings shall be forwarded to structural engineer for approval.

END OF SECTION

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SECTION 26 05 03
WIRING CONNECTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Electrical Connections to Equipment.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Section 26 05 19 - Building Wire and Cable.
4. Section 26 05 33 - Raceway and Boxes.

1.2 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

PART 2 - PRODUCTS

2.1 CORD AND PLUGS

A. Attachment Plug Construction: Conform to NEMA WD 1.

B. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.

C. Cord Construction: Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

D. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit over-current protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.2 INSTALLATION

A. Make electrical connections.

B. Make conduit connections to equipment that is subject to vibration using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations. Equipment subject to vibration shall include:
   1. Motors.
   2. Packaged HVAC equipment.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

F. Provide disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

G. Provide terminal block jumpers to complete equipment wiring requirements.

H. Provide interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.3 ADJUSTING

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

B. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

3.4 SPECIAL OUTLET AND MOTOR WIRING SCHEDULES

A. See Drawings.

END OF SECTION

SECTION 26 05 19

BUILDING WIRE AND CABLE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Building Wire.
2. Building Cable.
3. Wiring Connectors.
4. Connections.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Section 26 05 53 – Electrical Identification.

1.2 REFERENCES

A. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code (NEC).

1.3 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years.

1.4 FIELD MEASUREMENTS

A. Verify field measurements are as indicated on Drawings.

1.5 COORDINATION

A. Division 01 – General Requirements: Requirements for coordination.

B. When wire and cable destination is indicated and routing is not shown, determine routing and lengths required.

PART 2 - PRODUCTS

2.1 BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Insulation: Type THHN/THWN, XHHW-2 insulation for feeders and branch circuits.
1. Type XHHW-2 insulation for feeders with aluminum conductors.

a. Insulation shall not contain halogenated flame retardants, including but not limited to polybrominated diphenyl ethers.
b. Insulating jacket shall be 100% lead free.

2.2 WIRING CONNECTORS

A. Conductors No. 10 AWG and Smaller: Scotch 3M - Scotch-lok compression type solderless connectors with plastic cover.

B. Joints, Taps, and Splices in Conductors No. 8 AWG and Larger: Solderless compression type connectors, tool and die applied, of type that will not loosen under vibration or normal strains. Burndy "Hy-Dent" type or equivalent as acceptable to Engineer.

C. Rubber insulating electrical tape: Scotch 3M model 23, 30-mil tape.

D. Split bolt connectors are not acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Install in accordance with manufacturer's written instructions and in accordance with recognized industry practices.

B. Run wire and cable in conduit, unless otherwise indicated on drawings.

C. Do not draw conductors into conduits until building is enclosed and watertight and until work that may cause conductor damage has been completed.

D. Voltage drop for branch circuits and feeder circuit combined shall not exceed requirements of NEC Article 215.

E. Examine areas and conditions under which conductors are to be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of work.

F. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 JOINTS, TAPS AND SPLICES

A. Each tap, joint, or splice in conductors No. 8 AWG and larger shall be taped with two half-lap layers of vinyl plastic electrical tape and finish wrap of color coding tape, where required by code.

B. Cable splices shall be made only in distribution and junction boxes.

3.3 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.4 INSTALLATION

A. Route wire and cable to meet project conditions.

B. Conductors shall not be installed at temperatures below manufacturer's minimum installation temperature.

C. Neatly train and lace wiring inside boxes, equipment, and panelboards.

D. Identify and color code wire and cable under provisions of Section 26 05 53 – Electrical Identification.

E. Identify each conductor with its panel and circuit number or other designation indicated.

F. Special Techniques - Building Wire in Raceway:
1. Pull conductors into raceway at same time.
2. Install building wire 4 AWG and larger with pulling equipment.

G. Special Techniques - Wiring Connections:
1. Clean conductor surfaces before installing lugs and connectors.
2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
4. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
5. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
6. When 10 AWG and smaller stranded conductors are used install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.

3.5 BRANCH CIRCUIT CONDUCTORS

A. Install branch circuits and switched circuits as required to comply with circuiting, switching, and control functions shown on drawings.

B. Conductors shall be size 12 AWG minimum, unless otherwise noted, for branch circuit wiring, including motor circuits.

C. Size 120V branch circuits for length of run on following basis:
1. 0 to 75 ft. run from panelboard to first outlet: No. 12 AWG minimum.
2. 75 to 125 ft. run: increase one wire size, No. 12 AWG becomes No. 10 AWG.
3. 126 to 200 ft run: increase two wire sizes, No. 12 AWG becomes No. 8 AWG.
4. 201 and above: wiring to be sized for 3 percent maximum voltage drop.

D. Provide individual neutral conductors for all branch circuit phase conductors. Multi-wire branch circuits sharing common neutral will not be allowed.

E. Route branch circuits and switch legs as dictated by construction, these specifications, or instruction from Engineer.

F. Size conduit, outlet boxes, and other raceway system components in accordance with NEC requirements as minimum.

G. Circuit numbers as shown on drawings are for Contractor to plan their wiring and for estimating purposes and are not necessarily exact circuit numbers to be used in specific panel for particular load.

H. Exact circuit numbers for each load are to be selected by Contractor at their option.

I. Balanced load on panelboard bus will be determining factor in arrangement of circuits. Panelboards average load shall not differ from phase to phase by plus or minus 7.5 percent.

J. Motor and equipment branch wiring.
   1. Furnish and install motor circuits in accordance with schedules on drawings and code requirements, from source of supply to associated motor starter, and from starter to motor terminal box, including necessary and required intermediate connections.
   2. Conductor and conduit size for motor branch circuits, if shown on drawings, are sized for motor requirement only.
   3. Control wiring is not included in conduit sizes shown on drawings.
   4. Motors shall have proper conductor sizes as per NEC requirements and nameplate ratings.
   5. Contractor shall be responsible for verification of ratings of motors and installing proper branch circuits.
   6. Obtain manufacturer's wiring diagrams and shop drawings for equipment requiring electrical connections.
   7. Check drawings and specifications of other divisions of work for equipment and work, which shall be included in order to provide complete electrical installation.
   8. Motor connections shall be made by compression type connectors using proper tools and fittings to assure good electrical continuity and low resistance joint.

3.6 FEEDER INSTALLATION

A. Install in accordance with manufacturer's written instructions, and in accordance with recognized industry practices.

B. Extend feeders at full capacity from origin to termination.

C. Feeder conduits shall contain only those conductors constituting a single feeder circuit.

D. Where feeder conductors are run in parallel, conductors shall be of same length, same material, circular-mil area, insulation type, and terminated in same manner.

E. Where parallel feeder conductors run in separate raceways, each raceway shall have same physical characteristics.

F. Feeders shall follow most accessible routes, concealed in construction in finished areas, exposed to minimum temperature gradient and to minimum temperature fluctuation.

G. Confine feeders to insulated portions of building, unless otherwise specified.

H. Trapped feeder runs without facilities for continuous drainage are not acceptable.

I. Feeder conduits shall not be routed in conduit floor slabs or below basement or grade level floor slabs.

J. Feeder conductors in switchboards, panelboards, pullboxes, gutters, and other open wiring spaces shall be bundled by feeder using plastic tie wraps at intervals not greater than 3 feet on center.

3.7 FIXTURE WIRES

A. Use conductor with insulation suitable for current, voltage, and temperature to which conductor will be subjected.

B. Provide minimum No. 12 wire size for conductors supplying power to a single fixture. 600V insulation minimum.

C. Insulation suitable for operation at 90 degrees C. minimum for lighting fixtures with integral ballast, mogul base sockets, quartz lamps, or otherwise where subject to excessive temperatures.

D. Fixture wiring shall be continuous wiring system to lampholder or to ballast and from ballast to lampholder.

3.8 IDENTIFICATION AND LABELLING

A. For materials specified in this section, see specification Section 26 05 53 for identification and labeling requirements.

3.9 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

END OF SECTION

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SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rod electrodes.
2. Wire.
3. Mechanical connectors.
4. Exothermic connections.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Section 26 05 19 - Building Wire and Cable.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers (IEEE):
1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.

B. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code.

1.3 SYSTEM DESCRIPTION

A. Grounding systems use the following elements as grounding electrodes:
1. Metal underground water pipe.
2. Concrete-encased electrode.
3. Rod electrode.

1.4 DESIGN REQUIREMENTS

A. Provide all material, labor and incidentals necessary for the completion of this section of work.

1.5 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

B. Perform Work in accordance with National Electric Code and state and local code requirements.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years' experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products under provisions of Division 01 – General Requirements.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.8 COORDINATION

A. Coordinate complete grounding and bonding of building reinforcing steel prior to concrete placement.

PART 2 - PRODUCTS

2.1 ROD ELECTRODES

A. Manufacturers
1. Galvan Industries/Erico Inc.
2. LTV/Copperweld, Inc.
3. Eritech/Erico, Inc.
4. Lyncole XIT Grounding
5. Harger Lightning and Grounding

B. Product Description
1. Material: Copper-Clad steel

C. Connector: Connector shall be exothermic welded connection unless otherwise noted. Provide U-bolt clamp in ground test wells and where indicated on drawings.

2.2 WIRE

A. Material: Stranded copper. Provide tin plated copper where exposed to corrosive environment.

B. Connection to Electrodes: 2/0 AWG, minimum size.

C. Grounding Electrode Conductor: Copper conductor, bare.

D. Bonding Conductor: Copper conductor, bare.

2.3 MECHANICAL CONNECTORS

A. Manufacturers:
1. Erico, Inc.
2. ILSCO Corporation.
3. O-Z Gedney Co.
4. Thomas & Betts, Electrical.
5. Burndy Electric.

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

C. Ground clamp fittings shall be interlocking clamp type, fabricated from high strength corrosion resistant metal with high strength silicon bronze u-bolts, nuts, locks, and lock washers.

2.4 EXOTHERMIC CONNECTIONS

A. Manufacturers:
1. Thermoweld.
2. Cadweld, Erico, Inc.
3. Harger Lightning Protection.
4. Exothermic Welding Co.
5. Thomas & Betts, Electrical.

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.5 GROUND BUSSES

A. Copper only.

B. Cross section shall be 1/4 inch x 2 inches, lengths as shown on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify of existing conditions before starting work.

B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

A. Install in accordance with IEEE 142.

B. Install rod electrodes near location of electric service entrance unless otherwise shown on drawings. Install additional rod electrodes, if required, to achieve specified resistance to ground.

C. Install interconnecting wire 2 feet below finish grade.

D. Install grounding and bonding conductors concealed from view.

E. Bond together metal siding not attached to grounded structure; bond to ground.

F. Install continuous grounding using underground cold water system, driven ground rods, and building steel as grounding electrode.

G. Ground electrical systems and equipment as required by code, utility, local ordinances, and to requirements herein.

H. Install separate code rated grounding conductors to special equipment and activity areas as required by code.

I. Bond all metallic piping systems and service equipment as required by NEC.

J. Permanently attach grounding conductors prior to energizing equipment.

K. Drive ground rods to depth of 4 inches below finished grade.

L. Grounding electrode conductor shall be continuous without splice from nearest building grounding electrode. Ground to service equipment. Install bonding jumper around water meter. Attach non-ferrous metal tag to warn against removal. Make connections to ground electrodes with approved molded exothermic weld process.

3.3 EQUIPMENT GROUND

A. Bond metallic conduits, supports, cabinets, and other equipment so ground will be electrically continuous from service to outlet boxes.

B. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

C. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits.

D. Size grounding conductors in accordance with NEC.

E. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment.

F. Install grounding conductor in nonmetallic and flexible conduit to complete equipment ground continuity.

G. Ground wire shall be bonded at equipment and at first junction box of conduit system on line side of flexible conduit to the system.

H. Install grounding conductors to permit shortest and most direct path from equipment to ground.

I. When grounding conductor runs through metallic conduit, bond to conduit at entrance and exit with bolted clamp.

J. Ground neutral at service only.

K. Install separate equipment grounding conductor in each conduit containing feeder conductors.

L. Install green equipment grounding conductor in all conduits serving branch circuits.

M. Green ground bar in panels, where required to be similar to neutral bar, except tinted green and bonded to panel tub.

N. Connections shall be accessible for inspection and checking.

O. No insulation shall be installed over ground connections.

P. Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.

Q. Attach grounds permanently before permanent building service is energized.

R. Ground Busses:
1. Mount to walls with insulated standoffs.
2. At splice points, splice bus shall overlap busses being spliced with dimension twice width of buss being spliced. Splice bus shall be connected to each bus with a minimum of two splice bolts.
3. Bus splice bolts shall utilize belleview washers.

3.4 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform ground resistance testing in accordance with IEEE 142. Contractor shall make ground resistance measurements. Measure in normally dry conditions, not less than 48 hours after rainfall.

C. Perform continuity testing in accordance with IEEE 142.

END OF SECTION

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SECTION 26 05 29

ELECTRICAL HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Sleeves.
5. Mechanical sleeve seals.
6. Firestopping relating to electrical work.
7. Firestopping accessories.
8. Equipment bases and supports.

B. Related Sections
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Division 03 Concrete: Product requirements for concrete for placement by this section.
3. Section 26 00 00 – Basic Electrical Requirements.

1.2 REFERENCES

A. ASTM International (American Society for Testing and Materials):
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

B. FM Global (FM):
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Electrical Contractors Association (NECA):
1. Standard of Installation.

D. National Electrical Manufacturers Association (NEMA).

E. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code.

F. Underwriters Laboratories Inc. (UL):
1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL - Fire Resistance Directory.

G. Intertek Testing Services (Warnock Hersey Listed) (WH):
   1. WH - Certification Listings.

1.3 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.

B. Surface Burning: ASTM E84, UL 723 with maximum flame spread / smoke developed rating of 25/450.

C. Firestop interruptions to fire rated assemblies, materials, and components.

1.5 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with State and Municipality standards.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products under provisions of Division 01 – General Requirements.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Division 01 – General Requirements: Environmental conditions affecting products on site.

PART 2 - PRODUCTS

2.1 CONDUIT SUPPORTS

A. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

B. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

C. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

D. Conduit clamps - General Purpose: One hole malleable iron for surface mounted conduits.

E. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self-locking.

2.2 FORMED STEEL CHANNEL

A. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

A. Product Description: Mounting hole and screw closure.

2.4 SLEEVES

A. Sleeves Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

C. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.5 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Link-Seal, Inc.
2. NMP Corporation.
3. Equivalent as acceptable to Engineer.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.6 FIRESTOPPING

A. Manufacturers:
1. Dow Corning Corp.
2. Fire Trak Corp.

3. Hilti Corp.
4. International Protective Coating Corp.
5. 3M Fire Protection Products.
6. Specified Technology, Inc.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
   1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
   2. Foam Firestopping Compounds: Single component foam compound.
   3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
   4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
   5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
   6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
   7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: Dark gray.

2.7 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

C. General:
   1. Furnish UL listed products.
   2. Select products with rating not less than rating of wall or floor being penetrated.

D. Non-Rated Surfaces:
   1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.
   2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Do not drill or cut structural members.

D. Install hangers, supports, and anchors only after structural work, where work is to be installed, has been completed. Correct inadequacies such as proper placement of inserts, anchors, and other building structural attachments.

E. Examine areas and conditions under which equipment and associated components are to be installed and notify Architect, in writing, of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
1. Concrete Structural Elements: Provide precast inserts, expansion anchors, powder actuated anchors and preset inserts.
2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners, and welded fasteners.
3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.
8. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent transfer of loading and stresses to connected equipment.
9. Installation methods shall be in conformity with manufacturer's recommendations for maximum holding power, but in no case shall the depth of hole be less than four bolt diameters. Minimum distance between center of any expansion anchor and edge of exterior corner of concrete shall be not less than 4-1/2 times the diameter of hole in which it is installed.

B. Inserts:
1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

C. Install conduit and raceway support and spacing in accordance with NEC.

D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

E. Install multiple conduit runs on common hangers.

F. Supports:
1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface mounted cabinets and panelboards with minimum of four anchors.
3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
4. Support vertical conduit at every floor.

3.4 LIGHTING FIXTURE SUPPORT

A. Items including (but not limited to) stems, hickeys, bar hangers, and clips required to securely attach fixtures to ceilings or walls.

B. Studs and unistrut support for fixture outlet and ceiling support.

C. Fixture grid hangers for mounting surface fluorescent units to exposed grid ceiling.

D. Drilled expansion insert type anchors rated for load and application requirements including (but not limited to) sleeve anchors, lag shields, and plastic anchors.

E. Provide auxiliary supports so that fixtures can be drawn up tightly, cannot be tilted or rotated, and will not be affected by vibrations.

3.5 SUPPORT OF CONDUIT

A. Fasten conduit to structural parts of building in a manner acceptable to Engineer.

B. Do not use perforated hanger iron.

C. Install concrete insert channel as required, with spacings as recommended by manufacturer. Install with anchor and caps, insert joiner clips and closer seals as required.

D. Support conduit as follows:
1. Single conduit runs vertical surfaces: Galvanized, heavy duty, sheet steel straps; back straps to be provided for all exposed conduit and conduit on exterior walls.
2. Single conduit runs horizontal surfaces: Galvanized, heavy duty, one hole malleable iron or 2 hole steel pipe straps.
3. Multiple conduit runs vertical surfaces: Horizontal or vertical rack channel with conduit straps as required.

4. Multiple conduit runs horizontal surfaces: Single or double rack channel trapeze, complete with conduit straps as required; all supported with threaded hanger rods.
5. Conduit runs through roof: Conduit extending through roof shall pass through ceiling box at roof lines. Provide 14 gauge minimum copper box complete with watertight soldered seams and flanged to serve as pitch pocket for each conduit. Conduit and pitch pocket shall be installed in advance of roofing work.
6. Vertical Cable Support. Conductors in vertical raceways shall be supported using cable supports. Locate supports so that each 25 feet length of conductor in a vertical raceway is supported.

3.6 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating.

D. Fire Rated Surface:
1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
   a. Install sleeve through opening and extending beyond minimum of one (1) inch on both sides of building element.
   b. Size sleeve allowing minimum of one (1) inch void between sleeve and building element.
   c. Pack void with backing material.
   d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
2. Where cable tray, bus, cable bus, conduit, wireway, trough, and penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

3.7 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Division 03 - Concrete.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

3.8 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors one (1) inch above finished floor level. Caulk sleeves.

F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

G. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

3.9 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

A. Provide under provisions of Division 01 – General Requirements.

B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

A. Provide under provisions of Division 01 – General Requirements.

B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 26 05 33
RACEWAY AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Conduit.
2. Tubing.
3. Raceways.
4. Wireways.
5. Outlet Boxes.
6. Pull Boxes.
7. Junction Boxes.
8. Handholes.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Section 26 05 34 - Floor Boxes.
4. Section 26 05 53 - Electrical Identification.

1.2 REFERENCES

A. American National Standards Institute (ANSI):
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).

B. National Electrical Manufacturers Association (NEMA):
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products under provisions of Division 01 – General Requirements.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.4 COORDINATION

A. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

2.2 METAL CONDUIT

A. Rigid Steel Conduit: ANSI C80.1.

B. Intermediate Metal Conduit (IMC) or Rigid Metal Conduit (RMC).

C. Fittings and Conduit Bodies: NEMA FB 1; Fittings for metal raceways shall be steel or malleable iron and shall be zinc galvanized, or cadmium plated. Do not use aluminum or die cast fittings. Threaded and liquid tight.

D. Box connector bushings shall have insulated throats. Integral grounding lugs shall be provided where required by code, where detailed on the Drawings, or required elsewhere in these specifications.

2.3 PVC COATED METAL CONDUIT

A. Product Description: NEMA RN 1; rigid steel conduit with external PVC coating, 40 mil thick.

B. Fittings and Conduit Bodies: NEMA FB 1; steel fittings with external PVC coating to match conduit, PVC gasketed for mating surfaces

2.4 FLEXIBLE METAL CONDUIT (FMC)

A. Product Description: Interlocked steel construction.

B. Fittings: NEMA FB 1. Threaded, grounding type, insulated throat, two screw clamp type with locknuts, externally secured.

C. Minimum size 1/2 inch with the exception that 3/8 inch diameter may be used in lengths not to exceed 6 foot, to serve individual lighting fixtures installed in suspended accessible ceiling system.

2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Product Description: Interlocked steel construction with PVC sunlight resistant jacket.

B. Fittings: NEMA FB 1. Liquid tight, suitable for grounding, suitable for wet locations, tapered threaded hub, non-metallic materials.

2.6 ELECTRICAL METALLIC TUBING (EMT)

A. Product Description: ANSI C80.3; galvanized tubing.

B. Fittings and Conduit Bodies: NEMA FB 1; steel or malleable iron, compression, threaded, insulated throat, gland compression type, rain and concrete tight type.

C. Box connector bushings shall have insulated throats. Integral grounding lugs shall be provided where required by code, where detailed on Drawings, or required elsewhere in these specifications.

2.7 NONMETALLIC CONDUIT

A. Product Description: NEMA TC 2; Schedule 40 or 80 PVC, UL listed, and as required by NEC. Sunlight resistant.

B. Rated for 90 degrees C. cable.

C. Fittings and Conduit Bodies: NEMA TC 3, schedule 40 or 80, to match conduit.

D. Expansion fittings. PVC material, Carlon series E945 or equivalent.

E. Expansion straps. PVC material, Carlon series E978 or equivalent.

2.8 MULTI-CELL RIGID CONDUIT AND FITTINGS

A. Outer duct shall be HW PVC or Rigid Metal Conduit as specified in Section 26 05 33 – Raceway and Boxes.

B. Three cell schedule 40 factory installed inner ducts within 4 inches outer duct. Each cell shall have diameter of approximately 1.50 inches.

C. Inner ducts shall be PVC or nylon as required by Section 26 05 33 – Raceway and Boxes.

D. Inner ducts shall be pre-lubricated.

E. Outer markings to assist contractor in proper installation and alignment.

F. Internal spacers to keep cells straight throughout run.

G. Use manufacturer’s transition adapters when connecting HW PVC outer duct sections to GRC outer duct sections.

2.9 EXPANSION FITTINGS

A. Expansion fittings: Copper bonding jumper, Crouse-Hinds Type XJ.

B. Expansion/deflection fittings: Copper bonding jumper, Crouse-Hinds Type XD.

2.10 SURFACE METAL RACEWAY

A. Manufacturers:
1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Walker Systems Inc.
5. The Wiremold Co.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

C. Finish: Gray Stainless steel.

D. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.11 WIREWAY

A. Product Description: General purpose type wireway.

B. Knockouts: Manufacturer's standard.

C. Cover: Screw cover.

D. Finish: Rust inhibiting primer coating with gray enamel finish.

2.12 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch (13 mm) male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

B. Cast Boxes: NEMA FB 1, Type FD, aluminum. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

C. Wall Plates for Finished Areas: As specified in Section 26 27 26 – Wiring Devices.

D. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.13 PULL AND JUNCTION BOXES

A. Outlet Boxes:
1. Interior Wall Outlet Boxes – Flush Mounted: Stamped steel, four-inch square, 2-1/8 inch deep minimum, with square corners. Provide with raised device rings, height to match wall finish thickness. Mounting accessories. Larger width boxes shall be provided for ganging requirements indicated on drawings.

2. Interior Wall Outlet Boxes – Surface Mounted – Dry Location: Stamped steel, four-inch square, 2-1/8 inch deep, with round corners. Provide rounded corner raised box covers with openings for devices being installed.
3. Interior Wall Outlet Boxes – Surface Mounted – Damp or Wet Location: Cast malleable iron with threaded conduit hubs. Two inches deep minimum. Internal mounting ears. Boxes shall be coated with electroplated zinc, a dichromate coating, and aluminum polymer enamel finish.
4. Exterior Wall Outlet Boxes – Surface Mounted: Cast malleable iron with threaded conduit hubs. Two inches deep minimum. Internal mounting ears. Boxes shall be coated with electroplated zinc, a dichromate coating, and aluminum polymer enamel finish.
5. Ceiling Boxes – Flush Mounted – for Surface and Pendant Light Fixtures: Dropped ceiling construction. Stamped steel four-inch octagon box set flush with finished surface, with 3/8 inch fixture stud.
6. Cast in place concrete construction. Stamped steel four inch octagonal, galvanized concrete boxes having a minimum depth of 3 inches, with 3/8 inch fixture stud.
7. Electrical Boxes in Corrosive Locations: PVC coated cast steel boxes compatible with conduit system installed. Coating shall cover both interior and exterior surfaces. See floor plans for identification of corrosive areas.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Hinged Enclosures: As specified in Section 26 27 16 – Cabinets and Enclosures.

D. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box;
1. Material: Galvanized cast iron.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

E. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:
1. Material: Galvanized cast iron.
2. Cover: Smooth cover with neoprene gasket and stainless steel cover screws.
3. Cover Legend: "ELECTRIC".

F. Polymer concrete composite Handholes: Die-molded, polymer concrete composite hand holes:
1. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.
2. Cover: polymer concrete composite, weatherproof cover with nonskid finish. Secure cover with stainless steel hex bolts.

2.14 SEALS

A. Link seal type as manufactured by Thunderline Corporation or equivalent as acceptable to Engineer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 RESTRICTIONS

A. Split, crushed, or scarred conduit is not acceptable.

B. Welded conduit is not acceptable.

C. Do not route conduit over boiler, under boiler or in slabs below boiler, incinerator, or other high temperature equipment.

D. PVC conduit may not be used in interior of building except at following locations.
   1. PVC conduit may be used for grounding conductors.
   2. Parking Decks

3.3 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements.

B. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

C. Underground More than 5 feet outside Foundation Wall: Provide schedule 40 nonmetallic conduit, unless otherwise noted on drawings.

D. Provide cast metal boxes in pavement or sidewalks and nonmetallic handhole in grass areas, unless otherwise noted.

E. Underground Within 5 feet from Foundation Wall: Provide rigid steel conduit.

F. In or Under Slab on Grade: Provide schedule 40 nonmetallic conduit. Provide RMC elbows where conduits exit slab and are exposed to view.

G. Outdoor Locations, Above Grade: Provide rigid steel conduit, unless otherwise noted. Provide cast metal outlet, pull, and junction boxes.

H. In Slab Above Grade: Feeder conduit shall not be installed in slab. Provide schedule 40 nonmetallic conduit with EMT elbow so any conduit above slab shall be metallic.

I. Wet and Damp Locations: Provide rigid steel conduit. Provide cast metal junction and pull boxes. Provide flush mounting outlet box in finished areas.

J. Conduits for Parking Ramp
   1. Conduit for equipment in parking ramp shall be Schedule 40 PVC in all areas that offer physical protection (i.e. ceiling between concrete tees).
   2. Conduit in areas that are exposed to physical damage such as vertical runs less than 6 feet above floors or parking deck shall be galvanized rigid steel.
   3. Provide PVC expansion fittings in all exposed PVC conduit runs longer than 3 feet. Provide expansion fittings 30 feet on centers on runs longer than 30 feet. Expansion fittings shall have at least 6 inches of travel and shall be similar to Carlon E945 series. Set expansion fittings for installed ambient temperatures (i.e. half way at 50 degrees F).

4. Provide special PVC straps similar to Carlon E978 series for all PVC conduit. Provide two fasteners at each strap. Conduit supports shall be provided at 3 feet on center, maximum.

K. Concealed Dry Locations: Provide rigid steel, intermediate metal conduit or electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

L. Exposed Dry Locations: Provide rigid steel, intermediate metal conduit or electrical metallic tubing, unless otherwise noted. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

M. Conduits embedded in concrete lighting fixture pole bases shall be Rigid Metal Conduit.

N. Provide separate conduit system for each of the following systems:
1. 208 volt normal power wiring systems.
2. 208 volt code required emergency power wiring systems.
3. 208 volt legally required and optional emergency power wiring systems.
4. Low voltage lighting control systems.
5. Fire alarm systems.
6. Closed circuit television (CCTV) systems.
7. Voice/data communications raceway systems.

3.4 INSTALLATION

A. Install Work in accordance with State and Municipality standards.

B. All conduits containing service entrance conductors shall be rigid metal conduits.

C. Ground and bond raceway and boxes in accordance with Section 26 05 26 – Grounding and Bonding.

D. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29 – Electrical Hangers and Supports.

E. Identify raceway and boxes in accordance with Section 26 05 53 – Electrical Identification.

F. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.5 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29 – Electrical Hangers and Supports; provide space on each for 25 percent additional raceways.

E. Secure conduits in place with malleable corrosion-proof alloy straps or hangers. Conduit straps used in corrosive areas shall be PVC coated.

F. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports.

G. Do not attach raceway to ceiling support wires or other piping systems.

H. Construct wireway supports from steel channel specified in Section 26 05 29 – Electrical Hangers and Supports.

I. Route exposed raceway parallel and perpendicular to walls and structural members.

J. Route raceway installed above accessible ceilings parallel and perpendicular to walls and structural members.

K. Conduits under slab may be routed from point-to-point.

L. Conduits routed within concrete construction such as poured walls, floor slabs, topping slabs, shall comply with following requirements.
   1. Conduits shall be parallel to each other, spaced on center to center distance of at least three times conduit trade diameter, and provided with a minimum of 2 inches of concrete.
   2. Contractor shall note that precast planks below topping slabs may camber. Topping slab thickness will be less at high point of camber.
   3. Conduits larger than 1-1/4 inch inside diameter shall not be installed in floor slabs. Conduits over 3/4 inch ID shall not be installed in topping slabs.
   4. Conduits embedded in a structural frame slab shall comply with applicable provisions of American Concrete Institute (ACI), Standard 318. Refer to structural drawings for locations of structural frames.
   5. Conduits used for feeders shall not be embedded in concrete floor slabs or concrete topping slabs.
   6. Conduits in poured concrete construction shall not cross other conduits or other piping.
   7. Unless specifically indicated on electrical drawings, conduits installed in poured concrete construction shall be approved by Structural Engineer prior to conduit installation.
   8. Contractor will be required to submit drawings showing conduit sizes and routings to Structural Engineer for their review. Approval may not be given prior to bidding. Contractors who base their bid on assumption that conduits will be allowed in concrete construction do so at their own risk. No changes will be made to contract if, during construction, Structural Engineer prohibits installation of conduit in concrete construction.
   9. In areas constructed of precast concrete conduits may be run in cores of planks.

M. Maintain clearance between raceway and piping for maintenance purposes.

N. Maintain 12-inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F. Do not route conduit over boiler, incinerator, or other high temperature equipment.

O. Where conduits must cross or follow same path as water, steam or other fluid piping, run electrical conduits above such piping wherever possible.

P. Cut conduit square using saw or pipe cutter; de-burr cut ends.

Q. Bring conduit to shoulder of fittings; fasten securely.

R. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

S. Install conduit hubs to fasten conduit to cast boxes in damp and wet locations.

T. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install hydraulic one-shot bender to fabricate or factory elbows for bends in metal conduit larger than 2-inch size.

U. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

V. Provide watertight conduit system where installed in wet locations such as underground, or where embedded in concrete.

W. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints. Provide fittings with bonding jumper.

X. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

Y. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

Z. Close ends and unused openings in wireway.

AA. Conduit runs that extend through areas of different temperature or atmospheric conditions or that are partly indoors and partly outdoors shall be sealed, drained, and installed in a manner that will prevent drainage of condensed or entrapped moisture into cabinets, motors, or equipment enclosures. Install bushings with ground lugs and integral plastic linings at equipment with open-bottom conduit entrances.

BB. Conduit connections at motors, transformers, and other equipment that vibrates.
1. Flexible metal conduit between 18 inches and 36 inches long for conduit connections at equipment that vibrates.
2. Liquid-tight flexible metal conduit where flexible connections are required and where conduit will be exposed to moisture, dirt, fumes, oil, corrosive atmosphere, etc. Provide with connectors to assure a liquid-tight, permanently grounded connection. Locate so it is least subject to physical abuse. Corrosive areas are identified on floor plan.
3. Use double locknuts and insulated bushings with threads fully engaged.

CC. Direct buried underground conduit.
1. Exterior underground direct buried conduits shall be buried at a depth of not less than 30 inches below grade.

2. Provide conduits or ducts terminating below grade with means to prevent entry of dirt or moisture.
3. Underground conduits shall slope 1/8 inch per foot for proper drainage. Conduits shall drain toward manholes and junction boxes, not the electrical equipment.

DD. COVERED PARKING STRUCTURE CONDUITS

1. Provide PVC fittings and PVC cement, which are compatible with the conduit being used and installation temperature.
2. Provide PVC expansion fittings in all exposed PVC conduit runs longer than 36 inches. Provide every 30 feet for runs longer than 30 feet. Expansion fittings shall have 6 inches of travel. Set expansion fittings for installed ambient temperature, half way at 50 degrees F.
3. Provide special PVC expansion straps. Provide two fasteners at each strap. Conduit supports 3 feet on center maximum.
4. Provide cast iron junction boxes to support light fixtures.

3.6 INSTALLATION - SURFACE RACEWAY

A. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

B. Where exposed raceways and electrical devices are required in existing construction, exposed raceway, fittings and boxes shall be used provided that installation meets following:
   1. Raceways shall be routed horizontally along corner surfaces formed by walls and ceilings, directly above edges of bases at floor, along tops of window mullions and door frames.
   2. Raceways shall be routed vertically along corners formed by adjacent walls and along edges of door frames.
   3. Surface raceways shall not be routed down or across open wall surfaces except in portions of runs not exceeding 12 inches in length.
   4. Surface raceways shall be painted to match wall finishes on which the raceways are routed. If wood backing is required, it shall be continuous and painted to match surrounding surfaces.
   5. If raceways are installed prior to painting, raceways will then be painted as part of painting contract.
   6. Fittings and boxes used with surface metal raceways shall be specifically designed and approved for use with such raceways.

3.7 INSTALLATION - BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings.

B. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.

C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26 – Wiring Devices.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.

H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

I. Install stamped steel bridges to fasten flush mounting outlet box between studs.

J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

K. Install adjustable steel channel fasteners for hung ceiling outlet box.

L. Do not fasten boxes to ceiling support wires or other piping systems.

M. Support boxes independently of conduit.

3.8 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Section 07 84 00 - Firestopping.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified in Division 07 – Thermal and Moisture Protection.

C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.9 ADJUSTING

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused openings in boxes.

3.10 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION

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SECTION 26 05 53
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Nameplates.
2. Labels.
3. Wire markers.
4. Stencils.
5. Underground Warning Tape.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Division 09 – Finishes: Execution requirements for painting specified by this section.

1.2 SUBMITTALS

A. Division 01 – General Requirements: Procedures for submittals.

B. Product Data:
1. Submit manufacturer's catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

C. Samples:
1. Submit two tags, actual size.
2. Submit two labels, actual size.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with State and Municipality standards.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products under provisions of Division 01 – General Requirements.

B. Accept identification products on site in original containers. Inspect for damage.

C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Division 01 – General Requirements: Environmental conditions affecting products on site.

B. Install labels, nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color.

B. Nameplates shall match identification shown on drawings.

C. Letter Size:
1. 3/8-inch high letters for identifying voltages, phase and number of wires.
2. 3/4-inch high letters for identifying equipment and loads.
3. Panelboards: Nameplates shall state: panel identification, voltage, phase and number of wires (example: LP1/BH1, 120/208V, 3PH, 4W).

D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

A. Labels: Printed adhesive label tags, with 1/8-inch minimum height black letters on white background.

B. Wiring device labels: Printed adhesive label tags, with 1/8-inch minimum height black letters on clear background.

2.3 WIRE AND CABLE IDENTIFICATION

A. Different conductor insulation colors and electrical tape colors shall be used to identify different phases of conductors in a given circuit.

B. Branch wiring shall be color coded per industry standards. If Owner does not have pre-established color code, use the following colors unless otherwise required by code.

C. Code color requirements shall always be followed where applicable.

D. Following colors shall be as follows unless otherwise required by code:
   1. 120/208 volt systems
      a. A-phase: solid black.
      b. B-phase: solid red.
      c. C-phase: solid blue.
      d. Different colors shall be used to identify switched legs.
      e. Neutral conductor: solid white. Provide additional markings for neutral conductors in the same raceway as required by code.
   2. Ground Conductors: solid green. Provide additional markings for ground conductors in same raceway as required by code.

E. Where wires of different systems junction in common box, each cable shall be grouped with its own system and identified using tags or identification strips.

F. For 3 phase systems, each phase shall be identified at all terminals using cable markers.

G. Wire and cable labels:
   1. Feeder and branch circuits: label shall indicate panel and circuit number as actually installed.
   2. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams.

2.4 CONDUIT AND RACEWAY MARKERS

A. Conduit color/stencil markings:
   1. 208 Volt System: Blue color band.
   2. Fire Alarm System: Red colored band.
   3. Telephone/Data System: Gray colored band.

2.5 STENCILS

A. Stencils: With clean cut symbols and letters of following size:
   1. Up to 2 inches Outside Diameter of Raceway: 1/2-inch high letters.
   2. 2-1/2 to 6 inches Outside Diameter of Raceway: 1 inch high letters.
   3. 1/2-inch high letters minimum for identifying boxes and other equipment.

2.6 PANELBOARD DIRECTORIES

A. Suitable for complete description of load served.

B. Directory shall be removable.

C. Typewritten card, describing loads served.

D. Provide steel frame holder on inside cover of door to hold directory.

E. Directory shall be covered with a clear plastic sheet.

PART 3 - EXECUTION

3.1 GENERAL

A. Where mixed voltages are used in one building (e.g. 4160 volt, 480 volt, 208 volt) each switch, switchboard, junction box, equipment, etc., on each system must be labeled for voltage in addition to the other requirements listed herein.

B. All branch circuit and power panels must be identified with same symbol used in circuit directory in main distribution center.

C. Stenciling may only be used on equipment fronts in unfinished areas.

D. Receptacle labels shall identify panel and circuit number feeding receptacle.

E. Switch label shall indicate equipment controlled by switch. Do not label light switches unless otherwise noted on drawings.

3.2 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.3 INSTALLATION

A. Install identifying devices after completion of painting.

B. Adhesive type labels not permitted except for phase and wire identification.

C. Hand written labels or embossed tape are not permitted.

D. Entrance door to primary electrical room shall have porcelain enameled sign lettered “DANGER HIGH VOLTAGE”. This same sign shall also be placed on primary switch.

E. Each distribution and lighting panel shall be equipped with typewritten directory describing loads served. Directory shall be contained in steel frame mounted on inside face of panel’s door and shall be covered with sheet of clear plastic.

F. Switchboards, transformers, switchgear, telephone backboards, transfer switches, panels and cabinets shall be provided with 1/8-inch minimum thickness 5 ply lamecoid plastic nameplates indicating usage, plan designation and voltage where applicable. In Equipment and Mechanical Rooms, this identification may be on exterior of unit, in other areas identification shall be inside door or cover. Nameplates shall be black with white engraved lettering. Lettering shall be 1/2-inch high minimum. Fasten nameplates with escutcheon pins.

G. Junction and pullboxes smaller than 12 inch x 12 inch shall be identified by using permanent marker on coverplate indicating originating panelboard and circuit(s) or system served.

H. Junction and pull boxes with dimensions 12 inch x 12 inch and larger shall be stenciled or provided with permanent labels as follows:

1. Lighting and power feeders and branch circuits - 120, 208, 277, 480. Add "EM" for emergency circuits, ex. 120EM, etc.
2. Voice/Data communications - V/D COM.
3. Fire Alarm - FA.
4. Signal voltage lighting controls - LVLC.
5. Electronic Card Key Access System - CA.

I. Cover plates for control stations controlling remote equipment shall be engraved to identify device being controlled.

J. Motor starters, remote control stations, etc., shall be identified with engraved lamecoid nameplates fastened to equipment with escutcheon pins. Nameplates shall be 1/8 -inch 5 ply lamecoid with 1/4-inch white letters on a black background. Adhesive cloth labels, similar to those manufactured by Brady Label Co., may be used on motor switches and controls only, indicating number, designation, size and usage of motor.

K. On inside of coverplates for light switches, occupancy sensors, receptacles, and special purpose outlets, provide a permanent label identifying panel and circuit number feeding device. Adhesive plastic tape will be permitted for this use.

L. On light fixtures at wiring entrance point, provide permanent label identifying panel and circuit number feeding fixture. Adhesive plastic tape will be permitted for this use.

M. Refer to individual specification sections for more specific or additional identification requirements.

N. Nameplate Installation:
1. Install nameplate parallel to equipment lines.
2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners.
3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
4. Secure nameplate to equipment front using screws or rivets.
5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
6. Provide identification for the following:
    a. Conduit (provide stencil or color band).
    b. Wires and cables (provide Color code and label).
    c. Junction and pullboxes (provide color code and/or stencil).
    d. Wiring devices (provide label).
    e. Equipment (provide nameplates).
    f. Switchboards (provide nameplate to identify board and each load fed from switchboard)
    g. Panelboards (provide nameplates and directory).
    h. Transformers (provide nameplates).
    i. Motor starters (provide nameplates).
    j. Transfer switches (provide nameplates).
    k. Fire alarm panel (provide nameplates).
    l. Control panels (provide nameplates).
    m. Time contactor (provide nameplates).
    n. Contactor (provide nameplates).
    o. Disconnect switch (provide nameplates).

O. Label Installation:
   1. Install label parallel to equipment lines.
   2. Install label for identification of individual control device stations.
   3. Install labels for permanent adhesion.

P. Wire label Installation:
   1. Install wire marker for each conductor at panelboard gutters and outlet or equipment connection. Label shall be within one (1) foot of end of conductor.

Q. Conduit Marker Installation:
   1. Install conduit marker for each conduit longer than 6 feet.
   2. Conduit Markers Spacing: 50 feet on center, minimum of one visible in every room.
   3. Raceway Painting: Identify conduit using field painting in accordance with Division 09 – Finishes.
      a. Paint colored band on each conduit longer than 6 feet.
      b. Paint bands 50 feet on center, minimum of one in each room.

R. Stencil Installation:
   1. Apply stencil painting in accordance with Division 09 – Finishes.
   2. Junction boxes: identify system source and load served.
   3. Junction boxes for electrical communications, signal and control systems: Identify system source and equipment serviced, stenciled in black on cover.
   4. Junction boxes for Fire Alarm system: Junction box covers shall be painted red with “Fire Alarm” stenciled in black on cover.

S. Underground Warning Tape Installation:
   1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION

SECTION 26 05 73
SHORT CIRCUIT/COORDINATION STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. Electrical contractor shall retain services of independent third party firm to perform short circuit/coordination study as described herein.

B. Submit studies to Design Engineer along with submittal for distribution equipment Shop Drawings prior to release of equipment for manufacture.

C. Studies shall include all portions of electrical distribution system from normal power source or sources, and emergency/standby sources, down to and including smallest circuit breaker in distribution system. Adequately cover normal system connections and those which result in maximum fault conditions in study.

D. Firm performing study should demonstrate capability and experience to provide assistance during start up as required.

E. Perform study and assessment based on SKM's Dapper, Captor and PowerTool software.

F. Related Sections:
   1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
   2. Section 26 00 00 – Basic Electrical Requirements.

G. Complete system selective coordination shall be provided including time below 0.01 seconds for following specific systems:
   1. Emergency Systems: Per NEC 700.27.

H. Study shall be stamped and signed by Professional Engineer (PE). PE shall put statement in summary of report that all systems that are required to be selectively coordinated per NEC are completely coordinated.

1.2 DATA COLLECTION FOR STUDY

A. Contractor shall provide required data for preparation of studies. Engineer performing system studies shall furnish Contractor with listing of required data to be collected immediately after award of Contract.

B. Electrical Contractor shall furnish Engineer performing electrical system study wire sizes, insulation types, conduit types, and circuit length for use and verification in study.

1.3 REFERENCES

A. Perform studies in strict accordance with latest revision of the following standards.

B. American National Standards Institute (ANSI)
   1. ANSI C57.12.59 Guide for Dry-Type Transformer Through-Fault Current Duration.
   2. ANSI/IEEE Std. 141 IEEE Recommended Practice for Electric Power Distribution for Industrial Plants.
   3. ANSI/IEEE Std. 242 "Buff Book" IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

C. Insulated Cable Engineers Association (ICEA) Standards.

D. Occupational Safety and Health Administration (OSHA) Standards.

E. The National Fire Protection Association (NFPA)
   1. NFPA 70 – National Electrical Code.
   2. NFPA 70E Standard for Electrical Safety in the Workplace.

1.4 QUALIFICATIONS

A. Contractor shall have studies performed by qualified Engineers of electrical distribution equipment manufacturer or by Owner-approved consultant. Contractor is responsible for providing pertinent information required by preparers of studies.

B. Firm should be currently involved in high- and low-voltage power system evaluation. Studies shall be performed, stamped and signed by licensed Professional Engineer in State of Wisconsin. Minimum of five (5) years' experience in power system analysis is required for individual in charge of project.

1.5 SUBMITTALS

A. Third party qualifications. Submit qualifications of individual(s) who will perform Work for approval prior to commencing studies. Use Power Tools software by SKM to perform calculations.

B. Study Report:
   1. Provide studies in conjunction with equipment submittals to verify equipment ratings required.
   2. Summarize results of power system study in final report. Submit two (2) bound copies of final report. Provide PDF copy of study, so that it can be more easily stored and shared.
   3. Report shall include the following sections:
      a. Overview.
      b. Short Circuit Study.
         1) Purpose.
         2) Explanation of Data.
         3) Assumptions.
         4) Analysis of Results.
         5) Recommendations.
      c. Protective Device Coordination Study.
         1) Purpose.
         2) Explanation of Data.
         3) Assumptions.
         4) Analysis of Results.

5) Recommendations (Including NEC 700-27 Requirement).
6) CAPTOR Results.
7) Example Drawings.

d. Prioritized Recommendations and Conclusions.
e. Appendices
1) DAPPER One-line Diagrams.
2) AutoCAD One-line Diagrams.
3) SKM Protective Device Summaries.
4) Reference Data.
5) Sample Work Permit Form.

4. Above sections shall include the following items in detail:
a. Obtain available fault current from local utility company.
b. Short circuit studies shall evaluate available fault current at each bus (each change of impedance), including all three-phase motors.
c. Coordination study recommendations for relay settings, breaker settings, and motor protection settings.
d. Recommendations for improving coordination and/or load distribution, as well as ground fault requirements.
e. IEEE standard one-line diagram with equipment evaluation and circuit breaker setting forms that clearly define system data and are easy to interpret.
f. Prioritized report summarizing recommendations from this study. This shall include observed NEC code violations and their corrective action.
g. Contractor shall provide one-line diagram that meets IEEE/ANSI standard 141, mounted on 24-inch x 36-inch (minimum) extruded polystyrene backboard. Mount copies of this one-line diagram in each electrical room.

1.6 QUALITY ASSURANCE

A. Reference standards listed in IEEE “Buff Book”, latest edition.

B. Perform short circuit study in accordance with latest applicable IEEE and ANSI standards.

PART 2 - PRODUCTS – (Not Used)

PART 3 - EXECUTION

3.1 SHORT CIRCUIT AND COORDINATION STUDY

A. Perform short circuit, coordination, and arc flash hazard studies using SKM Dapper, Captor and PowerTool for Windows software packages.

B. In short circuit study, provide calculation methods and assumptions, base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout system. Provide ground fault current study

for same system areas, including associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault currents.

C. In protective device coordination study, provide time-current curves graphically indicating coordination proposed for system, centered on conventional, full-size, log-log forms. Include with each curve sheet complete title and one-line diagram with legend identifying specific portion of system covered by that particular curve sheet. Include detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings. Study should clearly demonstrate compliance with NEC selective coordination requirements.

D. Curve sheets shall include power company relay and fuse characteristics, system medium-voltage equipment relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.

E. Include adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

F. Select each primary protective device required for delta-wye connected transformer so that its characteristic or operating band is within transformer characteristics, including a point equal to 58 percent of ANSI withstand point to provide secondary line-to-ground fault protection. Where primary device characteristic is not within transformer characteristics, provide transformer damage curve. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by 16 percent current margin to provide proper coordination and protection in event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from curves for other devices by at least 0.4-second time margin.

G. Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors, or generators as noted on drawing one-lines.

H. Utilize equipment load data for study obtained by Contractor from contract documents, including Contract Addendums issued prior to bid opening.

I. Include fault contribution of motors in the study. Notify Engineer in writing of circuit protective devices not property rated for fault conditions.

J. Provide settings for motor starters for motors over 50 horsepower. Include in study package and comment.

K. When emergency generator is provided or existing, include phase and ground coordination of generator protective devices, to meet NEC Articles 700 and 701 requirements. Show generator decrement curve and damage curve along with operating characteristic of protective devices. Obtain information from generator manufacturer and include generator actual impedance value, time constants, and current boost data in study. Do not use typical values for generator.

L. Evaluate proper operation of ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss neutral grounds and ground fault current flows during neutral to ground fault.

M. For motor control circuits, show MCC full-load current plus symmetrical and asymmetrical of largest motor starting current to ensure protective devices will not trip major or group operation.

3.2 FIELD SETTINGS

A. Contractor shall perform field adjustments of protective devices as required to place equipment in final operating condition. Settings shall be in accordance with approved short circuit study, protective device coordination study, and arc flash hazard study.

B. Contractor shall carry out necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with approved short circuit and protective device coordination study at no additional cost to Owner.

END OF SECTION

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SECTION 26 07 00

ELECTRICAL UTILITY SERVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Coordination and arrangements with Electric Utility Company for permanent electric service; payment of Electric Utility Company charges for service; service provisions; and utility metering equipment.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Division 03 - Concrete: Concrete pads.
3. Section 26 00 00 – Basic Electrical Requirements.

1.2 REFERENCES

A. Local Electric Utility's Installation and Service Manual.

B. Local Electric Utility's Service Rules and Regulations.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Submit Shop Drawings of service entrance equipment for approval by Electric Utility before submitting approved drawings to Engineer.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Electric Utility Company's written requirements.

B. Maintain one copy of each document on site.

PART 2 - PRODUCTS

2.1 ELECTRICAL SYSTEM DESCRIPTION

A. Electric Utility Company Contact: Michael Beeler; Engineer; Madison Gas & Electric Company; 133 S. Blair Street; Madison, WI 53701-1231; PH 608-252-7087; MBeeler@mge.com

B. System Characteristics: 208Y/120 volts, three phase, four-wire, 60 Hertz.

C. Service Entrance: Underground.

2.2 UTILITY METERS

A. Furnished by Electric Utility Company.

2.3 UTILITY METER BASE

A. Furnished by Contractor to meet Electric Utility company requirements. Integral to main switchboard.

2.4 METERING TRANSFORMER CABINET

A. Furnished by Contractor to meet Electric Utility company requirements. Integral to main switchboard.

2.5 TRANSFORMER PAD

A. Furnished by Electric Utility Company.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify service equipment is ready to be connected and energized.

3.2 ELECTRICAL SERVICE APPLICATION

A. It shall be electrical contractor's responsibility to complete and submit any forms required for new electrical service extension to the building or re-wiring of building's existing electrical service as outlined on the drawings and as required by project.

B. Contractor shall note that forms may require information about Owner, developer, and building load characteristics. It shall be electrical contractor's responsibility to obtain this, and any other information, as necessary to complete the required utility application forms.

3.3 PREPARATION

A. Confirmation of Electric Service. Consult with Electric Utility to verify service information specified herein and shown on Drawings before submitting bid.

B. Contractor shall meet with Electric Utility prior to rough in to review and coordinate installation of electrical service and verify existing conditions and any special requirements.

C. Metering: Consult with Electric Utility regarding service entrance requirements and metering equipment.

D. Install metering equipment and empty conduit for metering conductors to meet standards and requirements of Electric Utility.

E. Service installation shall comply with latest applicable standards of utility and National Electric Code. Refer to current electrical service installation manuals.

3.4 INSTALLATION

A. Underground Service Provisions:
   1. Contractor shall provide:
      a. Install service entrance conduits to building service entrance equipment.
   2. Utility Company will connect service lateral conductors to service entrance conductors.

B. Install cast-in-place concrete pad for Electric Utility Company transformer, in accordance with Division 03 - Concrete.

END OF SECTION

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SECTION 26 09 26
LIGHTING CONTROL PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for intelligent lighting control panelboards as required for complete performance of work, and as shown on Drawings and as herein specified.

B. Section Includes:
1. Work specified in this Section includes, but shall not be limited to, extent of intelligent lighting control system work as indicated by Drawings and by requirements of this Section. It shall be defined to include, but shall not be limited to, the following:
   a. Panelboards containing both standard and remotely operable circuit breakers.
   b. Control electronics for switching circuit breakers and monitoring status of system.
   c. Integral main and branch circuit metering options.
   d. Interface for demand response signals options.
   e. Associated low voltage switches, occupancy and light level sensors, and dimming options.
   f. Any work stations, software, and communications hardware.
2. System installation shall include, but shall not be limited to, the following:
   a. Wiring of main and branch circuit conductors.
   b. Installation of external control devices and wiring to panelboard controller.
   c. Installation of communications conductors and associated hardware.

C. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.

1.2 REFERENCES

A. General: Publications listed below form part of this Specification to extent referenced. Publications are referred to in text by basic designation only. Edition/revision of referenced publications shall be latest date as of date of Contract Documents, unless otherwise specified.

B. International Code Council (ICC):
1. ICC IBC, "International Building Code."

C. National Electrical Manufacturers Association (NEMA):
1. NEMA AB 1, "Molded Case Circuit Breakers and Molded Case Switches."
2. NEMA KS 1, "Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)."
3. NEMA PB 1, "Panelboards."

4. NEMA PB 1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."

D. National Fire Protection Association (NFPA):
1. NFPA 70, "National Electrical Code," hereinafter referred to as NEC.

E. International Organization for Standardization (ISO):
1. ISO 9001, "Quality Management Systems - Requirements."

F. Telecommunications Industry Association (TIA):
1. TIA 568, “Commercial Building Telecommunications Cabling Standard.”

G. Underwriters Laboratories, Inc. (UL):
1. UL 50, "Enclosures for Electrical Equipment, Non-Environmental Considerations.”
2. UL 67, "Standard for Panelboards."
3. UL 98, "Standard for Enclosed and Dead-Front Switches."
4. UL 489, "Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.”

1.3 SUBMITTALS

A. General: See Division 01 – General Requirements: Submittal Procedures.
1. Substitutions: If system from another manufacturer is submitted for approval, the following submittals are required:
a. Short circuit study demonstrating NEC110-10 compliance for remotely operated switching devices.
b. Elevation drawing showing placement of equipment in equipment rooms.

B. Product Data: Submit product data showing material proposed. Submit manufacturer’s data sheet for intelligent lighting control system and specified components. Submit sufficient information to determine compliance with Drawings and Specifications.

C. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer’s standard product data.
1. Panel Drawings: Submit manufacturer’s dimensional drawings and circuit breaker placement locations for each panelboard.
2. One-Line Diagram: Submit one-line diagram of system configuration proposed if it differs from that illustrated in riser diagram included in these Specifications.

D. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed wiring and field-installed wiring, and between components provided by manufacturer and those provided by others.
1. Submit typical connection diagrams for components including, but not limited to, panelboards, low voltage switches, occupancy sensors, light level controllers, communications devices, and personal computers.

E. Operation and Maintenance Data: Submit operation and maintenance data for intelligent lighting control panelboards to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer Qualifications: Manufacturer shall be firm engaged in manufacture of intelligent lighting control panelboards of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of five years.
      a. Manufacture Quality System: Registered to ISO 9001 Quality Standard.
      b. Component Testing: Electronic component board assemblies shall be factory tested and burned in prior to installation.
      c. System Support: Factory fax/telephone/email support shall be available free of charge during normal business hours.
   2. Installer Qualifications: Installer shall be firm that shall have minimum of five years of successful installation experience with projects utilizing intelligent lighting control panelboards similar in type and scope to that required for this Project and shall be approved by manufacturer.

B. Regulatory Requirements: Comply with applicable requirements of laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.
   1. System referenced herein shall be designed and manufactured according to latest revision of the following specifications:
      a. FCC emissions: Compliance with FCC emissions standards (FCC 47 CFR Part 15) specified in Part 15, Subpart J for Class A applications.
      b. FS W-C-375.
      c. FS W-P-115 (Type I Class 1).
      d. Electronic panelboard components shall meet or exceed levels specified below:
         1) ESD Immunity: Level 4.
         2) RF Susceptibility: Level 3.
         3) Electrical Fast Transient Susceptibility: Level 3.
         4) Electrical Surge Susceptibility (Power Line): Level 4.
         5) Electrical Surge Susceptibility (Interconnection Lines): Level 3.
      e. NEMA PB 1.
      f. NEMA PB 1.1.
      g. NEMA AB 1.
      h. NEMA KS 1.
      i. NEMA compliance; applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.
      j. NEC compliance; applicable portions of the NEC including Articles 110-10.
      k. UL 50.
      l. UL 67.
      m. UL 98.
      n. UL 489.
      o. UL compliance; applicable UL standards for panelboards, circuit breakers, and energy management equipment.

C. Single Source Responsibility: Obtain intelligent lighting control panelboards and required accessories from single source with resources to produce products of consistent quality in appearance and physical properties without delaying work. Any materials which are not produced by manufacturer shall be acceptable to and approved by manufacturer.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.

B. Store materials in their original, undamaged packages and containers, inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.6 WARRANTY

A. General: See Division 01 – General Requirements - Closeout Procedures.

B. Special Warranty: Submit written warranty executed by manufacturer, Installer, and Contractor, agreeing to repair or replace intelligent lighting control panelboards that fail in materials or workmanship within specified warranty period.

C. Warranty Period: Warranty period shall be one year from date of installation or 18 months from date of purchase

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Product specified shall be "POWERLINK" intelligent panelboards as manufactured by Schneider Electric. Items specified are to establish standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. Design Professional will be sole judge of basis of what is equivalent.
   1. Substitutions:
      a. Substitutions (clearly identified as such) shall be submitted in writing for approval by Design Professional at least 10 working days prior to bid date. Substitutions shall be available to all bidders.
      b. Proposed substitutions shall include, but shall not be limited to, detailed summary of specification review noting compliance on line basis.
      c. Contractor accepts responsibility and associated costs for required modifications to circuitry, devices, and structural changes.
      d. Complete shop drawings with deviations shall be required for review prior to installation and rough-in.

2.2 MATERIALS AND COMPONENTS

A. Remotely Operated Circuit Breakers: Remotely operated branch circuit breakers shall provide overload and short circuit protection suitable for location in electrical system, as defined in panelboard schedules. Remotely operated power switching devices shall have the following:
   1. Integral branch circuit overcurrent protection as required by NEC. Circuit breakers shall have UL-listed interrupting rating sufficient for application or UL-listed series connected ratings for maximum available fault current at that point in system. Submittals reflecting use of relays or contactors to perform remote switching shall show evidence in writing that relays are listed to withstand available fault current.

2. UL-listed SWD ratings for 15 ampere and 20 ampere 1-pole, 2-pole, and 3-pole branch devices, HID ratings, and HACR ratings.
3. Handle operator that shall mechanically open power switching device contacts when moved to OFF position and disable contacts from being remotely closed.
4. Manual override switch to enable or disable remote operation of device and allow circuit breaker handle to fully control on/off state of circuit breaker. Override shall fully disengage remote operation of circuit breaker mechanism. Device utilizing one-shot or temporary overrides shall not be accepted.
5. Visible flag that clearly indicates status of circuit breaker contacts with panel trim installed. Flag shall indicate ON, OFF, and TRIPPED circuit breaker states. Visible flag shall be mechanical in nature, directly tied to circuit breaker mechanism, and shall be provided in addition to any status indicator supplied by system electronics.

B. Master Panelboard and G4 Control Electronics: Provide the following:
1. Auxiliary control power source for powering external control devices such as occupancy sensors and low voltage photo sensors, as indicated on Drawings.
2. Programmable input timers to permit timed override periods.
3. Adjustable blink notice.
4. Event logging to track circuit breaker, input, and zone state; schedule periods; bus operational status; and circuit breaker on-time.
5. Capability for accepting downloadable firmware without removing controller.
6. Time scheduling including, but not limited to, the following:
    a. Sixty-four (64) independent schedules, each configurable into 100 distinct periods.
    b. Clock configurable for 12 hour (AM/PM) or 24 hour format.
    c. Schedule periods settable to the minute.
    d. 365 day calendar, with automatic daylight savings and leap year adjustments.
    e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
    f. Ninety-six (96) special event periods with 14 pre-programmed holidays.
    g. Astronomical tracker to automatically adjust sunrise and sunset times throughout year.
7. Sixteen hard-wired terminals configurable for either 16 two-wire inputs, eight three-wire inputs, or eight two-wire inputs with status feedback for pilot LED’s (four Analog input terminals, each configurable to 0-5v, 0-10v, or 4-20ma with 256 possible thresholds). Configurations shall allow either momentary or maintained control devices to be attached. These inputs shall be configured according to Owner’s requirements and shall be capable of providing the following capabilities:
    a. Two-hundred-fifty-six (256) communication inputs available for network connections.
    b. Input synchronization service to synch inputs with other inputs, zones, time schedules, or remote sources. This synchronization service shall be used to control input state, input inhibit mode (enable/disable), or sync timers (enable/disable).
    c. Boolean custom controls, including, but not limited to, configuring sources. Sources shall include, but shall not be limited to, inputs, time schedules, or status. Up to four sources shall be permitted in custom configurable logic arrangement configured up to 256 zones.
8. Zone priorities, assignable to each zone, such that particular zone shall have priority over other zones. Zones priorities shall be capable of forcing all circuit breakers in zone to ON state or OFF state depending on particular configuration.
9. Ethernet communications. Each panel controller shall allow networking with other master panel controllers in peer-to-peer configuration using Ethernet 100Base-T full duplex network.

a. Each panel controller shall support three (3) Ethernet ports communicating using Modbus TCP/IP and/or BACnet/IP protocols.
b. Each input connected to controller shall be capable of controlling any branch circuit connected to any other controller.
c. Schedule programmed in one controller shall be capable of controlling any branch circuit connected to any other controller.
d. Means for setting initial Ethernet parameters via local operator interface without having to employ special software or configuration tools.
e. Each panel controller shall be capable of operating in pass-through mode for Modbus connected devices, such as meters, whereby information is automatically ported to Modbus TCP/IP port without separate gateway devices.

10. Each panel controller shall incorporate time synchronization service to update controller clock to network time server. Time serve shall incorporate both primary and secondary source. Update interval shall be settable from 1 to 24 hours.
11. Embedded web server. Each panel controllers shall incorporate web-enabled server for displaying information over standard web browser. Web-accessible information shall include:
    a. Secure, password protected login screen for modifying operational parameters to ensure only authorized access. Password administration shall be accessible to authorized users via web page interface.
    b. Separate web pages for each panel with arrangement of circuit breakers on page matching physical appearance of panel. Panel status pages shall also include, but shall not be limited to, circuit breaker nametags, pole configuration, location in panel, and actual contact state (on/off/tripped/manual) for master panel and each associated sub-panel. Web page shall also provide ability to observe circuit breaker on-time and blink information in real time.
    c. Panel summary showing master and sub-panels connected to controller.
    d. Controller summary showing controller diagnostic information.
    e. Panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. Mimic screens shall also allow direct circuit breaker control and zone overrides.
    f. Alarm and email notification. Each master controller shall incorporate alarm and automated email notification service. These services shall be capable of automatically initiating alarms based on preconfigured conditions and routing alarm alerts as directed by Owner.
12. Alarms shall be configurable for the following parameters:
    a. Global alarms (power loss, non-responding circuit breakers, loss and restoration of sub-net communications, loss and restoration of serial port communications, and loss and restoration of Modbus TCP Ethernet commands).
    b. Specific alarms (input status, zone status, circuit breaker status on-time (0 to 99,999 hours), and strike counter).
    c. Email notification service shall include, but shall not be limited to, ability to automatically route email message to five individual email addresses. Within body text of email, provide link that shall automatically redirect user to associated panels' status web page.
13. BACnet Conformance:
    a. Reference BACnet Standard, ASHRAE 135.
    b. Each panel controller shall, at minimum, support serial BACnet MS/TP and Ethernet BACnet/IP communications.

c. Each panel controller shall be able to communicate directly via BACnet RS-485 serial networks and Ethernet 100Base-T networks as native BACnet device.
d. Each panel controller shall comply with Annex J of ASHRAE 135 for IP connections.
e. Each panel controller shall function as BACnet application specific controller in accordance with Annex L of ASHRAE 135, and shall support the following BACnet interoperability building blocks:
   1) Data Sharing - Read Property - B.
   2) Data Sharing - Read Property Multiple - B.
   3) Data Sharing - Write Property - B.
   4) Data Sharing - Write Property Multiple - B.
   5) Device Management - Dynamic Device Binding - B.
   6) Device Management - Dynamic Object Binding - B.
   7) Device Management - Device Communication Control - B.
   8) Device Management - Time Synchronization - B.
   9) Device Management - UTC Time Synchronization - B.
   10) Device Management - Reinitialize Device - B.
f. Standard BACnet object types supported shall include, but shall not be limited to, analog value, binary value, multi-state value, and multi-state output.

C. Sub-Panel Panelboards:
1. Panels marked as sub-panels shall contain necessary busses and network hardware to allow connection of sub-net wiring between panels.
2. Sub-panels shall contain nameplate label, located on panel trim indicating its designation and designations and address of its associated master panel.
3. Sub-net wiring connections shall allow connection of wiring to terminal that can be removed from panel without interrupting communications to other panels.

D. Networks:
1. Sub-Net:
   a. Provide sub-net wiring between master and sub-panels as indicated on Drawings. Sub-net wiring shall permit sub-panels to receive power and control data from master panelboard. Each master/sub-panel system may consist of maximum of eight panels total.
   b. Sub-net communications shall follow Class 1 wiring practices. Communications conductors shall be Belden 27326 or equal having same voltage rating as branch circuit conductors. Wiring distances shall not exceed manufacturer's recommendations.
   c. Sub-net panels shall allow more than two smart busses per panel.
2. RS-232 and RS-485 Serial Network:
   a. Provide serial communication wiring between master panelboards and other master panelboards or other building controllers as indicated on Drawings.
   b. Total network length shall be up to 5000 feet (1524 m).
   c. Connected devices shall support baud rates of 4800, 9600, 19200, 38400 76800, and 115200.
   d. Network shall support up to 32 devices.
   e. Serial communication shall allow use of both RS-232 and RS-485 simultaneously.
   f. Network cable shall be shielded two-conductor twisted pair (Belden 9841 or equivalent), or shielded three-conductor with twisted pair (Belden 8723 or equivalent).
3. Ethernet Network:

a. Installing contractor shall coordinate work with network administrator to assure that proper connection points are available. Installing contractor shall also secure static IP address for each individual master controller and power monitoring web server.
b. Network shall support Ethernet 100Base-T communications.
c. Communications wiring to master panels shall be Category 5 cable having eight position eight contact (8P8C) modular plugs terminated using T568A or T568B pin/pair assignments as defined in TIA 568.
d. Shall utilize three (3) Ethernet ports to create independent Ethernet network.

4. Future integration and service shall be promoted by using only open communication protocols between lighting control panels. Open protocol is one that has specifications published in public domain and that is used by more than 10 manufacturers. Modbus (TCP/IP), Modbus (ASCII/RTU), BACnet IP, BACnet MS/TP, and DMX, are considered acceptable. Submittals listing any other protocol shall not be considered unless they demonstrate that these criteria are met. Same open protocol shall be used over all media that are part of system, including, but not limited to, serial busses, LAN, or other connections.
5. Installation of additional special purpose networks shall be minimized by using existing facility Ethernet LAN to connect various lighting panels or groups of lighting panels as shown on Drawings. Equipment shall be compatible with industry standard TCP/IP protocols.
6. Power monitoring metering devices as shown on Drawings shall connect using same network as lighting control panels. Controller shall support pass-through mode for Modbus connected meters whereby information shall be automatically ported to Modbus TCP/IP port without separate gateway devices.
7. Provide sub-net wiring between master and sub-panels as indicated on Drawings. Sub-net wiring shall permit sub-panels to receive power and control data from master panelboard. No more than eight bus rails shall be connected to sub-net.
8. Sub-net communications shall follow Class 1 wiring practices. Communications conductors shall be Belden 27326 or equivalent having same voltage rating as branch circuit conductors. Wiring distances shall not exceed manufacturer's recommendations.
9. Communications wiring to master panels shall use Category 5 cabling. Installing Contractor shall coordinate work with network administrator to assure that proper connection points are available. Installing Contractor shall also secure one static IP address for each master controller.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which work is to be installed, and notify Contractor in writing, with copy to Owner and Architect, of any conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Beginning of work shall indicate acceptance of areas and conditions as satisfactory by Installer.

3.2 INSTALLATION

A. General: Install intelligent lighting control panelboards in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on Drawings.

B. Customization:
1. Manufacturer shall provide any custom hardware or communication devices necessary to make system perform as specified above.
2. Manufacturer shall provide PC user interface custom screens. Rough layouts of screens shall be provided to manufacturer no less than 30 days before scheduled system start-up.

C. Contractor Installation:
1. Install equipment in accordance with manufacturer's installation bulletins.
2. Provide complete installation in accordance with contract documents.
3. Define each circuit breaker, dimmer, relay load type, and assign to required zone, input, and/or schedule.
4. Provide as-built drawings indicating sensor placements on drawings.
5. Provide one-line drawings indicating location and addresses of networked hardware, including but not limited to, panels, distributed relays and dimmers, keypads, and sensors.

D. System Programming:
1. Contractor shall be responsible for furnishing fully functional system, including, but not limited to, necessary programming, calibration, and operational interfaces to other devices.
2. Contractor shall meet with Owner to identify desired operation of control system. At minimum, intelligent lighting control system shall meet functional requirements of applicable energy building code for location of property.
3. Contractor shall fully document control operation of system, including, but not limited to, zone definitions, time schedules, input assignments, scenes, dimmer setpoints, occupancy sensor delays, light level settings, and any other special requirements, including, but not limited to, information that is to be shared with other building systems. Full documentation shall be made available to Owner and manufacturer no less than 14 days before planned start up.

E. Start-Up:
1. Installing Contractor shall provide factory-certified field service for site inspection to assure proper system installation and operation.
2. Factory service technicians shall:
   a. Have certification demonstrating competency with associated controls systems.
   b. Be certified by manufacturer on system installation and programming.
3. Upon visit, technician shall be responsible for performing the following:
   a. Verify power feeds and load circuits are properly labeled according to Drawings.
   b. Verify connection and location of external controls.
   c. Verify operation of supplied interfaces with other equipment.
   d. Verify sensors are properly calibrated.
   e. Verify addressing of network components in relation to Drawings.
   f. Program system to operate in accordance with energy code requirements and/or special requirements as noted in this Section.
   g. Verify equipment is properly operating in accordance with Drawings and local energy code requirements and/or sequence of operations.

h. Obtain sign-off on system functions.

3.3 DEMONSTRATION

A. Provide services of factory-authorized service representative of manufacturer to provide start-up service and to demonstrate and train Owner's personnel.
1. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
2. Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.
3. Review data in operation and maintenance manuals with Owner's personnel.
4. Schedule training with Owner, through Architect, with at least seven day's advanced notice.

3.4 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to Installer, that shall ensure that intelligent lighting control panelboards shall be without damage at time of Substantial Completion.

END OF SECTION

SECTION 26 24 13
SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Distribution Switchboards.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Section 26 05 26 - Grounding and Bonding.
4. Section 26 05 53 - Electrical Identification.
5. Section 26 35 53 – Surge Protection Devices.

1.2 REFERENCES

A. American National Standards Institute (ANSI):
1. ANSI C12.1 – Electric Meters Code for Electricity Metering.
2. ANSI C39.1 - Requirements, Electrical Analog Indicating Instruments.

B. Institute of Electrical and Electronics Engineers (IEEE):
1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

C. National Electrical Manufacturers Association (NEMA):
1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.
3. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
4. NEMA PB 2 - Deadfront Distribution Switchboards.
5. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Procedures for submittals.

B. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, and ground; and switchboard instrument details.

C. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 – General Requirements: Procedures for closeout submittals.

B. Project Record Documents: Record actual locations, configurations, and ratings of switchboards and their components on single line diagrams and plan layouts.

C. Operation and Maintenance Data: Submit spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years' experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products under provisions of Division 01 – General Requirements.

B. Accept switchboards on site. Inspect for damage.

C. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with NEMA PB 2.1. Lift only with lugs provided. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Division 01 – General Requirements: Environmental conditions affecting products on site.

B. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 SEQUENCING

A. Sequence Work to avoid interferences with building finishes and installation of other products.

1.10 MAINTENANCE MATERIALS

A. Division 01 – General Requirements: Spare parts and maintenance products.

B. Furnish one fuse puller.

1.11 EXTRA MATERIALS

A. Division 01 – General Requirements: Spare parts and maintenance products.

B. Furnish three of each size and type of fuse installed.

PART 2 - PRODUCTS

2.1 DISTRIBUTION SWITCHBOARDS

A. Manufacturers:
1. Square D.
2. Siemens.
3. GE Electrical.
4. Cutler-Hammer (Eaton).

B. Product Description: NEMA PB 2, enclosed switchboard with electrical ratings and configurations as indicated on Drawings.

C. Device Mounting:
1. Group mounted in frame sizes 100 amp through 600 amp.

D. Bus:
1. Switchboard bussing shall be plated and of sufficient cross-sectional area to continuously conduct rated full load current with maximum temperature rise of 50 degrees C, above ambient temperature of 40 degrees C bus bars (and all other current carrying parts such as fingers, neutral and ground buses) shall be cold rolled copper, 98 percent minimum conductivity.
2. All bus bars and connections shall be braced to withstand stressed resulting from short circuit currents of at least short circuit current rating as indicated on Drawings.
3. All bus bars and bus bar connections shall be machined for maximum contact surface and have silver plated contact connections. At the point of connection, use bronze alloy or cadmium plated bolts with Belleville washers. No clamp joints shall be used. Connections shall be bolted, accessible from front for maintenance.
4. Where spaces are indicated for future breakers, extend bus bars and drill and tap for future breakers.
5. Provide copper ground bus through length of switchboard.

E. Line and Load Terminations: Accessible from front only of switchboard, suitable for conductor materials and sizes as indicated on Drawings.

F. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, insulated and braced for short circuit currents. Furnish continuous current rating as indicated on Drawings.

G. Enclosure: Type 1 - General Purpose.

H. Align sections at front only.

I. Switchboard Height: 90 inches, excluding floor sills, lifting members and pull boxes.

J. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

2.2 FUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
1. Square D.
2. Siemens.
3. General Electric.
4. Cutler-Hammer (Eaton).

B. Product Description: NEMA KS 1, Type HD, load interrupter knife switch. Handle lockable in OFF position.

2.3 MOLDED CASE CIRCUIT BREAKER

A. Manufacturers:
1. Square D.
2. Siemens.
3. General Electric.
4. Cutler-Hammer (Eaton).

B. Product Description: NEMA AB 1, molded-case circuit breaker.

C. Solid-State Circuit Breaker: Electronic sensing, timing, and tripping circuits for adjustable current settings; ground fault trip with integral ground fault sensing; instantaneous trip; and adjustable short time and long time trip.

D. Accessories: As indicated on Drawings. Conform to NEMA AB.

2.4 INSULATED CASE CIRCUIT BREAKER

A. Manufacturers:
1. Square D.
2. Siemens.
3. General Electric.
4. Cutler-Hammer (Eaton).

B. Product Description: NEMA AB 1, enclosed, insulated-case circuit breaker.

C. Trip Unit: Electronic sensing, timing, and tripping circuits for adjustable current settings; ground fault trip (if indicated on drawings) with integral ground fault sensing; instantaneous trip; and adjustable short time and long time trip.

D. Accessories: As indicated on Drawings. Conform to NEMA AB.

2.5 SURGE PROTECTION DEVICES

A. Shall meet requirements of Section 26 35 53 – Surge Protection Devices.

2.6 SOURCE QUALITY CONTROL

A. Furnish shop inspection and testing in accordance with NEMA PB 2.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify surface is suitable for switchboard installation.

3.2 INSTALLATION

A. Install in accordance with NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Install fuses in each switch and coordinate sizes with connected load.

D. Install engraved plastic nameplates in accordance with Section 26 05 53 – Electrical Identification.

E. Install breaker circuit directory.

F. Ground and bond switchboards in accordance with Section 26 05 26 – Grounding and Bonding.

3.3 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

3.4 ADJUSTING

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

B. Adjust operating mechanisms for free mechanical movement.

C. Tighten bolted bus connections.

D. Adjust circuit breaker trip and time delay settings to values as indicated in short circuit coordination study.

3.5 CLEANING

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

B. Touch up scratched or marred surfaces to match original finish.

END OF SECTION

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SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Branch Circuit Panelboards.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Section 26 05 26 - Grounding and Bonding.
4. Section 26 05 53 - Electrical Identification.

1.2 REFERENCES

A. Institute of Electrical and Electronic Engineers (IEEE):
1. IEEE C62.41 – Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits.

B. National Electrical Manufacturers Association (NEMA):
1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 – Low Voltage Cartridge Fuses.
3. NEMA ICS 2 – Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
5. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
6. NEMA PB 1 - Panelboards.
7. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

C. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc. (UL):
1. UL 67 - Safety for Panelboards.
2. UL 1283 – Electromagnetic Interference Filters.
3. UL 1449 – Surge Protection Devices.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Procedures for submittals.

B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.

C. Product Data: Submit catalog data showing specified features of standard products.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.

B. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years' experience.

1.6 MAINTENANCE MATERIALS

A. Furnish two of each panelboard key. Panelboards shall be keyed alike.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Do not store panelboards exposed to weather.

B. Protect panelboards against damage from work of other trades.

PART 2 - PRODUCTS

2.1 BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
1. Square D, NQOD or NF Series.
2. GE Electrical.
3. Siemens.
4. Cutler-Hammer (Eaton).

B. Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Panelboard Bus: Copper, current carrying components, ratings as indicated on Drawings, 100 amp minimum. Furnish copper ground bus in each panelboard.

D. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical for 208 volt or 240 volt panelboards. Panels shall be fully rated, series rating is not acceptable.

E. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles; no handle ties of any sort will be approved. Type HACR for air conditioning equipment circuits, HID rated for high intensity discharge lighting systems, or as indicated on Drawings.

F. Provide metal directory holders with clear plastic covers.

G. Do not use tandem circuit breakers.

H. Enclosure: NEMA PB 1, Type 1 indoors, Type 3R outdoors and damp or wet locations.

I. Cabinet Box: 6 inches deep, 20 inches (508 mm) wide.

J. Where indicated on drawings, provide SPD units mounted integral to panel. SPD unit shall meet Section 26 35 53 requirements.

K. Furnish wiring gutters in accordance with NEC.

L. Top or bottom feed as required.

M. Furnish with branch breaker positions and nominal current rating as indicated on Drawings.

N. Fronts:
1. Dead front safety type.
2. Door shall be built into panel front cover trim which allows access to breakers as well as to trim screw fasteners. Front cover construction with concealed trim screws and door hinges. Breaker access door shall have the following features:
   a. Concealed piano hinge.
   b. Flush stainless steel cylinder tumbler type lock with spring loaded door pulls.
   c. Locks keyed alike.
   d. Code gauge steel with rust inhibiting primer and baked enamel finish.

O. Circuit Directory:
1. Suitable for complete descriptions.
2. Clear plastic cover.
3. Typewritten card, describing the loads served.
4. Provide steel frame holder on inside cover of door to hold directory. Directory shall be covered with a sheet of clear plastic.

2.2 NAME PLATES

A. Name Plates:
1. Engraved, laminated plastic type.
2. Letters 3/16-inch high minimum.
3. White letters on black background.
4. Verify panelboard designation with Owner's Representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's written instruction, applicable requirements of NEC, NECA's "Standard of Installation," NEMA PB1.1, and in accordance with recognized industry practices.

B. Install flush or surface mounted as specified on drawings and schedules.

C. Support panel cabinets independently to structure with no weight bearing on conduits.

D. Install recessed panelboards to allow cover to be drawn tight against wall to provide neat appearance.

E. Install surface mounted panelboard interior so there is no gap between the panelboard back-box and cover.

F. Adjacent panel cabinets shall be of same size and mounted in horizontal alignment.

G. Attach nameplates. Nameplates for panels in public areas shall be attached to the inside face of the cover. Nameplates for panels in equipment rooms and other non-public areas shall be attached to the outside face of the cover.

H. Install panelboards plumb.

I. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

J. Install filler plates for unused spaces in panelboards.

K. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes to balance phase loads.

L. Install engraved plastic nameplates in accordance with Section 26 05 53 – Electrical Identification.

M. Install spare conduits out of each recessed panelboard to accessible location: (2) 1 inch to above ceiling, (2) 1 inch to floor below. Identify each as SPARE.

N. Ground and bond panelboard enclosure according to Section 26 05 26 – Grounding and Bonding. Connect equipment ground bars of panels in accordance with NFPA 70.

3.2 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

3.3 INSPECTION

A. Examine area to receive new panelboards to assure adequate clearance for installation.

B. Start work only after unsatisfactory conditions are corrected.

3.4 ADJUSTING

A. Adjust doors and operating mechanisms for free mechanical movement.

B. Tighten lugs and bus connections.

C. Clean interior of panelboard.

D. Sand, prime and paint scratched or marred surfaces to match original finish.

E. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION

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SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Wall Switches.
2. Receptacles.
3. Occupancy Sensors.
4. Device Plates.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Section 26 05 33 - Raceway and Boxes.

1.2 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Procedures for submittals.

B. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide all wiring device types from a single manufacturer.
1. Use of manufacturer's name and model or catalog number is for purpose of establishing standard of quality and general configuration desired.
2. Equivalent as acceptable to Engineer.

B. Devices and Cover Plate Colors:
   1. Coordinate device and cover plate color with final wall finish; verify color with Architect before ordering.
   2. Unless noted otherwise, receptacles and light switches controlling emergency or critical loads shall be red in color.
   3. Adjustments in device or cover plate color shall be made in the field without additional compensation.

C. Unless otherwise indicated acceptable manufacturers are:
   1. Hubbell.
   2. Leviton.
   3. Arrow-Hart, Inc.
   4. Pass & Seymour.

2.2 WALL SWITCHES

A. Switches:
   1. Single Pole Switch: 20 amps, 120-277 volt, specification grade, back or side wired equal to Hubbell cat. No. HBL1221.
   2. Double Pole Switch: 20 amp, 120-277 volt, specification grade, back or side wired equal to Hubbell cat. No. HBL1222.
   3. Three-way Switch: 20 amps, 120-277 volt, specification grade, back or side wired equal to Hubbell cat. No. HBL1223.
   4. Four-way Switch: 20 amps, 120-277 volt, specification grade, back or side wired equal to Hubbell cat. No. HBL1224.
   5. Pilot Light (lighted) - Single Pole Switch: 20 amp, 120-277 volt, specification grade, clear polycarbonate toggle, back or side wired equal to Hubbell cat. No. HBL1221ILC.

2.3 RECEPTACLES

A. General:
   1. Receptacles shall be flush mounted.
   2. Receptacles shall have full grounding straps and be suitable for side or side and back wiring.
   3. Receptacles shall be Hubbell Nos. listed below or equal by approved manufacturer.
   4. Unless noted otherwise, receptacles shall be 125 volt, 2 pole, 3 wire grounding.

B. Receptacles
   1. General use Duplex Convenience Receptacle: heavy duty, specification grade, 15 amp, 125 volt, NEMA 5-15R Hubbell cat. No. HBL5262.
   2. Duplex Receptacle Where a single duplex receptacle is wired to a dedicated 20 ampere: heavy duty, specification grade, 20 amp, 125 volt, NEMA 5-20R Hubbell cat. No. 5362.
   3. Weather-Resistant: Corrosion resistant heavy duty, specification grade, 20 amp duplex, 125 volt, NEMA 5-20R, HBL53CM62 (Color – Yellow)
   4. GFCI Receptacle: heavy duty, specification grade, self-testing, 20 amp, 125 volt, NEMA 5-20R, UL 2006 compliant, Hubbell cat. No. GFST20.
   5. Weather-Resistant GFCI: Extra heavy duty grade, 20 amp duplex, 125 volt, NEMA 5-20R, UL 2006 compliant, Hubbell cat. No. GFR5362.

C. Weatherproof Cover Plate: Gasketed die cast metal plate with hinged and gasketed device covers. Cover shall allow cords to be plugged in and cover closed. Provide Intermatic WP1010MC for single duplex receptacles or WP1030MC for double (quad) duplex receptacles.

D. Receptacles fed from emergency circuits shall be red.

2.4 SPECIAL PURPOSE OUTLETS

A. Refer to "Special Outlet Schedule" on Drawings.

B. Electrical Contractor shall be responsible for coordinating the following items with actual equipment being furnished for the project prior to installation of outlet.
1. Exact location and orientation of outlet. Field coordinate location of outlet with Engineer/Architect's field representative, location shall not be scaled off electrical drawings.
2. Electrical characteristics of equipment, including voltage, phasing, ampacity, etc.
3. Physical characteristics of termination, e.g. receptacle configuration, cord-and-plug versus hard-wired equipment, etc.

2.5 WALL PLATES

A. Provide wall plates for wiring devices, with ganging and cutouts as indicated and with metal screws for securing plates to devices, screw heads colored to match finish of plate.

B. Cover Plate for flush mounted devices: Smooth, 302 stainless steel.

C. Device plates for surface mounted 4 inch square boxes; 1/2-inch raised galvanized steel covers.

D. Do not use jumbo cover Plates.

E. Weatherproof Cover Plate: Gasketed die cast metal plate with hinged and gasketed device covers. Cover shall allow cords to be plugged in and cover closed. Provide Intermatic WP1010MC for single duplex receptacles or WP1030MC for double (quad) duplex receptacles.

2.6 OCCUPANCY SENSORS

A. General:
1. Unit shall have convenient means to bypass sensor in case of failure so lighting can be operated manually.
2. Unit shall be provided with readily viable test LED to indicate when sensor detects motion.
3. Sensor sensitivity and time delay shall be adjustable. Time delay shall be adjustable from 1 minute to 30 minutes at a minimum.
4. Unit shall be UL or ETL listed.
5. Unit shall be provided with 3 year warranty.
6. Occupancy sensors may be infrared, ultrasonic or combination type. Chosen manufacturer shall provide optimum technology needed for each space where a sensor is shown.

B. Manufacturers:
1. Watt Stopper.
2. Leviton.
3. MyTech.

4. Hubbell.

C. Passive Infrared Wall Switch:
1. Sensor shall use passive infrared detection method for detecting room occupancy. Unit shall fit in/on standard single gang switch box and require only two wires and grounded box for operation.
2. Rated capacity: 600 watts minimum at 120 volts, 60 Hz, 1000 watts minimum at 277 volts, 60 Hz for fluorescent lamps, larger size to accommodate load as shown on Drawings.
3. Switch shall have manual override for positive off.
4. Area of coverage shall be 250 square feet minimum, greater range to accommodate room size as shown on Drawings.
5. Model Watt Stopper: DI Series.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify outlet boxes are installed at proper height.

B. Verify wall openings are neatly cut and completely covered by wall plates.

C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Switches controlling equipment operation of which is not evident from switch position shall include pilot light in conjunction with proper switch.

B. Each switch shall be complete with engraved plate to identify equipment being controlled. Provide black letters on clear background, 1/8-inch high, minimum.

C. Do not install devices until after wall finishes have been completely applied.

D. Any outlets installed prior to walls being finished and used for construction power shall be replaced at time of substantial completion.

E. Install devices and wall plates plumb and level.

F. Install switches with OFF position down.

G. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

H. Install receptacles with grounding pole on top.

I. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

J. Route continuous green equipment grounding conductor with branch circuit conductors serving isolated ground receptacles. Terminate equipment ground on isolated ground bus in panelboards.

K. Install emergency switches, which occur adjacent to normal light switches in separate boxes to maintain systems isolation in accordance with the NEC.

L. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

M. Connect wiring devices by wrapping solid conductor around screw terminal. Install stranded conductor for branch circuits 10 AWG and smaller.

N. When stranded conductors are used in lieu of solid, use crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under device screws.

O. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

P. Do not use terminals on wiring devices (hot or neutral) for feed-through connections, looped or otherwise make circuit connections via wire connectors and pigtails.

Q. Provide a layer of electrical tape around perimeter sides of each wiring device so that terminations are insulated.

R. Where GFI protected receptacles are indicated on Drawings, each receptacle indicated shall be GFI receptacle. Standard receptacles protected with an upstream GFI receptacle shall not be approved.

S. Multiple or Special Switch Stations:
   1. Grouped local switches under common cover plate as scheduled or noted on drawings. Provide pilot lights on all circuits remote from general area or exterior to building. Eight-gang plate maximum - where two plates are required, same shall be equal in size and located one above the other. Switch plates shall include engraved, Bakelite nameplate to identify function of each switch. Nameplate shall be screwed in place.

T. Occupancy Sensors:
   1. Install sensors within rooms in accordance with manufacturer’s guidelines and recommendations.
   2. Infrared sensors shall be placed where they will have direct line of sight to occupied areas.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 26 05 33 – Raceway and Boxes to obtain mounting heights as indicated on Drawings.

3.5 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect each wiring device for defects.

C. Operate each wall switch with circuit energized and verify proper operation.

D. Verify each receptacle device is energized.

E. Test each receptacle device for proper polarity.

F. Test each GFCI receptacle device for proper operation.

G. Occupancy Sensors:
   1. Sensitivity Test: After sensor has been energized for at least 15 minutes, walk to middle of room (if conference room) or sit at normal desk position (if an office). Make no motion for 20 seconds. Move one arm up and down slowly. Test LED should blink.
   2. Time Delay Test: Set time delay for 10 minutes. Walk into room to activate sensor, then leave room. Sensor must turn lights off at approximately 10 minutes.

H. If a device fails to properly operate, replace at no extra charge to Owner.

3.6 ADJUSTING

A. Devices and face plates on common wall with common mounting heights shall be level and square to each other. Adjustments required after installation shall be made without additional compensation.

B. Mark conductors with panel and circuit number serving device, at device.

C. Mark panel and circuit number serving device on backside of device plate with permanent marking system that does not show through front of plate.

3.7 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 26 28 19

ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fusible and Non-fusible switches.

B. Related Sections:
   1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
   2. Section 26 00 00 – Basic Electrical Requirements.
   3. Section 26 28 13 - Fuses.

1.2 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. NEMA FU 1 - Low Voltage Cartridge Fuses.
   2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

1.3 SUBMITTALS

A. Division 01 – General Requirements: Procedures for submittals.

B. Product Data: Submit switch ratings and enclosure dimensions.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 – General Requirements: Procedures for closeout submittals.

B. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years' experience.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
   1. Square D.
   2. Cutler Hammer/Westinghouse/Eaton.

3. Siemens.
4. General Electric.

B. Product Description: NEMA KS 1, Type HD with externally operable handle interlocked to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Provide means to temporarily override interlock and allow door to be opened with switch on.

C. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.

D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
1. Interior Dry Locations: Type 1.
2. Parking Ramp Space: Type 3R.

E. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

F. Provide ANSI/UL Class RK1, dual element, time delay, 600 volt fuses in disconnect switches, sized as shown on drawings.

G. Quick make and break operator mechanism.

H. Handle attached to box, not cover.

I. Handle position indication, ON in up position and OFF in down position.

J. Padlock provisions for up to three padlocks in OFF position.

K. UL listed lugs for type and size of wire specified.

L. Spring reinforced fuse clips for Type R fuses.

M. Provisions for insulated or grounded neutral.

2.2 NONFUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
1. Square D.
2. Cutler Hammer/Westinghouse/Eaton.
3. Siemens.
4. General Electric.

B. Product Description: NEMA KS 1, Type HD with externally operable handle interlocked to prevent opening front cover with switch in ON position enclosed load interrupter knife switch. Provide means to temporarily override interlock and allow door to be opened with switch on.

C. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
1. Interior Dry Locations: Type 1.
2. Parking Ramp Space: Type 3R.

D. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

E. Furnish switches with entirely copper current carrying parts.

F. Quick make and break operator mechanism.

G. Handle attached to box, not cover.

H. Handle position indication, ON in up position and OFF in down position.

I. Padlock provisions for up to three padlocks in OFF position.

J. UL listed lugs for type and size of wire specified.

K. Provisions for insulated or grounded neutral.

2.3 SWITCH RATINGS

A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.

B. Short Circuit Current Rating: UL listed for 200,000 rms symmetrical amperes when used with or protected by Class R fuses (30-600 ampere switches employing appropriate fuse rejection schemes).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide disconnect switches for loads as required by code. Review HVAC and Plumbing specifications to determine what equipment is furnished with disconnect switches.

B. Install all disconnect switches whether furnished under this contract.

C. Electrical Contractor shall determine need for a disconnect switch requirements for each specific load.

D. Contractor shall include in their bid all disconnect switches required whether indicated on the drawings or not.

E. Install enclosed switches plumb.

F. Height: 5 feet to operating handle.

G. Install fuses for fusible disconnect switches. Refer to Section 26 28 13 - Fuses for product requirements.

H. Install engraved plastic nameplates in accordance with Section 26 05 53 – Electrical Identification.

I. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

J. Install in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices.

K. Locate disconnect switches as shown on drawings or as required by NEC.

L. Install on equipment support where feasible, or anchor firmly to wall or structural surface.

M. Provide control circuit interlock as required by NEC.

3.2 ADJUSTMENT

A. Adjust covers and operating mechanism for free mechanical movement.

B. Verify overcurrent protection to provide proper operation and compliance with NEC.

C. Tighten wire and cable connections.

D. Clean interior of enclosure.

E. Touch up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

END OF SECTION

SECTION 26 28 26

ENCLOSED TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Transfer Switches.
2. Individual Enclosures.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Section 26 05 53 - Electrical Identification.

1.2 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
1. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment.

B. Underwriters Laboratories Inc. (UL):
1. UL 1008 - Transfer Switch Equipment.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Procedures for submittals.

B. Product Data: Submit catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.

C. Submit manufacturer’s instructions for start-up, performing cleaning, operating, and maintaining transfer switch system.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 – General Requirements: Procedures for closeout submittals.

B. Project Record Documents: Record actual locations of enclosed transfer switches.

C. Operation and Maintenance Data: Submit routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years’ experience, and with service facilities within 100 miles of Project.

B. Supplier: Authorized distributor of specified manufacturer with minimum five years' experience.

1.6 MAINTENANCE SERVICE

A. Division 01 – General Requirements: Maintenance service.

B. Furnish service and maintenance of transfer switches for one year from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCH

A. Manufacturers:
1. Russelectric.
2. ASCO.
3. Kohler.
4. Cummins Power Generation

B. Configuration: Electrically operated, mechanically held transfer switch. Operated by single solenoid or motor energized from the source it is being transferred to.

C. Ratings: NEMA ICS 2; as follows, unless otherwise indicated on drawings:
1. Voltage: 208Y/120 volts, three phase, four wire, 60 Hz.
2. Switched Poles: 3.
3. Load Inrush Rating: Combination, Tungsten lamp, Electric discharge lamp, Resistive load.
4. Continuous Rating: See Drawings.
5. Withstand Current Rating: 65K rms symmetrical amperes, when used with molded case circuit breaker unless otherwise noted on Drawings.

D. Switches shall be rated for continuous duty and shall be inherently double throw, mechanically interlocked to ensure only one of two possible positions, normal or emergency.

E. Load carrying parts shall have full 600 volt insulation and main contacts, as well as arcing contact and shall be replaceable without disassembly of operating mechanism or disconnection of power conductors.

F. Transfer switches shall consist of power transfer module and control module separately mounted. Control module shall be mounted on inside surface of enclosure door to facilitate safe adjustment and service. Harnessing between transfer module and control module shall have built-in disconnect.

G. Automatic transfer switches for life-safety lighting shall be suitable for use in emergency systems, listed by Underwriter's Laboratories under Standard 1008 for total system transfer.

H. Transfer switches shall be equipped with a manual operator per paragraph 14 of UL standard 1008 that is designed to prevent injury to operating personnel if electrical operator should suddenly become energized during manual transfer.

I. Manual operator shall provide same contact-to-contact transfer speed as electric operator to prevent flashover from switching main contacts slowly. Manual operator shall be designed to operate without opening enclosure door. Provide a mechanical visual indicator for switch position.

J. All relay, timers, control wiring and accessories shall be front accessible. Test switch and pilot lights shall be on front of cabinet door.

K. Voltage sensing relays and all adjustable times shall be capable of being adjusted while energized, through calibrated dials. All control wire terminals shall be ring or locking spade terminals.

L. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, switch position.

M. Test Switch: Mount in cover of enclosure to simulate failure of normal source.

N. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate source to normal source.

O. Transfer Switch Auxiliary Contacts: Two contacts to indicate when connected to normal source; two contacts to indicate when connected to emergency source. Contacts shall be field convertible to normally open or normally closed.

P. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 percent from rated nominal value.

Q. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal value.

R. In-Phase Monitor: Inhibit transfer until source and load are within 5 electrical degrees.

S. Interlocked molded case circuit breakers or contactors are not acceptable.

T. Equipment ground bar shall be provided in each switch enclosure.

U. Switched Neutral: Non-Overlapping, full rated contacts.

V. Automatic Sequence of Operation:
   1. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
   2. Time Delay To Start Alternate Source Engine Generator: 0 to 3 seconds, adjustable, factory set at 3 seconds to ignore momentary power outages.
   3. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
   4. Time Delay Before Transfer to Alternate Power Source: 0 to 120 seconds, adjustable, factory set at 0 seconds.
   5. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.

6. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable, factory set at 5 minutes; bypass time delay in event of alternate source failure.
7. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, factory set at 10 minutes, of unloaded operation.
8. Engine Exerciser: Start engine every 7 to 30 days adjustable, factory set at 30; run for 30 minutes before shutting down. Bypass exerciser control when normal source fails during exercising period.
9. Alternate System Exerciser: Transfer load to alternate source during engine exercising period.
10. Operating transfer time of switch in either direction shall not be greater than 1/6 of second.
11. Test Switch: Mount in cover of enclosure to simulate failure of normal source by interrupting the power signal to the normal source monitor.
12. Legally-Required Transfer Switch: Equipped with integral elevator recall relay.

W. Enclosure:
1. Enclosure: ICS 10, Type 1.
2. Finish: Manufacturer's standard gray enamel.

2.2 SOURCE QUALITY CONTROL

A. Furnish shop inspection and testing of each transfer switch.

B. Allow witnessing of factory inspections and tests at manufacturer’s test facility. Notify Owner at least seven days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install engraved plastic nameplates in accordance with Section 26 05 53 – Electrical Identification.

B. Examine area to receive transfer switch to assure adequate clearance for transfer switch installation. Start work only after unsatisfactory conditions are corrected.

C. Install transfer switch in accordance with manufacturer’s written instructions and NEC.

D. Electrical Contractor shall provide control wiring as required between transfer switch starting contacts and generator. Starting contacts for multiple transfer switches served from the same generator shall be wired in parallel. Control wiring shall be in conduit.

3.2 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

3.3 MANUFACTURER'S FIELD SERVICES

A. Division 01 – General Requirements: Manufacturers’ field services.

B. Check out transfer switch connections and operations and place in service.

3.4 ADJUSTING

A. Adjust control and sensing devices to achieve specified sequence of operation.

3.5 DEMONSTRATION AND TRAINING

A. Retain services of transfer switch manufacturer's factory trained technician to perform following services:
   1. After engine/generator load bank test and after engine/generator set is electrically connected to automatic transfer switch, provide comprehensive demonstration of system maintenance and operation to OWNER or OWNER's maintenance personnel.
   2. Include minimum of six simulated power failures.

END OF SECTION

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SECTION 26 29 33
MOTOR WIRING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Connections and wiring to motors.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Section 26 05 19 - Building Wire and Cable.
4. Section 26 05 26 - Grounding and Bonding.
5. Section 26 05 53 - Electrical Identification.

1.2 REFERENCES

A. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electric Code.

1.3 QUALITY ASSURANCE

A. Installation shall conform to the requirements of the following agencies:
1. National Electrical Code (NEC).
a. Including State of Wisconsin and local supplements.
2. National Electrical Contractors Association (NECA).
a. NECA - Standard of Installation.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

A. Motor starters shall be furnished by Contractor supplying motor requiring starter.

B. Drawings show anticipated horsepower loads and circuit sizes. Loads and circuit sizes shall be used as guide to provide final performance requirements. Verify actual requirements with Contractor and install accordingly under this Contract.

C. Contractor to verify, and correct if necessary, if heater elements in starters match installed motor characteristics.

D. Contractor shall check drawings and specifications of other trades to determine requirements for motor disconnect switches. In each case, Contractor shall install all required disconnect switches.

E. Contractor shall provide, where required by Code and for motors out of sight of controller, all disconnect switches not specifically supplied by others.

F. Unless otherwise indicated on drawings or elsewhere in these specifications, all motors shall be furnished by others.

G. Motors shall be set in place by others and associated motor starters and controllers shall be turned over to Electrical Contractor for installation.

H. Contractor supplying starters and controllers shall index same and provide Electrical Contractor with written instructions as to proper location in sufficient time to permit installation of concealed raceway system.

I. Control wiring, regardless of voltage, shall be responsibility of HVAC Contractor. Electrical Contractor shall extend circuit to control transformers and make final 120V transformer connections. Transformers will be supplied by HVAC Contractor. Control transformer shall be in starter enclosure.

J. Review HVAC and plumbing specifications and provide all line voltage wiring and connections to controls and auxiliary equipment specified as to be provided by Electrical Contractor or Division 26.

K. Final conduit connection to motor shall be made with liquid-tight flexible metal conduit or flexible metal conduit, except where prohibited by any other section of these specifications.

L. All conductors serving motors shall be stranded.

M. Install separate green equipment grounding conductor, with circuit conductors, to all motors.

N. Verify proper rotation of each motor as it is being wired or before motor is energized for any reason.

END OF SECTION

SECTION 26 32 13
ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Engine Generator Set.
2. Exhaust Silencer and Fittings.
3. Fuel Fittings.
4. Remote Control Panel, Battery, and Charger.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Section 26 28 26 - Enclosed Transfer Switches.

1.2 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
3. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment.
4. NEMA MG 1 - Motors and Generators.

B. National Fire Protection Association (NFPA):
1. NFPA 30 - Flammable and Combustible Liquids Code.
2. NFPA 110 - Standard for Emergency and Standby Power Systems.

1.3 SYSTEM DESCRIPTION

A. Description: Engine generator assembly and accessories to provide source of power for Level 2, Type 10 applications in accordance with NFPA 110.

1.4 SUBMITTALS

A. Division 01 – General Requirements: Procedures for submittals.

B. Shop Drawings: Indicate electrical characteristics and connection requirements. Include plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.

C. Product Data: Submit data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, and radiator.

D. Single line diagram in accordance with ANSI Y32.2 indicating connections and controls.

E. Test Reports: Indicate results of performance testing.

F. Manufacturer's Field Reports: Indicate inspections, findings, and recommendations.

1.5 CLOSEOUT SUBMITTALS

A. Division 01 – General Requirements: Procedures for closeout submittals.

B. Division 01 – General Requirements and Section 26 00 00 – Basic Electrical Requirements - Operation and Maintenance Data: Submit instructions and service manuals for normal operation, routine maintenance, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience, and with service facilities within 100 miles of project.

B. Supplier: Authorized distributor of specified manufacturer with minimum five years documented experience.

1.7 MAINTENANCE SERVICE

A. Division 01 – General Requirements: Maintenance service.

B. Furnish service and maintenance of engine generator for one year from Date of Substantial Completion.

1.8 MAINTENANCE MATERIALS

A. Division 01 – General Requirements: Spare parts and maintenance products.

B. Furnish one set of tools required for preventative maintenance of engine generator system. Package tools in adequately sized metal tool box.

C. Furnish two of each fuel, oil and air filter element.

PART 2 - PRODUCTS

2.1 GENERATOR

A. Manufacturers:
1. Generac Industrial Power Division.
2. Caterpillar
3. Cummins
4. Kohler

B. Product Description: NEMA MG1, 12 lead reconnectable synchronous generator with brushless exciter.

C. Brushless, direct-connected type exciter with shaft mounted diodes and built-in permanent magnets to eliminate field flashing.

D. Standby Rating: 60 kW, 75 kVA, at 0.8 power factor, 208Y/120 volts, three phase, 60 Hz. Rating are at elevation of 1000 feet above sea level and 27 degrees C. ambient temperature using specified engine cooling scheme.

E. Insulation Class: H.

F. Temperature Rise: 130 degrees C Standby.
   1. AC alternator shall be synchronous, four pole, 2/3 pitch, brushless, revolving field, drip proof construction, single pre-lubricated sealed bearing, air cooled by direct drive centrifugal blower fan, and directly connected to engine with flexible drive disc. Alternator design shall prevent shaft current from flowing and eliminate need for insulated bearings. All insulation system components shall meet NEMA MG1 requirements for Class H insulation systems. Actual temperature rise measured by resistance method at full load shall not exceed 1058C in 408C ambient.
   2. Generator set shall include automatic microprocessor based voltage regulation system that is matched and prototype tested by engine manufacturer with governing system provided. It shall be immune from mis-operation due to load induced voltage waveform distortion and provide pulse width modulated output to alternator exciter. Voltage regulation system shall be equipped with three phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. Voltage regulation system shall be based on full wave rectified input, pulse width modulated output design. System shall include torque matching characteristic, which shall reduce output voltage in proportion to frequency below adjustable frequency threshold. Voltage regulator shall include adjustments for gain, damping and frequency roll off. Adjustments shall be broad range and made via digital raise lower switches, with alphanumeric LED readout to indicate setting level.
   3. Generator set shall be provided with utility grade protective relay designed to provide thermal overload protection for alternator, and performance certified for that purpose by third party testing organization. Supplier shall submit time overcurrent characteristic curves and thermal damage curve for alternator demonstrating effectiveness of protection provided. Relay shall be installed to allow shutdown of generator excitation system on alternator overload condition, with engine operating for cool down period before shutdown. Relay shall not include instantaneous trip function.

G. Enclosure: NEMA MG1, open drip proof.
   1. Alternator shall be capable of recovering to minimum of 90 percent of rated no load voltage following application of specified kVA load at near zero power factor applied to generator set in compliance to requirement of NEMA MG1-32.

H. Voltage Regulation: Furnish generator mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Furnish manual controls to adjust voltage droop, voltage level (plus or minus 5 percent) and voltage gain.

I. Voltage Regulator system filtered to be compatible with and capable of regulating generator output to permit starting and running of loads as shown on drawings, simultaneously with maximum of 15 percent voltage dip at locked rotor current with return to steady state in less than 2 seconds. Steady state is defined as operation with terminal voltage remaining constant within ± 1/2 of 1 percent of rated voltage.

J. Transient Voltage Performance
1. Not more than 20 percent variation for 50 percent step load increase or decrease. Voltage shall recover and remain within steady state operating band within 5 seconds. On application of a 100 percent load step the generator set shall recover to stable voltage within 10 seconds.

K. Transient Frequency Performance
1. Not more than 15 percent variation for 50 percent step load increase or decrease. Frequency shall recover and remain within steady state operating band within 5 seconds. On application of 100 percent load step generator set shall recover to stable frequency within 10 seconds.

2.2 GOVERNOR

A. Product Description: Electronic governor to maintain engine speed within 0.5 percent, steady state, and 5 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes.

2.3 ENGINE

A. Product Description: Water-cooled in-line or V-type, four-stroke cycle, electric ignition internal combustion engine.

B. Rating: Sufficient to operate under 10 percent overload for one hour in ambient of 90 degrees F.

C. Fuel System: Natural gas.

D. Engine speed: 1800 rpm.

E. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.

F. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Furnish remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.

G. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 120 volts AC.

H. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F. Radiator air-flow restriction 0.5 inches of water maximum. Sized for 50 percent ethylene-glycol solution at 40 degrees C. ambient and 1,000 foot elevation. Ethylene-glycol antifreeze with rust inhibitor to –40 degrees C.

I. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, gear-driven water pump. Furnish fuel pressure gage, water temperature gage, and lube oil pressure gage on engine/generator control panel.

J. Electric fuel solenoid shut-off valve with standard fuel filter on engine.

K. Lubrication break-in oil.

L. Flexible fuel connections

M. Oil drain extension through side of skid base

N. Mounting: Furnish unit with suitable spring-type vibration isolators and mount on structural steel base.

O. Unit shall meet EPA emissions regulations for spark-ignited engine generator sets.

2.4 EXHAUST EQUIPMENT

A. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, sized in accordance with engine manufacturer's instructions. Silencer shall have companion flanges and gaskets and drain plug at bottom of muffler opposite of exhaust outlet.

B. Exhaust Piping. Black steel with condensate drip pocket and drain valve.

C. Insulation: Insulate piping and silencer with aluminum cover insulation rated for 650 degrees C.

2.5 ACCESSORIES

A. Provide remote manual stop station of type similar to break-glass station located outside generator room to shut down generator.

B. Batteries: Heavy duty, diesel starting type lead-acid storage batteries, meeting per NFPA 110 requirements. Match battery voltage to starting system. Furnish cables and clamps.

C. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.

D. Battery Charger: Current limiting type designed to float at 2.17 volts for each cell and equalize at 2.33 volts for each cell. Furnish overload protection, full wave rectifier, DC voltmeter and ammeter, with high-low rate capable and 120 volts AC fused input. Furnish wall-mounted enclosure to meet NEMA 250, Type 1 requirements.

E. Engine-Generator Control Panel: NEMA 250, Type 1 wall-mounted control panel enclosure with engine and generator controls and indicators. Furnish provision for padlock and the following equipment and features:
   1. Frequency Meter: 45-65 Hz. range, 3.5 inch dial.
   2. AC Output Voltmeter: 3.5 inch dial, 2 percent accuracy, with phase selector switch.
   3. AC Output Ammeter: 3.5 inch dial, 2 percent accuracy, with phase selector switch.
   4. Output voltage adjustment to allow minimum plus 5 percent voltage adjustment.

5. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, overspeed, and overcrank.
6. Engine Run/Off/Auto selector switch.
7. Engine running time meter.
8. Oil pressure gage.
9. Water temperature gage.
10. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
11. Additional visual indicators and alarms in accordance with by NFPA 110.
12. Remote Alarm Contacts: Factory wire SPDT contacts to terminal strip for remote alarm functions in accordance with NFPA 110.
13. Controls shall shut down and lock out prime mover following conditions stated in NFPA 110.
14. All safety indications and shutdowns stated in NFPA 110 Table 3-5.5.2(d).

F. Remote Annunciator Panel: Surface mounted panel with painted finish. Furnish audible and visible indicators and alarms in accordance with NFPA 110.

2.6 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 ADJUSTING

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

B. Adjust generator output voltage and engine speed to meet specified ratings.

3.2 CLEANING

A. Division 01 – General Requirements: Final cleaning.

B. Clean engine and generator surfaces. Replace oil and fuel filters with new.

3.3 DEMONSTRATION AND TRAINING

A. Furnish 8 hours of instruction each for 6 persons, to be conducted at project site with manufacturer's representative.

B. Describe loads connected to emergency system and restrictions for future load additions.

C. Simulate power outage by interrupting normal source, and demonstrate system operates to provide emergency power.

3.4 INSPECTION

A. Examine area to receive engine/generator to assure adequate clearance for engine/generator installation.

B. Examine air intake and exhaust to assure adequate air requirements.

C. Verify that mounting area is level and free of irregularities.

D. Start work only after unsatisfactory conditions are corrected.

3.5 INSTALLATION

A. Install engraved plastic nameplates in accordance with Section 26 05 53 – Electrical Identification.

B. Ground and bond generator and other electrical system components in accordance with Section 26 05 26 – Grounding and Bonding.

C. Engine – Generator:
1. Install engine/generator in accordance with manufacturer's written instructions and NEC.
2. Lubrication and break-in oil to be supplied and installed by supplier or manufacturer's technician at time of start-up.
3. Anti-freeze with rust inhibitor (set to –40 degrees C.) to be supplied and installed by supplier's or manufacturer's technician at time of start-up.

D. Starting Batteries and Charger:
1. Locate freestanding battery rack inside enclosure as directed by manufacturer. Connect cables to starter with suitable lugs.
2. Mount battery charger near batteries and extend battery-charging wires in conduit.

E. Exhaust System:
1. Exhaust system will be installed by Mechanical Contractor.
2. Install black steel piping system in accordance with industry standards.
3. Provide with drip pocket to collect condensation and drain valve.
4. Size pipe as recommended by engine manufacturer.
5. Pitch horizontal piping downward away from engine, route as high as possible, with outside rainguard.
6. Insulate silencer and piping. Do not insulate flexible connection.
7. Cover insulation with aluminum cover.

3.6 WIRING AND CONNECTIONS

A. Provide flexible liquid-tight conduit connections with standard conductor to equipment requiring power and control connections.

B. Provide electrical connections from appropriate panel boards as indicated on drawings for the following:
1. Air intake and exhaust dampers.
2. Lube oil heater.

3. Coolant heater.
4. Battery charger.

C. Provide wiring between the generator controller and the remote alarm annunciator.

D. Provide 2 #14 between each automatic transfer switch and the generator controller for engine start.

E. All control wiring shall be routed in dedicated raceway separate from power conductors.

3.7 FIELD TESTS PRIOR TO START UP

A. Megger check of phase-to-phase and phase-to-ground insulation levels. Do not megger check solid state equipment.

B. Ground continuity.

C. Short circuit.

D. Perform additional tests according to engine/generator manufacturer's instructions.

3.8 SUPPLIER'S OR MANUFACTURER'S SERVICES

A. Retain services of engine/generator set manufacturer's factory trained technician employed by engine/generator set manufacturer or his authorized distributor to perform following services: installation services, testing services and instructional services.

3.9 INSTALLATION SERVICES

A. Visit project site to review installation requirements with Contractors involved. Visit shall be made prior to permanently installing equipment and/or making mechanical or electrical connections.

B. Visit site and meet with all concerned Contractor to ensure installation is properly coordinated. Contractor to coordinate meeting to ensure presence of all parties concerned.

3.10 TESTING SERVICES

A. Include minimum of six simulated power failures in presence of transfer switch manufacturer's start-up representative.

B. Test remotely connected engine/generator status indication signals.

C. Test transfer switch.

3.11 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Lift engine/generator using eyes, yokes and skids provided by manufacturer.

B. Do not store indoor type equipment exposed to weather.

C. Protect from work of other trades.

END OF SECTION

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SECTION 26 35 53
SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Surge Protection Devices.

B. Related Sections:
   1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
   2. Section 26 00 00 – Basic Electrical Requirements.
   3. Section 26 24 13 - Switchboards: Surge protection devices integrated in switchboards.
   4. Section 26 24 16 - Panelboards: Surge protection devices integrated in panelboards.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers (IEEE):
   1. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.
   2. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   3. IEEE C62.45 - Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association (NEMA):
   1. NEMA LS 1 - Low Voltage Surge Protection Devices.

C. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code, Article 285.

D. Underwriters Laboratories Inc. (UL):
   1. UL 1283 - Electromagnetic Interference Filters.
   2. UL 1449 - Surge Protection Devices.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Procedures for submittals.

B. Product Data: Submit capacity, dimensions, weights, details, and wiring configuration.

C. UL 1449 Second Edition Listing, Standard for Safety, Surge Protection Devices, documentation.

D. UL 1283 Listing, Electromagnetic Interference Filters, documentation.

E. IEEE C62.41, Category C3 (20kV-1.2/50, 10kA-8/20μs waveform) clamping voltage test results.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 – General Requirements: Procedures for closeout submittals.

B. Project Record Documents: Record actual locations of surge protection devices.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, installation instructions, and maintenance and repair data.

1.5 QUALITY ASSURANCE

A. List individual units under UL 1449 and UL 1283.

B. Perform Work in accordance with state and local codes.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years' experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products under provisions of Division 01 – General Requirements.

B. Accept equipment on site in factory packaging. Inspect for damage.

C. Protect equipment from damage by providing temporary covers until construction is complete in adjacent space.

PART 2 - PRODUCTS

2.1 SURGE PROTECTION DEVICES (SPD)

A. Manufacturers:
1. Cutler-Hammer, Inc. (Eaton)
2. General Electric Company.
3. Square D Company.
4. Siemens Energy & Automation, Inc., TPS Series.

B. Manufacturer of SPD shall be the same as manufacturer of distribution equipment in which devices are installed and shipped.

C. SPD shall be installed by and shipped from electrical distribution equipment manufacturer's factory.

D. Product Description: Surge protective devices for protection of AC electrical circuits.

E. Each module shall be fused with surge rated fuse.

F. Unit Operating Voltage: As indicated on Drawings.

G. SPD shall have UL approved means of disconnect.

H. SPD shall have copper bus for surge current path. Small round wiring connections shall not be used in the path for surge current diversion.

I. Construction:
   1. Balanced Suppression Platform: Equally distribute surge current to Metal Oxide Varistor (MOV) components to ensure equal stressing and maximum performance. Furnish surge suppression platform with equal impedance paths to each matched MOV.
   2. Internal Connections: Hardwired with connections using low impedance conductors and compression fittings.
   3. Safety and Diagnostic Monitoring: Equipped with standard overcurrent protection:
      a. Continuous monitoring of fusing system.
      b. Monitor individual MOV's (including neutral to ground). Capable of identifying open circuit failures not monitored by conventional fusing systems.
      c. Monitor for overheating in each mode due to thermal runaway.
      d. Furnish green and red solid state indicator light on each phase. Absence of green light and presence of red light indicates which phases have been damaged. Fault detection activates flashing trouble light and alarm. Alarm on/off switch shall be provided to silence alarm. Units not capable of detecting open circuit damage, thermal conditions, and over current will not be accepted.
   4. Labeling: Permanently affix UL 1449 suppression voltage ratings to unit.

J. Rating:
   1. Electrical Noise Filter: Furnish each unit with high performance EMI/RFI noise rejection filter. Electric line noise attenuation no less than 50 dB at 100 kHz using MIL-STD-220A insertion loss test method.

K. Accessories:
   1. Local audible alarm.
   2. Form C dry contacts one normally open (NO) and one normally closed (NC) for remote status monitoring.

L. SPD shall be listed in accordance with UL 1449 Second Edition and UL 1283, Electromagnetic Interference Filters.

M. SPD shall be listed in accordance with UL 1449 Second Edition to include Section 37.3 highest Short Circuit Current Rating (SCCR) of 200 kA.

N. SPD shall be tested with the Category C3 high exposure waveform (20kV-1.2/50μs, 10kA-8/20μs) per ANSI/IEEE C62.41 - 1991.

O. Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE C62.41 Category C3 transients without failure or degradation of clamping voltage by more than 10 percent:

P. Service Entrance Type SPD shall have a minimum surge current rating of 160 kA per phase.

Q. Distribution type SPD shall have minimum surge current rating of 120 kA per phase.

R. Protection Modes: For Wye configured system, furnish device with directly connected suppression elements between line to line (L-L), line-neutral (L-N), line-ground (L-G), and neutral-ground (N-G). For Delta configured system, furnish device with suppression elements between line to line (L-L) and line to ground (L-G).

S. Do not exceed the following for maximum UL 1449 suppression voltage ratings:

Modes	208Y/120
WYE - L-N; L-G; N-G	400 V

T. SPD shall be designed to withstand a maximum continuous operating voltage of not less than 115 percent of nominal RMS voltage.

2.2 SOURCE QUALITY CONTROL AND TESTS

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test units to specified surge ratings to ensure devices will achieve required life expectancy and reliability. Testing to full ratings also verifies internal construction quality of suppressors. Provide withstand testing for each mode and each phase basis.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify mounting area is ready for equipment.

C. Verify circuit rough-ins are at correct location.

3.2 INSTALLATION

A. Mount internally to new power distribution equipment or on existing distribution equipment as noted on drawings.

B. Install in accordance with IEEE 1100.

C. Install using direct bus bar connection.

D. Install indicator lights and trouble alarms in face of power distribution equipment.

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Interior Luminaires.
2. Interior Lamps.
3. Ballasts.
4. Exit Signs.
5. Emergency Battery Units.
6. Accessories.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.

1.2 SUBMITTALS

A. Division 01 – General Requirements: Procedures for submittals.

B. Shop Drawings:
1. Include outline drawings, catalog cut sheets, lamp and ballast data, support points, weights, accessory information, and performance data for each luminaire type.
2. For all luminaries with paint color or finish options, include single color original of manufacturers color or finish choices for Architects review.

C. Product Data: Submit dimensions, ratings, and performance data.

D. Record Drawings: For installations utilizing remotely mounted low voltage transformers, Electrical Contractor shall provide set of record drawings indicating location of installed transformers to facilitate future maintenance.

1.3 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

PART 2 - PRODUCTS

2.1 GENERAL – INTERIOR LIGHTING

A. Furnish all labor, materials, tools, equipment, and services for all interior lighting, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of all other trades.

C. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for sound, secure and complete installation.

2.2 INTERIOR LUMINAIRES

A. Subject to compliance with requirements, fixtures that may be incorporated into work include products specified in lighting fixture schedule on Drawings, and equals from manufacturers listed on fixture schedule.

B. Basic catalog number only is indicated in lighting fixture schedule. Electrical Contractor shall furnish complete lighting fixtures in quantities, and row lengths as shown on Drawings, including plaster frames, ends, or caps, couplings, connectors, suspension assemblies, mounting brackets and all auxiliary accessories as required.

C. Reference schedule for description of fixture nomenclature and associated ceiling type and suspension system.

D. Housing:
1. Shall be free from burrs, sharp corners and edges.
2. Shall be steel, unless noted otherwise, formed and supported to prevent warping and sagging.
3. Provide spring loaded latches for all troffers.

E. Mounting Accessories
1. Recessed fixtures:
   a. Provide trim type and accessories required for installation in ceiling types specified shown on reflected ceiling plan.
   b. Fixtures mounted in sloped ceilings shall be provided with sloped ceiling adapters and appropriate trim rings and other accessories as required.
2. Surface mounted fixtures: Provide ceiling spacers as required for fixtures not labeled as suitable for direct mounting to low density ceiling.
3. Suspended fixtures:
   a. Provide swivel canopy to accommodate any sloped ceilings shown on plans.
   b. Provide pendant or cable length required to suspend luminaries at indicated height.
   c. Swivel hangers in mechanical equipment areas shall be shock absorbing type.

F. Finishes:
1. Painted finishes shall be polyester powder painted enamel finish, and painted after fabrication unless noted otherwise.
2. Polished, brushed or other metal finishes shall be finished with clear coat to inhibit finish deterioration and corrosion.
3. Finish types and colors shall be verified with Architect/Engineer prior to ordering.

G. Louvers, Reflectors, Lenses:
1. Louvers and reflectors shall be semi-specular, low iridescent, clear alzak, unless noted otherwise.

2. Parabolic louver depth shall have minimum actual dimension of 3 inches, unless noted otherwise.
3. Acrylic lenses shall be pattern 12 prismatic, overall 0.125 inch minimum thickness.

H. Provide IC rated light fixtures for light fixtures that will be in contact with insulation.

2.3 LAMPS

A. General – Lamps:
1. Lamps shall be provided new.
2. Approved manufacturers;
a. Low-Voltage:
1) Philips.
2) Osram/Sylvania.
3) General Electric.
4) Ushio.
5) Equivalent as acceptable to Engineer.

2.4 EXIT SIGNS

A. Exit signage shall have 6-inch high lettering meeting code and standard requirements of federal, state, and local jurisdictions where project is located.

B. Provide directional arrows as indicated and required by authorities having jurisdiction.

C. Provide mounting accessories as required to back, end, pendant, or top mount in accordance with project requirements.

D. Provide with internal, pre-wired Nicad battery backup unless noted otherwise in light fixture schedule.

E. Exit signage shall be modular design, facilitating replacement of individual parts.

F. Exit signage shall be illuminated by LED’s, unless noted otherwise in light fixture schedule.

G. Provide exit signs with internal battery backup with integral test switch.

2.5 EMERGENCY BATTERY UNITS

A. Shall have two (2) MR-16 lamp heads, minimum 12 watts per lamp, or as indicated in light fixture schedule.

B. Provide internal, pre-wired lead acid battery, unless noted otherwise.

C. Provide test switch and LED to indicate proper operation.

D. As noted on Drawings or schedules, each fixture shall be provided with time delay circuit to keep emergency lighting on for user selected amount of time after normal power is restored.

2.6 MAINTENANCE MATERIALS

A. Division 01 – General Requirements: Spare parts and maintenance products.

B. Furnish two of each plastic lens type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install suspended luminaires using pendants supported from swivel hangers. Install pendant length required to suspend luminaire at indicated height.

B. Support luminaires larger than 2 x 4 foot size independent of ceiling framing.

C. Locate recessed ceiling luminaires as indicated on Drawings. Coordinate all discrepancies between lighting and reflected ceiling plans with architect.

D. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

E. Install recessed luminaires to permit removal from below.

F. Install wall-mounted luminaires at height as indicated on Drawings.

G. Install accessories furnished with each luminaire.

H. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

I. Install specified lamps in each luminaire.

J. Electrical Contractor shall check Structural Drawings, architectural reflected ceiling plans, General Construction Drawings and Mechanical Drawings to verify construction and type of surface on or in which lighting fixtures are installed, for ceiling construction proper type of suspended ceiling and space above same and possible conflicts with equipment of other trades.
   1. Determine specific ceiling construction including ceiling materials and ceiling suspension system in each area where suspended ceiling is to be provided.
   2. Verify suspended ceiling type with ceiling contractor prior to releasing lighting fixtures for delivery.
   3. Furnish fixture of type scheduled complete with accessories necessary to make installation accordance with manufacturer’s recommendations including plaster frames, couplings and connectors, suspension assemblies mounting brackets and other auxiliary equipment.

K. Bond fixtures and metal accessories to branch circuit equipment grounding conductor.

L. Fixture Connections:
   1. Surface and wall recessed fixtures shall be connected directly to junction box or solid conduit.

2. Ceiling recessed fixtures shall be connected to flexible metal conduit, originating at solidly supported J-Box.
3. Flexible metal conduit shall be minimum 3/8 inch diameter. Conduit length shall allow movement of fixture for maintenance purposes.
4. Minimum wire size shall be #12 AWG.

M. Provide box-outs and other accessories around recessed fixtures as required to maintain fire ratings for spacing required from insulation in ceiling space. Final installation shall meet regulatory requirements and manufacturer's recommendations.

N. Contractor shall verify exit signs are provided and visible along all exit paths shown on Architectural Life Safety Plan.

3.2 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection.

B. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Aim and adjust luminaires as indicated on Drawings and adjust as directed by designated Owner personnel.

3.4 CLEANING

A. Remove dirt and debris from enclosures.

B. Clean photometric control surfaces as recommended by manufacturer.

C. Clean finishes and touch up damage.

3.5 PROTECTION OF FINISHED WORK

A. Division 01 – General Requirements: Protecting finished work.

B. Relamp luminaires having failed or noticeable dim lamps at Substantial Completion.

END OF SECTION

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SECTION 26 60 00

MULTIPLEXED ADDRESSABLE FIRE ALARM/DETECTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Furnish and installation of multiplexed/intelligent Fire Alarm System including:
   a. Control panel.
   b. Manual stations.
   c. Automatic detectors.
   d. Alarm indicating appliances.
   e. Necessary material for operating system.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Division 26: Conduits.
4. Division 26: Low Voltage Wires, Cables and Connectors.

1.2 REFERENCES

A. National Fire Protection Association (NFPA):
1. NFPA70 - National Electrical Code (NEC).
2. NFPA 72 - National Fire Alarm Code.
3. NFPA 101 - Code for Safety to Life.

B. Underwriters' Laboratories, Inc. (UL).

1.3 GENERAL SYSTEM DESCRIPTION

A. Fire Alarm System shall consist of necessary hardware and software equipment to perform or initiate functions as Multiplexed Fire Alarm and Detection System.

B. Fire Alarm System, as installed within this facility, shall consist of single Fire Alarm Control Panel (FACP), and specified required remote panels. Each item of Fire Alarm System shall be listed as product of single fire alarm system manufacturer under appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear UL label, unless specified otherwise. Notification Appliances may be products of single, different manufacturer – provided that Primary Equipment Provider or Manufacturer provides written documentation of compatibility, and agrees to assume responsibility for compatibility with Control Equipment. Control Equipment for Systems shall be listed under UL category UOJZ as Single Control Unit. Each piece of equipment shall contain manufacturer's name. Each initiating device shall be product of single manufacturer and be cross-listed with fire alarm panel (initiating devices must bear same manufacturer’s name).

C. System shall use latest intelligent and intelligent analog, addressable technology currently available from manufacturer. New panels shall be modular to allow for expansion of required modules. Non-intelligent addressable devices shall be unacceptable.

1.4 SYSTEM DEFINITIONS

A. In order to clarify intent of this specification, and in order to provide defined equivalence between different technologies, which are used by different system vendors, the following definitions shall be incorporated into this specification section:
   1. "Analog Addressable Sensor" technology: Non-intelligent or semi-intelligent sensors report analog values to FACP. Where this technology is employed, historical data and floating average values associated with each sensor – including but not limited to average, peak, and current obscuration values, shall be maintained within memory of FACP. Where analog addressable sensors are utilized, alarm conditions shall be determined by FACP, based upon readings reported by various sensors.
   2. "Intelligent Addressable Smoke Detector": Intelligent detectors shall contain processing and memory circuits within each detector unit. Analog smoke obscuration value at detector shall be capable of being manually retrieved to FACP for report or adjustment purposes. Where intelligent addressable detectors are utilized, historical data floating average values associated with each sensor, including but not limited to average, peak, and current obscuration values, shall be maintained within memory of detector itself. Where intelligent addressable smoke detectors are utilized, alarm conditions shall be determined locally, at detectors.

1.5 SYSTEM ALARM FUNCTIONS

A. Standby Mode:
   1. Under normal condition front panel shall display "SYSTEM IS NORMAL", or similar message, current time and date, and GREEN LED, which shall indicate that Primary AC Power is present.
   2. When abnormal condition is detected, appropriate LED (Alarm, Supervisory or Trouble) shall flash, and corresponding unique audible signal shall sound for each of three possible abnormal conditions.

B. Trouble Sequence Mode:
   1. Trouble status condition, originating from the following device types, shall cause initiation of the Supervisory Status Condition Sequence of Operation:
      a. Disconnection, disarrangement, or Ground Fault of Supervised Fire Alarm Circuit.
      b. Partial/Component Failures sensed via Fire Alarm On-Board Diagnostics.
      c. Loss of power used for shunt-trip actuation.
      d. Failure of Primary Power Source.
      e. Failure of Remote Fire Alarm Power Supplies/NAC Booster Panels.
      f. Fire Pump Controller Trouble (where Fire Pumps are monitored via Fire Alarm System).
      g. Trouble status condition originating from other monitored sub-system (kitchen hood suppression, sprinkler system shut off valves).
   2. When Trouble status condition has been determined by system, the following responses shall be automatically initiated. The following events are not required to occur in stated order:

a. Trouble status condition shall be both audibly and visually indicated at fire alarm control panel (FACP), and annunciators.
b. Programmed Trouble message shall appear on LCD displays, in a manner that is similar to Alarm messages.
c. Trouble status condition shall be automatically logged to FACP internal history log file, which shall reside within non-volatile memory.
d. Each Trouble status condition shall continue to be indicated, until acknowledged or cleared.
e. "Trouble Reminder" feature shall cause re-sounding of Trouble indication at FACP and at Annunciators at least once per 24 hours, until condition causing Trouble is corrected and/or until system is Reset.

C. Alarm sequence mode, non-smoke sensing initiation devices:
1. Alarm status condition originating from the following device types shall cause initiation of Fire Alarm Sequence:
a. Manual pull stations.
b. Ceiling and wall mounted heat detectors, regardless of type.
c. Sprinkler system flow switches.
d. Sprinkler system pressure switches that are used as flow/release indicators.
2. When valid fire alarm condition has been determined by system, the following responses shall be automatically initiated. The following events are not required to occur in stated order:
a. Fire alarm status condition shall be both audibly and visually indicated at fire alarm control panel (FACP), and annunciators.
b. Programmed alarm message shall appear on LCD displays. This message shall be field programmable and consist of point description, device address, alarm type, and associated date and time.
c. Audible notification appliances shall activate, and emit ANSI S3.41 fire alarm evacuation, Temporal Code 3 pattern, until silenced by signal silence switch.
d. Visible notification appliances shall flash continuously until system is manually reset. Visible notification appliances shall be synchronized.
e. Air handlers shall be shut down on general alarm via addressable control module. Required dampers shall also be closed on general alarm via addressable control module. Fire alarm supplier shall provide control modules at HVAC Temperature Control Panel.
f. Magnetically held open doors shall release on general alarm.

D. Alarm sequence mode, device specific operations:
1. Elevator Recall: Locate smoke detectors as shown on plans. Control modules shall be used for elevator recall, four wire bases and relays shall not be accepted. One control module shall be provided for primary floor recall, one for alternate floor recall, and one for activating separate distinct visual alarm to notify fire department of unsafe elevator condition (upon activation of smoke detector in elevator machine room or shaft). Elevator recall operation shall meet NFPA 72 requirements.
2. Elevator Shunt Trip: Locate heat detectors as shown on plans; within two feet of sprinkler head (detectors shall have lower temperature rating and lower rate-of-rise than sprinkler head). Control module shall be used to activate elevator shunt trip, four wire detectors and relays shall not be accepted. Monitor module shall be provided to monitor power to shunt trip breaker circuit.

E. System alarm acknowledgement function:
   1. System shall have alarm list key to allow operator to display alarms, troubles, and supervisory service conditions with time of occurrence. This shall allow for determination of not only most recent alarm but may also allow tracing path of fire.
   2. Pressing appropriate acknowledge button shall globally acknowledge each point in alarm.
   3. As points have been acknowledged, associated control panel and annunciator LED's shall cease flashing and shall glow steady. After alarms have been acknowledged panel audible signal shall be silenced. Total number of alarms, supervisory, and trouble conditions shall be displayed along with prompt to review each list chronologically. End of list shall be indicated by message "END OF LIST".
   4. Provision shall be made for passcode protection of: Acknowledge Alarm Silence, System Reset, and Manual Control functions. Four (4) access levels shall be provided. Passcodes shall consist of up to ten (10) digits. Changes to passcodes shall only be made by authorized personnel.

F. System reset:
   1. "System Reset" button shall be used to return system to its normal state after alarm condition has been remedied. LCD display shall step user through reset process with simple English language messages.
   2. Visual signals shall cease operation upon System Reset.
   3. System reset function shall be ineffective until system initiation device(s) have been reset to their normal, standby condition. When alarm condition continues to exist, system shall remain in alarm state and system control relays shall not reset. Display shall indicate total number of alarms and troubles present, along with prompt to review points.
   4. When Alarm Silence Inhibit function is active, message, "SYSTEM RESET INHIBITED", shall be displayed.

1.6 SYSTEM SERVICE FUNCTIONS

A. Walktest. System shall have multiple levels of passcode protected walktest groups, allowing only portion of system to be disabled during testing. When walktest mode is activated control unit shall perform the following functions:
   1. DACT and suppression release circuits shall be bypassed.
   2. Control relay functions shall be bypassed.
   3. Control unit shall indicate trouble condition.
   4. Alarm activation of initiation device in testing group shall cause audible notification appliances to sound code to identify device.
   5. Unit shall automatically reset itself after signaling.
   6. Momentary opening of initiating or notification appliance circuit wiring shall cause audible signals to sound for 4 seconds indicating trouble condition.

B. System override functions:
   1. Bypass Switches shall be configured to report trouble status condition when bypass function is active. Trouble message shall indicate active function(s). Bypass LEDs corresponding to active function(s) shall illuminate, and shall remain lit until associated bypass function is de-activated (until system is restored to normal operating status). General Trouble Condition shall also be reported to required Supervising Station where “Bypass” function is active. This Trouble condition shall continue to be reported, as long as Trouble status condition

continues to exist. At each FACP, Switches and LEDs shall be provided for the following functions:

a. Central Monitoring Bypass: When this bypass function is active, reporting of various status conditions to Supervising Station (Central Station Monitoring Service, via DACT) shall be disabled. (Actuation of relay outputs, Control Modules, or Pseudo-Points, which are tied to DACT, shall be prevented.) This function is primarily intended to reduce nuisance activity at Supervising Station, while testing system. (It shall be acceptable to use standard "city circuit" features of systems, keypads built into separate DACT units, provided they operate in similar manner and associated switches are properly labeled).
b. Elevator Interface Bypass: When this bypass function is active, actuation of Control Modules or Supervised Relays, which interface to Elevator Controls and to Shunt-Trip Circuit Breaker(s) shall be prevented. This function is primarily intended to allow testing of Smoke and Heat Detectors/Sensors, which are associated with Elevator, without interrupting normal operation of elevators.

C. Access levels:
1. FACP shall be capable of providing a means of securing access to critical operator functions. This security shall be multi-tiered method to allow multiple groups of users access to system, while restricting user access to features for which they are trained.
2. The following Operator Function Access Restrictions shall be adhered to as closely as possible. Where system limitations do not allow for restrictions to be configured exactly as listed, alternate methods shall be brought to attention of Engineer and Owner.
3. Basic Operator Functions: The following Basic Operator functions are essential to typical event processing. These functions shall simply require key – either to access controls, which are located behind locked door.
4. Acknowledge: Acknowledge ALARM, TROUBLE, and SUPERVISORY conditions, and to view lists/ logs associated with these functions.
5. Signal Silence: Silence audible signals.
6. System Reset: Reset Fire Alarm System.
7. High Security Functions. Access to highest level of system operation shall require proper password entry before access to these functions are allowed. Areas of system operation which require this level of protection include:
   a. System Programming – Making changes to system operation programming.
   b. Passcode Protection – Changing a user's password or access level.
8. Other Functions: Access to the following functions shall be limited. Access levels for these functions shall be between Basic Operator Functions and High Security Functions:
   a. Enable/Disable Points
   b. Perform Bypass/Override Functions/Features
   c. Generate Hard-Copy, Printed Reports
   d. Add/Delete/Change Pass codes, and associated links to system features
   e. Set/Change System Clock
   f. Set/Change Sensitivity of Detectors
   g. Clear History Logs
   h. Walktest

D. Historical logging.
   1. System shall be capable of logging and storing last 600 events (alarm & trouble) in history log. These events shall be stored in battery protected random access memory (non-volatile memory). Each recorded event shall include time and date of that event's occurrence. Historical logs shall be configured to utilize “Stack Management”. Once memory is filled, oldest information shall be automatically discarded, maximizing amount of relatively current information stored and available for retrieval.
   2. The following historical alarm log events shall be stored:
      a. Alarms
      b. Alarm acknowledgment
      c. Alarm silence
      d. System reset
      e. Alarm historical log cleared
   3. The following historical trouble log events shall be stored:
      a. Trouble conditions and return to normal
      b. Supervisory conditions and return to normal
      c. Trouble acknowledgment
      d. Supervisory acknowledgment
      e. Automatic verification tallies
      f. Walk test results
      g. Trouble historical log cleared

1.7 SUBMITTALS

A. Division 01 – General Requirements: Procedures for submittals.

B. Submit Product Data: In accordance with Division 01 – General Requirements.

1.8 QUALITY ASSURANCE

A. Perform Work in accordance with State and Municipality standards.

1.9 MANUFACTURER’S SERVICES

A. System manufacturer shall provide authorized representative to supervise installation. Supervision shall be provided by trained service technician from manufacturer of fire alarm equipment. Technician shall possess minimum of NICET (National Institute for Certification in Engineering Technology) Level 2 certification and have had minimum of two (2) years of service experience in installation of fire alarm systems. Technician's name shall appear on equipment submittals and letter of certification from fire alarm manufacturer shall be made available to engineer, upon request.

B. Manufacturer's service technician shall be responsible for the following items:
   1. Pre-installation visit to job site to review equipment submittals and verify method by which system shall be wired. Prepare and submit report documenting observations made and directives given.
   2. During job progress, make job site visits to verify installation and wiring of system. For each visit, technician shall prepare and submit report documenting observations made and directives given.

3. Upon completion of wiring, connections shall be made under supervision of this technician.
4. Checkout and certification of the system shall be performed.
5. At time of checkout, technician shall give operational instructions to Owner his representative on system.

C. Job site visits shall be dated and documented in writing and signed by Electrical Contractor. Discrepancies shall be noted on this document and copy kept in system job folder shall be available to Project Engineer during project.

1.10 SHOP DRAWING SUBMITTALS

A. Shop drawing submittal shall include the following as minimum:
1. Cover sheet including submittal date, specification section, contractor name, fire alarm vendor name, name of manufacturers on site technician, and project name.
2. Equipment list, including quantities, manufacturer, manufacturer part number, and equipment description. Spare parts shall be listed separately and labeled as spares. Vendors utilizing equipment from other manufacturers shall provide vendor part number and manufacturer's part number as it appears on packing list. Both part numbers shall be listed on individual data sheets as well. Separate equipment list shall be provided for each specification section.
3. Manufacturer's Data Sheets for each piece of equipment provided. Data sheets shall be bound in order they occur in equipment list. If item occurs more than once in equipment list, only one data sheet is needed. Data sheets shall be clearly marked, noting which item or items on that sheet are being provided.
4. Sequence of Operation shall be provided giving description of functions of system. Sequence of operation shall be in narrative form or matrix form. System Operation section, of this specification shall be acceptable providing changes be highlighted on original copy and new operation inserted. If there are no changes to original system operation, then each paragraph shall be labeled "No Change".
5. Addressable Device List showing device address, device type, and room number/name.
6. Floor Plan Drawing shall be provided at time of submittal and shall be job specific. Floor plan drawings shall show panel locations, device locations, device addresses, and wire types. Copies of CAD Files, for fire alarm floor plans, shall be made available to successful bidder.
7. Riser diagrams shall be provided to illustrate fire alarm circuits. Each riser diagram shall be job specific and show point of origin for each circuit, areas served by each circuit, circuit type and wire type.
8. Standby battery calculations showing current draw for each device and module during standby, alarm, and trouble conditions. Battery calculations shall be provided for each fire alarm and NAC panel. Maximum load calculations shall be acceptable. Required spare battery capacity shall be indicated.
9. Voltage Drop Calculations for each signal circuit. Voltage drops shall be calculated using voltage supplied by batteries after period of 24 hours of standby. Listed minimum operating voltage for each signaling device shall be provided.

B. Addressable Device List, as stated above, shall be provided to Owner, for review, minimum of 20 (twenty) days prior to acceptance testing. This version shall include device types, addresses, and proposed custom labels, as they are to be programmed into system.

1.11 WISCONSIN DEPARTMENT OF SAFETY AND PROFESSIONAL SERVICES – FIRE PROTECTION SYSTEM PLAN APPROVAL

A. Where fire protection system plan approval is required, Contractor shall assist Engineer in preparation of submittal. Refer to State Register October 2015, Safety and Professional Services Code, Chapter 361, paragraph 361.30 and table 361.30.1 for buildings where fire protection system plan approval is required. Submittal requirements and areas of responsibility are as follows:
   1. Fire Alarm System Floor Plans dimensioned and drawn to scale with appropriate symbols, system wiring requirements, and other information required by Department of Safety and Professional Services. Four sets required to be furnished to Engineer by electrical contractor.
   2. Copy of fire alarm system control panel and device shop drawings. Four sets required to be furnished to Engineer by electrical contractor.
   3. Fire alarm system voltage drop calculations and standby battery calculations. Four sets required to be furnished to Engineer by electrical contractor.
   4. One set of fire alarm system specifications. Provided by electrical engineer.
   5. Additional information required by Department of Safety and Professional Services relating to specific system to be installed, system wiring requirements, calculations, or other components shall be furnished to engineer by electrical contractor. Costs associated with this shall be included in contractor's bid.
   6. Application for Approval to be completed and submitted by Engineer.
   7. Permit approval fees. Paid for by the Engineer.

B. Contractor shall note that fire alarm system shall be submitted and approved prior to installation of system.

1.12 AS BUILT DRAWING SUBMITTAL

A. As-Built Drawings shall be provided to Owner within 25 days of final acceptance. Drawings shall consist of:
   1. Floor plan layout showing devices, addresses, wire types, circuiting and conduit runs.
   2. Panel module drawings showing wiring terminations inside fire alarm panels.
   3. Addressable Device List, as programmed.
   4. Set of Operation and Maintenance manuals.

1.13 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products under provisions of Division 01 – General Requirements.

B. Contractors and suppliers involved in installation and checkout of fire alarm system shall, as a minimum, observe the following material handling precautions:
   1. Receive equipment at job site; verify applicable components and quantity delivered.
   2. Handle equipment to prevent internal components' damage and breakage, as well as denting and scoring of enclosure finish.
   3. Do not install damaged equipment.
   4. Store equipment in clean, dry space and protect from dirt, fumes, water, construction debris and physical damage.
   5. After installation, protect equipment from damage by work of other trades.

1.14 ENVIRONMENTAL REQUIREMENTS

A. Division 01 – General Requirements: Environmental conditions affecting products on site.

PART 2 - PRODUCTS

2.1 GENERAL

A. Being listed as acceptable Manufacturer in no way relieves obligation to provide equipment and features in accordance with these specifications.

2.2 ACCEPTABLE MANUFACTURERS

A. EST.

B. Notifier.

C. Simplex.

D. Siemens.

2.3 FIRE ALARM PANEL

A. This "FIRE ALARM CONTROL PANEL" portion of this specification shall refer to each panel designated as "FACP" as shown on the construction drawings. Where this portion of specification refers to Operator Interface Components – including but not limited to Displays, Switches and LED's, it is intent of specification that Operator Interface Components shall be located within designated new FACP.

B. This "FIRE ALARM CONTROL PANEL" portion of this specification shall also be applied to modular components of Fire Alarm System. Components may be located within FACP itself, within other Remote Equipment Cabinets/Transponders, or Annunciator Panels, or within several different panels. Modular components shall be UL listed as components of single, modular, Fire Alarm System.

C. Control Panel shall be modular, and shall be expandable with microprocessor-based electronics. It shall display through front viewing window only those primary controls and displays essential to monitor status of system, including indication of abnormal status conditions.

D. Input power for fire alarm panel shall be 120VAC.

E. Circuits requiring system power shall be 24 VDC and be individually fused at control panel. Minimum of five (5) amps auxiliary fused power shall be provided.

F. FACP capacity/sizing requirements.
   1. Cabinet Space: Each FACP Equipment Cabinet shall be properly sized to accommodate quantities of Fire Alarm Circuits specified below, plus additional equipment required for operation as specified, plus additional ten percent (10%) spare internal capacity.

2. Signaling Line Circuits (SLCs) – Each FACP shall contain quantity of Signaling Line Circuits (SLCs) required to serve designated area, plus minimum of ten percent (10%) spare capacity.
3. Notification Appliance Circuits (NACs) – Each FACP shall contain:
   a. Audible NAC Capacity (Horn Circuits) - quantity required to serve designated area, plus minimum of ten percent (10%), but no less than one spare circuit. Each active circuit shall be loaded to no more than 75% of maximum allowable current draw.
   b. Visual NAC Capacity (Strobe Circuits) - quantity required to serve designated area, plus minimum of ten percent (10%), but no less than one spare circuit. Each active circuit shall be loaded to no more than 75% of maximum allowable current draw.
   c. Where Audible and Visual functions are combined onto common circuit pairs (synchronized Audible and Visible Notification Appliances via single NAC), quantity of circuits provided shall be minimum quantity required to serve designated area, plus minimum of ten percent (10%), but no less than one spare circuit. Each active circuit shall be loaded to no more than 75% of maximum allowable current draw.
   d. Initiating Device Circuits (IDCs/"Zones") – Each FACP shall contain quantity of IDCs specified, plus minimum of ten percent (10%), but no less than one spare circuit.

G. FACP features. In addition to features that have been previously specified, each FACP provided for this project shall incorporate features required for operation as specified, plus the following:
   1. On-Board Diagnostics: System shall include on-board diagnostic features to detect, diagnose and report failures and to isolate failures to printed circuit board level. When failures are detected and identified via these on-board diagnostics, corresponding specific Trouble status conditions shall be reported. On-Board diagnostics shall also monitor/supervise charge level of system batteries, internal power supplies, and charger status.
   2. Alphanumeric Display: System shall provide alphanumeric text messages, via backlit liquid crystal display, with minimum capacity of 80 simultaneously displayed characters.
   3. Internal Clock: This internal clock shall provide automatic time-stamping of logged and printed events.
   4. Non-Volatile Memory: System shall contain non-volatile memory, which shall contain programmed instructions, plus system configuration/settings and history log(s).
   5. Field Programmability: System shall be programmable, configurable, and expandable in field without need for special tools or PROM programmers and shall not require replacement of memory IC's. Programming shall be accomplished through standard control panel keyboard or keyboard at printer, or use of PC. Programs shall be stored in non- volatile memory. Keyboards or keypads shall not be required to operate system during fire alarm conditions – only minimal function keys, as previously specified.

H. FACP status indicators and displays:
   1. Local audible device shall sound during Alarm, Trouble or Supervisory conditions. This audible device shall also sound during each key-press to provide audible feedback to indicate that key has been pressed properly. Visual display shall distinguish between alarm, trouble and supervisory conditions.
   2. 2-line by 40-character liquid crystal display shall be backlit for enhanced readability. So as to conserve battery standby power, it shall be acceptable for illumination to be switched off during AC power failure unless alarm condition occurs or there is keypad activity.

I. FACP signaling line circuits:
   1. System shall contain Signaling Line Circuits and supporting electronics, to allow each intelligent initiating and control device to be identified by system and configured on individual basis. Intelligent initiating and control devices shall be individually annunciated at control panel and at required annunciators. Annunciation shall include, but shall not be limited to the following conditions for each point:
      a. Alarm.
      b. Trouble.
      c. Open.
      d. Short.
      e. Device missing/failed.
   2. It shall be possible for trained users to disable and enable each intelligent initiating and control device, via menu-driven utilities that shall be built into FACP Operator Interface/operating software.
   3. There shall be no limit to number of detectors, stations, or addressable modules, which may be activated or "in alarm" simultaneously.
   4. Special-purpose Isolator devices shall be used to provide further isolation/protection of sections of Signaling Line Circuits. Areas served by Signaling Line Circuits shall be isolated as specified within “scope” portion of this specification. The following Isolation devices shall be acceptable for use in performing this function:
      a. Isolator Modules: Field Mounted.
      b. Isolator Circuit Boards/Cards/Modules – Mounted within FACP
      c. Isolator Bases – which redesigned to be used in conjunction with Detectors.
   5. Control panel shall be provided with standby battery. If 120-volt input power to panel is lost, battery shall have capacity to power system for minimum of 24 hours in standby mode and then have capacity to allow system to operate in alarm mode for minimum of 10 minutes after this 24 hour period. An additional 20% amp-hour spare capacity shall be provided to account for battery degradation. Normal operating, supervisory, and battery power and fault conditions shall be supervised and annunciated.

2.4 DIGITAL ALARM COMMUNICATIONS TRANSMITTER (DACT)

A. DACT Unit shall be provided for each FACP. Each DACT provided shall be UL listed for Commercial Fire Alarm usage. Each DACT provided shall be equipped for dual phone lines with line-seizure, and shall be capable of transmitting quantity of points specified within “Operation” portion of this specification. Each DACT provided shall be field-configurable for transmission of several different non-proprietary formats.

B. Each DACT shall consist of module, designed for mounting within FACP wherever DACT units are available, and wherever DACP units meet previously specified operational requirements.

C. Where DACT is not listed component of Fire Alarm Control Panel, DACT units shall be provided within separate metal enclosure, which shall be located adjacent to associated FACP, unless specified otherwise. DACT units shall contain independent power supplies and batteries, which shall be sized in same manner as FACP batteries.

2.5 REMOTE ANNUNCIATOR

A. Annunciator shall be supervised by fire alarm panel and shall be UL listed for annunciator use with fire alarm panel.

B. LCD display/control shall provide the following features:
1. 80 character alphanumeric display.
2. Control Pushbutton Switches: For alarm silence, trouble silence and manual evacuation duplicating control panel switches. Key "enable" switch shall be provided to activate or deactivate control switches. Display shall not have system reset button.
3. Tone Alert: Duplicates control panel tone alert during alarm and trouble conditions.
4. System trouble LED.
5. Power on LED.
6. To accommodate and facilitate job site changes control switches shall have capability to be programmed on site to provide for manual switch input operation other than their standard purpose.

2.6 NAC BOOSTER PANEL

A. NAC Booster Panel as defined within this specification is remote power supply and notification appliance circuit panel. Where they are used, NAC booster panels shall be individually supervised. Interconnecting panels in manner which does not allow individual panel troubles to be identified shall not be accepted, unless multiple units are located in same room.

B. Where NAC booster panels are not located adjacent to FACP, location of panels shall be coordinated by EC and shall be submitted to engineer for approval. EC shall be responsible for providing dedicated power for each panel with circuit breaker. EC shall also be responsible for adding smoke or heat detector coverage to each room with NAC panel.

2.7 INTELLIGENT ADDRESSABLE DETECTORS

A. Detectors shall utilize addressable, analog communication. Detectors shall have flashing status indicating LED for visual supervision. When the detector is actuated, flashing LED shall latch on steady and at brilliance.

B. Detectors shall only transmit analog information to fire alarm panel; panel shall be responsible for determining alarm condition.

C. Detectors shall be furnished with means of remote testing without use of smoke or heat (magnetic contact point). This test shall send alarm condition to fire alarm panel.

D. Detector head or base shall provide binary address for each addressable loop. Combination of addressable loop number and device address shall uniquely identify each device in system. System that use jumpers or rely on electrical positioning shall not be accepted.

2.8 ADDRESSABLE BASES FOR AUTOMATIC DETECTORS

A. Bases shall be common, twist-lock mounts for photoelectric, ionization, and thermal detectors. Connection between head and base shall be completed via bifurcated, self-wiping contacts.

Wiring shall be terminated at detector base. Detector heads shall be interchangeable without disconnecting wiring.

B. Bases must include method of locking detector head to base. Locking feature shall be removable when not required.

C. Removal of head from base shall send trouble signal to fire alarm control panel.

D. Detector bases shall be sealed to prevent rear airflow.

2.9 PHOTOELECTRIC SMOKE HEAD

A. Smoke detector heads shall be of photoelectric type which utilizes light scattering principal to measure smoke density.

B. Smoke detectors shall work in alarm verification mode.

2.10 ADDRESSABLE HEAT DETECTORS

A. Automatic heat detectors shall be programmable to be combination rate-of-rise and fixed-temperature type or straight fixed temperature (where indicated on plans). Detectors shall be capable of being programmed to sense temperatures from 32 – 158 degrees. Rate-of-rise function shall be adjustable from 15 to 20 degrees per minute.

2.11 MANUAL PULLSTATIONS – SINGLE ACTION

A. Manual stations shall be single action and shall be constructed of high impact, red lexan with raised white lettering and smooth high gloss finish. Stations shall be furnished with hinged cover with key lock. Stations, which utilize screwdrivers, allen wrenches, or other commonly available tools shall not be accepted. When station is operated, handle shall lock in protruding manner to facilitate quick visual identification of activated station.

2.12 ADDRESSABLE MODULES

A. Addressable modules shall be used where needed for monitoring of non-addressable initiation devices or interface to other systems or equipment.

B. Where versions or accessory mounting plates are available, which provide status indicator LEDs.

C. Addressable Modules shall be labeled in manner, which indicates associated equipment being monitored or status being monitored, wherever function is not obvious due to placement of device, or to visible connection to monitored device.

D. Monitor Modules shall be provided as needed, for monitoring of non-addressable equipment. Type of Monitor Module provided shall be appropriate for type of monitored equipment. Monitor Modules shall provide interface between IDC and SLC, to communicate status of IDC as equivalent addressable point. In most cases, both module power and communications with FACP shall be obtained via SLC. (Where Monitor Modules are used to support 4-wire type non-

addressable detectors or 2-wire type non-addressable, electronic detectors, separate 24 VDC connections shall be acceptable).

E. Mini-Monitor Modules (Mini-MMs) shall be miniature devices, and shall be used primarily for monitoring of single, non-addressable, N.O. contact type devices or points – including but not limited to Sprinkler System Flow and Tamper Switches. Mini-MMs shall receive their operating power directly from SLC, to which they are connected. Connections from each Mini-MM to contacts which they are used to monitor shall be supervised.

F. Where Mini-MMs are installed within back box, immediately behind associated devices – outside of device shall be labeled with "MM" and address of associated Mini-MM.

G. Where Mini-MMs are installed inside electrical junction boxes – j-box covers shall be painted RED, and shall be clearly marked with "MM" and address(s) of Mini-MM(s) contained within.

H. Control modules shall be addressable and individually controllable from FACP. This type of module shall provide double pole double throw relay switching for 2 A @ 28 VDC resistive, power limited and at 1/2 A @ 120 VAC resistive, non-power limited. It shall contain easily replaceable 2 amp fuses, one on each common leg of relay. System shall be capable of energizing 100% of relays connected to signaling line circuit. Where loads exceed contact rating of module, relay shall be provided with adequate contact ratings.

I. Fault Isolator Modules (FIM) shall be provided for isolation of Signaling Line Sub-Circuits or isolated branches. SLC segment protected by each FIM shall be separated from SLC to isolate single short-circuit condition to only affect Addressable Field Devices/Detectors, which are served by isolated SLC segment.

J. Several types of FIM units shall be acceptable, as indicated within "Products - FACP – Signaling Line Circuits" portion of this specification. (Also refer to Bases for Intelligent Addressable Detectors.)

K. Each FIM shall automatically re-connect isolated section of SLC upon correction of fault conditions. FIM shall not require address settings, and its operations shall be totally automatic. It shall not be necessary to replace or reset FIM after its normal operation.

L. Each FIM shall include LED, which shall flash under normal operation and shall illuminate steady, or shall change color to indicate short circuit.

M. FIMs shall be located as close as practical to point where isolated SLC sub-circuit branches off of main SLC, and shall also be located at accessible location. Their locations shall be clearly indicated on floor plan drawing, on system riser drawing, and on permanently-affixed labeling, which shall be attached to device itself.

2.13 NOTIFICATION APPLIANCES

A. Use of Notification Appliances, where Audible and Visible functions are served via single pair of conductors, shall be acceptable, provided that the following conditions are met:
   1. Audible Signal Tone shall be synchronized, as specified within "Audible Notification Appliance" requirements.

2. Visible flashing shall be synchronized, as specified within "Visible Notification Appliance" requirements.
3. Audible and Visible functions shall be independently controllable. When "Signal Silence" is actuated, production of Audible Signal Tone shall cease, while strobes shall continue to flash until reset.

B. Where conditions above cannot be met, separate Audible and Visible NACs shall be provided.

C. Audible Notification Appliances, and audible portion of combination Audible/Visible Notification Appliances shall have the following characteristics:
1. Audible notification appliances shall consist of electronic or electro-mechanical horn-type units and support synchronized operation, which shall be independent of Visible Notification, such that Audible Signal Tone produced shall consist of 3-pulse temporal pattern, compliant with ANSI S3.41, as described in NFPA-72 A.11.3.4 (2002).
2. Temporal Pattern sounds, which are generated individually, by each Audible Notification Appliance and are not synchronized, shall be unacceptable.

D. Audible notification appliances, and audible portion of combination audible/visible notification appliances shall have three field selectable dBA ratings of 90, 95, or 99. Ratings shall be based on anechoic dBA ratings measured at 10 feet.
1. Audible Notification Appliances, and Audible portion of combination Audible/Visible Notification Appliances shall produce minimum audible output of 90 dBA at 10-feet, as tested [A1]per UL Standard 464.
2. Unless specified otherwise, Audible Notification Appliances provided shall be designed for either flush or semi-flush mounting.

2.14 VISIBLE NOTIFICATION APPLIANCES

A. Visible Notification Appliances, and Visible portion of Audible/Visual combination units, shall consist of Xenon Strobe units. Notification Appliances shall be listed by UL for Fire Alarm usage.

B. Each strobe shall be provided with minimum UL 1971 Listed intensity, as shown on Drawings. Units used in corridors and small spaces (identified as minimum of 15 Candela on Drawings) shall comply with 75 Candela minimum output requirements of ADAAG/ UL-1638. (These units are generally referred to as "15/75" candela strobe-lens patterns – 15 Cd per UL-1971 / 75 Cd per UL-1638.)

C. Unless specified otherwise, strobes shall be designed for synchronized flash operation at one flash per second (1 Hz) minimum over device's listed input voltage range. Strobes shall be synchronized (As minimum, devices on each floor shall flash simultaneously, with flash timing within limits established by current UL standards.).

D. Combination Audible/Visible Notification Appliances shall comply with both audible and visible notification requirements, as specified above. Mounting heights of these devices shall be determined, based upon location of Visible (Strobe) portion of device.

2.15 DOOR HOLDERS

A. Door holders shall be furnished by the door hardware vendor.

2.16 FIRE RATED POWER LIMITED FIRE ALARM CABLE

A. Two hour fire rated cable as listed by UL.

B. UL listed type FPLR-CI fire alarm cable intended for use in power limited fire alarm circuits.

C. Solid annealed copper conductors.

D. Fire rated insulation covering.

E. Copper/polyester tape shield.

F. Overall jacket, low smoke, zero halogen polyolefin.

G. Rockbestos Surprenant VITALink CI or equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Contractor shall provide and install system in accordance with plans and specifications, national and state applicable codes, NEC wiring criteria, and manufacturer's recommendations. Communications wiring shall be twisted and shielded cables.

B. Wiring shall be in conduit system separate from other building wiring. Junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout scope of work.

C. Wiring shall be identified at terminal and junction locations, in manner that shall prevent unintentional interference with signaling circuit during testing and servicing.

D. Installation of equipment and devices that pertain to other work in Contract shall be closely coordinated with appropriate subcontractors.

E. Manufacturer's authorized representative shall provide on-site software modifications and supervision of installation of Fire Alarm System installation, perform functional test of system, and submit written report to Contractor attesting to proper operation of system.

F. Typically control and monitor modules are represented by symbols on Drawings. Required signal addressable modules are not indicated by symbol on Drawings.

G. It is assumed that 120-volt power required for system operation is derived at system control panel. If Contractor, at his option, chooses to use distributed power supplies, cost for additional circuit breakers and branch wiring associated with these, shall be included in his bid. Distributed power supplies shall derive their 120VAC from same branch circuit as main fire alarm control

panel. Spare breakers have not been provided for this eventuality. Contractor shall be responsible for providing and installing smoke detector in room with remote power supply.

H. Mechanical spaces shall be furnished with minimum of 90dBA throughout the space.

I. DACT/associated phone lines. Unless phone lines are specifically indicated for this purpose within telecom drawings, EC shall coordinate installation of two (2) telephone lines to FACP (if internal DACT is provided), or to externally-mounted DACT. EC shall provide required coordination with Owner, and with Owner's Telecom provider, by sub-contract, if necessary.

3.2 WIRING INTEGRITY

A. Signaling Line Circuits (SLC), for intelligent addressable devices, shall be Class B, Style 4. Each SLC shall incorporate isolator modules or isolation devices which shall provide independently isolated SLC sub-circuits. Short circuit occurring on isolated sub-circuits shall not interfere with proper operation of the devices on other sub-circuits.

B. Where conventional devices are to be monitored by addressable monitor modules, wiring between module and conventional device shall be Class B, Style B Initiation Device Circuit.

C. Notification Appliance Circuits shall be Class B, Style Y, as defined by NFPA 72, 6.7 (2002 Edition). Strobes and audible devices shall operate separately.

D. Wiring installed between fire alarm control panel and first devices in each of fire alarm zones, other than zone FACP is located in, shall be two hour fire rated cable assembly as required by NFPA 72.

3.3 CONDUCTORS

A. Cable shall be installed in accordance with NEC Article 760.

B. Cables and wires size #14 AWG and larger shall be stranded.

C. Wiring shall be supervised. In event of primary power failure, disconnected standby battery, disarrangement of components, open circuits or grounds in system, audible and visual trouble signal shall be activated until system is restored to normal.

D. Conductors shall be color-coded. Coding shall be consistent throughout the facility. Green wire shall be used only for equipment ground.

E. Fire Alarm Control Panel shall be connected to separate dedicated branch circuit from building emergency panel, maximum 20 amperes. Circuit shall be labeled as "FIRE ALARM".

F. Power wiring for Fire Alarm Control Panel shall be #12 AWG.

G. Fire Alarm Control Panel shall have #12 AWG green equipment ground wire.

H. Leave 8-inch wire tails at each device box and 36-inch wire tails at Fire Alarm Control Panel and Remote Annunciator Panel(s).

I. Cable for Intelligent Detector Loops shall be #18 to #12 AWG twisted/shielded pair. Shield continuity must be maintained and connected to earth ground only at control panel. Intelligent detector wiring must not be in same conduit with 120/240 VAC power wiring or other high current circuits. T-taps or branch circuit connections are allowed for class B intelligent loop circuits.

J. Splices or connections shall be made within junction boxes and with acceptable fittings. Boxes shall be red labeled "FIRE ALARM SYSTEM" by decal or other approved markings.

K. EC shall provide two separate phone lines for DACT use. EC shall be responsible for coordinating phone requirements with Owner's phone system provider.

L. NAC panel wiring shall be #14 AWG minimum.

M. Strobe wiring shall be #12 AWG minimum.

N. Horn wiring shall be #14AWG minimum.

3.4 DEVICE MOUNTING

A. Electrical contractor and fire alarm vendor are responsible for mounting devices according to code. The following comments are to be used as guidelines to supplement codes where required:
1. Fire Alarm Control Panel (FACP): FACP shall be mounted with LCD readouts at 60 inches above finished floor (AFF). Use only identified conduit entries or request approval for other penetration in cabinet. Cabinets shall be grounded per code.
2. Remote Annunciators: Mount annunciators with LCD readouts at 60 inches above finished floor (AFF). Annunciators are to be flush mounted unless otherwise noted on plans.
3. Smoke and Heat Detectors: Detectors shall be ceiling mounted unless otherwise noted. Detectors shall be minimum of 3 feet from HVAC supply or return vents.
4. Duct Smoke Detectors: Duct smoke detectors shall be mounted by electrical contractor and locations shall be coordinated with HVAC contractor.
5. Addressable Control Modules and Relays: Control modules and relays shall be mounted within three (3) feet of device being controlled, unless wired for fail safe operation.
6. Notification Appliances: Wall mounted strobes shall be mounted per ADA requirements (80 inches AFF to bottom of device). Ceiling mounted strobes shall be approved by engineer and local AHJ.
7. Manual Stations: Pull stations shall be mounted per ADA requirements (48 inches AFF to operable part of station).

3.5 DEVICE IDENTIFICATION

A. Each intelligent device must be uniquely identified by address code entered on each device at time of installation. This address, along with SLC loop number shall be indicated on permanent, machine-generated label. Label shall be affixed to device to be readable from ground.

B. Each end of line device shall be identified with permanent, machine-generated label.

3.6 TESTING

A. Fire alarm system shall be tested by Contractor in presence of Owner's representative, Architect, Consulting Engineer, and manufacturer's technical representative. Upon completion of successful test, Contractor shall so certify in writing to Owner, Architect and General Contractor using form similar to standard NFPA Fire Alarm System Record of Completion Form found in NFPA 72 Chap. 1. Forms submitted must provide same information required in NFPA Record of Completion Form.

B. Vendor shall perform pre-test of system before final testing with AHJ. Peripheral interface equipment (air handlers, electric locks, and DACT operation shall be part of pre-test. Vendor shall be responsible for retesting fees due to inoperable fire alarm equipment at time of testing.

3.7 TRAINING

A. Equipment manufacturer's representative shall provide, as part of this Contract, minimum of six (6) hours system operating training for building Owner, Consulting Engineer, and fire department personnel. Training sessions shall be broken up into two parts: System Operation and System Maintenance. These sessions shall be set up at Owner’s convenience.

3.8 INSTRUCTION MANUALS

A. Contractor shall supply, in three ring binder, three sets of O&M manuals to include: one approved copy of original submittal (including corrected items from shop drawing review), operating instructions and system service and testing documentation. Manuals shall be furnished prior to, or during training.

3.9 SPARE PARTS

A. In addition to system devices by symbol on floor plans the following extra devices in quantities indicated shall be provided by Electrical Contractor and turned over to Owner:
   1. Addressable photoelectric smoke detector, quantity of one.
   2. Addressable heat detector, quantity of one.
   3. Addressable detector base, quantity of one.
   4. Addressable manual pullstations, quantity of two.
   5. Alarm indicating appliances, audio and visual, quantity of one of each size provided.
   6. Addressable modules - one of each type specified.

END OF SECTION

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SECTION 31 05 13
SOILS FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Subsoil materials.
2. Topsoil materials.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 02 41 13 - Site Demolition.
3. Section 02 41 14 - Utility Abandonment and Removal.
4. Section 31 05 17 - Aggregates for Site Earthwork.
5. Section 31 10 00 - Site Clearing.
6. Section 31 22 13 - Rough Grading.
7. Section 31 23 15 - Excavation, Backfill, and Compaction for Buildings and Structures.
8. Section 31 23 17 – Site Excavation, Backfill, and Compaction.
9. Section 31 25 13 – Erosion and Sediment Control: Erosion and sediment control requirements.
10. Section 32 91 13 – Soil Preparation.
11. Section 32 93 00 – Plantings.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation (WISDOT):
1. Standard Specifications for Highway and Structure Construction, Current Edition.
2. http://roadwaystandards.dot.wi.gov/standards/stndspec/index.htm

B. ASTM International (ASTM):
1. ASTM D2487 - Classification of Soils for Engineering Purposes (Unified Soil Classification System).
2. ASTM D5268 – Topsoil Used for Landscaping Purposes.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Product Data: Submit testing laboratory results for each type of specified soil.

C. Materials Source: Submit name of source of imported materials.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Wisconsin Department of Transportation standards.

PART 2 - PRODUCTS

2.1 SUBSOIL MATERIALS

A. Subsoil Type S1:
1. Excavated and re-used material.
2. Graded.
3. Free of lumps larger than three (3) inches, rocks larger than two (2) inches, and debris.

B. Subsoil Type S2:
1. Imported borrow.
2. Graded.
3. Free of lumps larger than three (3) inches, rocks larger than two (2) inches, and debris.
4. Imported subsoil and borrow shall be similar in composition when compared to existing site subsoil.

2.2 TOPSOIL MATERIALS

A. Topsoil Type T1:
1. Excavated and reused material.
2. Graded.
3. Soil shall be free of roots, twigs, stones, subsoil, debris, weeds, and foreign matter larger than 1/2-inch.
4. Topsoil shall be evaluated in accordance with ASTM D5268.

B. Topsoil Type T2:
1. Imported borrow.
2. Friable loam.
3. Soil shall be free of roots, twigs, stones, subsoil, debris, weeds, and foreign matter larger than 1/2-inch.
4. Acidity range (pH) of 5.5 to 7.5.
5. Containing minimum of four (4) percent and maximum of 25 percent inorganic matter.
6. Limit decaying matter to five (5) percent of total content by volume.
7. Topsoil shall be evaluated in accordance with ASTM D5268.

2.3 SOURCE QUALITY CONTROL

A. Division 01 – General Requirements: Testing and analysis of soil material.

B. Testing and Analysis of Topsoil Material designated for Landscaping Purposes: Perform in accordance with ASTM D5268.

C. When tests indicate materials do not meet specified requirements, change material and retest.

D. Furnish materials of each type from same source throughout the Work.

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 31 05 16
AGGREGATES FOR STRUCTURE EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Aggregate materials and designations for building structure aggregate base course.
2. Aggregate materials and designations for backfill.
3. Aggregate materials and designations for grading purposes.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 02 41 13 – Site Demolition.
3. Section 02 41 14 – Utility Abandonment and Removal.
4. Section 31 05 13 – Soils for Earthwork.
5. Section 31 22 13 - Rough Grading.
6. Section 31 23 15 - Excavation, Backfill, and Compaction for Buildings and Structures.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation (WISDOT):
1. Standard Specifications for Highway and Structure Construction, Current Edition. http://roadwaystandards.dot.wi.gov/standards/stndspec/index.htm

B. ASTM International (ASTM):
1. ASTM C33 – Standard Specification for Concrete Aggregates.
2. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Product Data: Submit gradation information for each type of aggregate specified. Gradation results shall be taken within the past three (3) months from contract date.

C. Samples: Submit, in airtight containers, 10 lb sample of each type of fill to testing laboratory.

D. Materials Source: Submit name of source of imported materials.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Wisconsin Department of Transportation standards.

PART 2 - PRODUCTS

2.1 AGGREGATE MATERIALS

A. Aggregate Type A1 (Gravel): Crushed Gravel: free of organic matter and debris; graded in accordance with:
   1. WISDOT 3/4-Inch Gradation.

B. Aggregate Type A2 (Gravel): Crushed Gravel: free of organic matter and debris; graded in accordance with:
   1. WISDOT 1-1/4-Inch Gradation.

C. Aggregate Type A3 (Recycled): Crushed Concrete; free of from wood, steel, roots, bark or other extraneous material; graded in accordance with:
   1. WISDOT 1-1/4-Inch Gradation.

D. Aggregate Type A5 (Stone): Crushed Stone; free of clay, shale, organic matter; graded in accordance with:
   1. WISDOT Open-Graded Gradation.

E. Aggregate Type A7 (3/4-Inch Stone Chips): Crushed stone; free of clay, shale, organic matter; graded in accordance with the following limits:

Sieve Size	Percent Passing
1-inch	100
3/4-inch	90 - 100
3/8-inch	20 - 55
No. 4	0 - 10
No. 8	0 – 5

F. Aggregate Type A9 (Granular Fill): Natural gravel/stone; free of clay, shale, organic matter; graded in accordance with:
   1. WISDOT 3-Inch Gradation.

G. Aggregate Type A10 (Bank Run Sand/Gravel): Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter; graded in accordance with following limits:

Sieve Size	Percent Passing
2-inch	95 - 100
No. 4	35 - 60
Finer Than No. 200	5 - 15

H. Aggregate Type A13 (Sand Fill): Natural river or bank sand; free of silt, clay, or loam, friable or soluble materials, or organic matter; consisting of durable particles ranging in size from fine to coarse in uniform combinations; maximum moisture content shall be 10 percent, graded within following limits:

Sieve Size	Percent Passing
3/8-inch	100
No. 4	95 - 100
No. 8	75 - 90
No. 16	55 - 75
No. 30	30 - 50
No. 50	10 - 25
No. 100	2 - 10
No. 200	0

I. Aggregate Type A14 (Stone): Crushed Stone; free of clay, shale, organic matter; graded in accordance with ASTM C33, Size No. 2.

2.2 SOURCE QUALITY CONTROL

A. Division 01 – General Requirements: Testing and analysis of aggregates.

B. When tests indicate materials do not meet specified requirements, change material or material source and retest.

C. Furnish materials of each type from same source throughout the Work.

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 31 05 17
AGGREGATES FOR SITE EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Aggregate materials and designations for structure aggregate base course.
2. Aggregate materials and designations for pavement aggregate base course.
3. Aggregate materials and designations for backfill.
4. Materials and designations for drainage aggregate.
5. Aggregate materials and designations for grading purposes.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 02 41 13 – Site Demolition.
3. Section 02 41 14 – Utility Abandonment and Removal.
4. Section 31 05 13 – Soils for Earthwork.
5. Section 31 22 13 - Rough Grading.
6. Section 31 23 15 - Excavation, Backfill, and Compaction for Buildings and Structures.
7. Section 31 23 17 – Site Excavation, Backfill, and Compaction.
8. Section 31 25 13 – Erosion and Sediment Control: Erosion control requirements.
9. Section 32 91 13 – Soil Preparation.
10. Section 32 93 00 – Plantings.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation (WISDOT):
1. Standard Specifications for Highway and Structure Construction, Current Edition. http://roadwaystandards.dot.wi.gov/standards/stndspec/index.htm

B. ASTM International (ASTM):
1. ASTM C33 – Standard Specification for Concrete Aggregates.
2. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Product Data: Submit gradation information for each type of aggregate specified. Gradation results shall be taken within the past three (3) months from contract date.

C. Materials Source: Submit name of source of imported materials.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Wisconsin Department of Transportation standards.

PART 2 - PRODUCTS

2.1 AGGREGATE MATERIALS

A. Aggregate Type A1 (Gravel): Crushed Gravel: free of organic matter and debris; graded in accordance with:
   1. WISDOT Gradation No. 3 (3/4-inch).

B. Aggregate Type A2 (Gravel): Crushed Gravel: free of organic matter and debris; graded in accordance with:
   1. WISDOT Gradation No. 2 (1-1/4-inch).

C. Aggregate Type A3 (Recycled): Crushed Concrete; free of from wood, steel, roots, bark or other extraneous material; graded in accordance with:
   1. WISDOT Gradation No. 2 (1-1/4-inch).

D. Aggregate Type A5 (Stone): Crushed Stone; free of clay, shale, organic matter; graded in accordance with:
   1. WISDOT Open-Graded Gradation.

E. Aggregate Type A6 (3/8-Inch Stone Chips): Crushed stone; free of clay, shale, organic matter; graded in accordance with the following limits:

Sieve Size	Percent Passing
1/2-inch	100
3/8-inch	85 - 100
No. 4	10 – 30
No. 8	0 - 10
No. 16	0 – 5

F. Aggregate Type A7 (3/4-Inch Stone Chips): Crushed stone; free of clay, shale, organic matter; graded in accordance with the following limits:

Sieve Size	Percent Passing
1-inch	100
3/4-inch	90 - 100
3/8-inch	20 - 55
No. 4	0 - 10
No. 8	0 – 5

G. Aggregate Type A8 (Pea Gravel): Fractured, washed, free of clay, shale, organic matter; graded in accordance with the following limits:
   1. Minimum Size: 1/4-inch.
   2. Maximum Size: 3/8-inch.

H. Aggregate Type A9 (Granular Fill): Natural gravel/stone; free of clay, shale, organic matter; graded in accordance with:
   1. WISDOT Gradation No. 1 (3-inch).

I. Aggregate Type A10 (Bank Run Sand/Gravel): Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter; graded in accordance with following limits:

Sieve Size	Percent Passing
2-inch	95 - 100
No. 4	35 - 60
Finer Than No. 200	5 – 15

J. Aggregate Type A11 (Drainage Aggregate): Crushed stone; free of clay, shale, organic matter; graded in accordance with the following limits:

Sieve Size	Percent Passing
1-inch	100 - 75
3/4-inch	50 - 75
No. 4	0 - 60
No. 40	0 - 50
No. 200	0 - 5

K. Aggregate Type A12 (Bedding Sand): Unwashed bank-run sand or rejected concrete sand; approximately six (6) percent fine clay or loam particles but free of silt and clay or loam lumps consisting of durable particles ranging in size from fine to coarse in uniform combinations; maximum moisture content shall be 10 percent, graded within following limits:

Sieve Size	Percent Passing
1-inch	100
No. 16	45 - 80
No. 200	2 - 10

2.2 SOURCE QUALITY CONTROL

A. Division 01 – General Requirements: Testing and analysis of aggregates.

B. When tests indicate materials do not meet specified requirements, change material or material source and retest.

C. Furnish materials of each type from same source throughout the Work.

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 31 10 00
SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Removal of grass and vegetation.
2. Removal of trees, shrubs, and other plant life.
3. Removal of site debris.
4. Clearing activities near existing permanent utilities and structures.
5. Protection of project entrances and exits.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 02 41 13 - Site Demolition: Removal of site demolition material.
3. Section 31 22 13 - Rough Grading: Removal of topsoil and subsoil.
4. Section 31 23 17 – Site Excavation, Backfill, and Compaction: Backfill and compaction of cleared areas.
5. Section 31 25 13 – Erosion and Sediment Controls.
6. Section 32 91 13 – Soil Preparation.
7. Section 32 93 00 – Plantings: Shrub and tree relocation.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation (WISDOT):
1. Standard Specifications for Highway and Structure Construction, Current Edition. http://roadwaystandards.dot.wi.gov/standards/stndspec/index.htm

B. State of Wisconsin Department of Natural Resources (WDNR):
1. Construction Site Erosion & Sediment Control. http://dnr.wi.gov/topic/stormwater/

C. U.S. Environmental Protection Agency (USEPA):
1. Developing Your Stormwater Pollution Prevention Plan, A Guide for Construction Sites. http://cfpub.epa.gov/npdes/stormwater/swppp.cfm

1.3 DEFINITIONS

A. Tree - Woody perennial plant, single main stem with trunk, diameter of six (6) inches or greater. Multiple-stem trees with forks up to four (4) feet from ground elevation shall be considered a cluster of trees. Trees that fork above four (4) feet shall be considered a single tree.

B. Sapling - Woody perennial plant with single stem with trunk less than six (6) inches in diameter.

C. Root Zone - Area around a tree extending as far from tree base as longest horizontal branches.

D. Surface Water - Soil water that flows through ditch lines, creeks, and streams by gravity.

E. Grubbing - To clear project site by removing roots and stumps.

F. Clearing - Cutting down of bushes and trees and the digging and removal of their roots and stumps.

G. Clearing Limits - Area designated on Drawings scheduled for clearing operations within project site or right-of-way.

1.4 REGULATORY REQUIREMENTS

A. Contractor shall comply with local, state, and federal regulations applicable to Work of this Section.

B. Contractor shall comply with and be solely responsible for compliance with U.S. Department of Labor OSHA Part 1926 Safety and Health Regulations for Construction for this Work.

C. Contractor performing Work of this Section shall be solely responsible for identifying, furnishing, installing and maintaining equipment and materials required by State and Federal regulations to establish safe working conditions during Work of this Section.

D. Conform to applicable code for environmental requirements, disposal of debris, burning debris on site and use of herbicides.

E. Coordinate clearing Work with utility companies.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 NOTIFICATION

A. Contractor, prior to any excavation work, shall notify (1) a designated locating service; (2) utilities, governmental agencies, entities, known to, or which can reasonably be assumed to, have above or below ground pipe, conduit cables, structures, or similar items within limits of project; to locate and mark location of such items.

B. In accordance with Wisconsin Statute 182.0175, "Damage to Transmission Facilities," Excavator, as defined in 182.0175(1)(bm), shall be solely responsible to provide advance notice to “One-Call System - Diggers Hotline” (811) or (800) 242-8511, not less than three (3) working days prior to commencement of any Excavation, as defined in the statute, required to perform work contained in this Project, and further, Excavator shall comply with all other requirements of this Statute relative to Excavation.
Wisconsin Statute 182.0175 - Damage to Transmission Facilities

3.2 PREPARATION

A. Verify erosion control is in place prior to start of Work.

B. Verify that existing plant life designated to remain is tagged or identified and protected.

C. Identify a temporary waste area for placing removed materials.

3.3 PROTECTION

A. Maintain and repair damaged erosion control items throughout Work.

B. Protect utilities that remain, from damage.

C. Do not divert or relocate surface water without prior written approval from Engineer.

D. Protect trees, plant growth, and features designated to remain as final landscaping.

E. Protect benchmarks, survey control points, and existing structures from damage or displacement.

F. Keep entrances and exits, and adjacent roadways affected, free of debris from clearing operations.

3.4 CLEARING

A. Clear area required for access to site and execution of Work.

B. Remove trees and shrubs indicated. Remove stumps, root zone, and main root ball completely.

C. Remove surface rock larger than two (2) inches.

D. Clear undergrowth and deadwood, without disturbing subsoil.

3.5 REMOVAL

A. Remove debris, rock, and extracted plant life from site.

B. Notify Engineer if underground storage tanks and piping is uncovered during Work.

C. Cease work in immediate area of tanks until direction is given to proceed.

END OF SECTION

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SECTION 31 22 13
ROUGH GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Removal of topsoil and subsoil.
2. Cutting, grading, filling, rough contouring and compacting site for site structures, pavements, and landscaping.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 02 41 13 – Site Demolition.
3. Section 31 05 13 – Soils for Earthwork.
4. Section 31 05 17 – Aggregates for Site Earthwork.
5. Section 31 10 00 - Site Clearing.
6. Section 31 23 15 - Excavation, Backfill, and Compaction for Buildings and Structures: Building excavation and building area backfill.
7. Section 31 23 17 – Site Excavation, Backfill, and Compaction.
8. Section 31 25 13 – Erosion and Sediment Controls.
9. Section 32 91 13 – Soil Preparation: Finish grading with topsoil to contours.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation (WISDOT):
1. Standard Specifications for Highway and Structure Construction, Current Edition. State of Wisconsin DOT Standard Specifications

B. ASTM International (ASTM):
1. ASTM C136 – Test Method For Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D698 – Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft.-lbf/ft^3.
3. ASTM D1557 - Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft.-lbf/ft^3.
4. ASTM D6938 – Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 CLOSEOUT SUBMITTALS

A. Division 01 – General Requirements: Requirements for project closeout submittals.

B. Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Wisconsin Department of Transportation standards.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil: Type T1 or T2 as specified in Section 31 05 13 – Soils for Earthwork.

B. Subsoil Fill: Type S2 as specified in Section 31 05 13 – Soils For Earthwork.

C. Aggregate Fill: Type A10 as specified in Section 31 05 17 – Aggregates for Site Earthwork.

PART 3 - EXECUTION

3.1 NOTIFICATION

A. Contractor, prior to any excavation work, shall notify (1) a designated locating service; (2) all utilities, governmental agencies, entities, known to, or which can reasonably be assumed to have above or below ground pipe, conduit cables, structures, or similar items within limits of project; to locate and mark location of such items.

B. In accordance with Wisconsin Statute 182.0175, "Damage to Transmission Facilities," Excavator, as defined in 182.0175(1)(bm), shall be solely responsible to provide advance notice to “One-Call System - Diggers Hotline” (811) or (800) 242-8511, not less than three (3) working days prior to commencement of any Excavation, as defined in the statute, required to perform work contained in this Project, and further, Excavator shall comply with all other requirements of this Statute relative to Excavation.
Wisconsin Statute 182.0175 - Damage to Transmission Facilities

3.2 EXAMINATION

A. Division 01 – General Requirements: Verification of existing conditions before starting work.

B. Verify project survey benchmarks and intended elevations are as indicated on Drawings.

3.3 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Locate, identify, and protect utilities, indicated to remain, from damage.

D. Notify utility company to remove and relocate utilities.

E. Protect above and below grade utilities indicated to remain.

F. Protect plant life, lawns, and other features remaining as portion of final landscaping.

G. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.4 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.

B. Do not excavate wet topsoil.

C. Temporary stockpile in area designated on site to depth not exceeding eight (8) feet and protect from erosion.

D. Protect temporary stockpiled material from erosion. Provide silt fencing or other approved erosion prevention method.

E. Remove excess topsoil from site.

F. Excess topsoil to be disposed off site shall become property of Contractor.

3.5 SUBSOIL EXCAVATION

A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-graded.

B. Do not excavate wet subsoil or excavate and process wet material to obtain optimum moisture content.

C. When excavating through roots, perform Work by hand and cut roots with sharp ax.

D. Remove subsoil from site in accordance with soils management plan.

E. Temporary stockpile subsoil in area designated on site to depth not exceeding eight (8) feet and protect from erosion.

F. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key placed fill material to slope to provide firm bearing.

G. Stability: Replace damaged or displaced subsoil as specified for fill.

3.6 FILLING

A. Install Work in accordance with Wisconsin Department of Transportation Standards.

B. Fill areas to contours and elevations with unfrozen materials.

C. Place fill material on continuous layers and compact in accordance with schedule at end of this section.

D. Maintain optimum moisture content of fill materials to attain required compaction density.

E. Slope grade away from building as noted on the Drawings.

F. Make grade changes gradual. Blend slope into level areas.

G. Remove surplus fill materials from site.

3.7 TOLERANCES

A. Division 01 – General Requirements: Tolerances.

B. Top Surface of Subgrade: Plus or minus 1/10-foot from required elevation.

3.8 FIELD QUALITY CONTROL

A. Division 01- General Requirements: Testing and inspection services.

B. Testing and Analysis of Fill Material: In accordance with ASTM D1557.

C. Density and Moisture Testing: In accordance with ASTM D6938.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

E. Frequency of Tests: As determined by Construction Manager.

3.9 SCHEDULES

A. Aggregate Fill:
1. Fill Type A10: Maximum seven (7)-inch loose lifts.
2. Compact each lift to minimum 95 percent of modified Proctor density.

B. Subsoil Fill:
1. Fill Type S2: Maximum 12-inch loose lifts.
2. Compact each lift to minimum 95 percent of modified Proctor density.

C. Topsoil Fill:
1. Fill Type T1 or T2: Maximum 12-inch loose lifts.
2. Compact each lift to minimum 80 percent of modified Proctor density.

END OF SECTION

SECTION 31 23 15
EXCAVATION, BACKFILL, AND COMPACTION
FOR BUILDINGS AND STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Verification of subsurface conditions and utilities prior to excavation.
2. Excavation for structure foundation.
3. Excavation for pile caps.
4. Excavation for slabs-on-grade.
5. Structure backfilling to subgrade elevations.
6. Fill under slabs-on-grade.
7. Backfill for over-excavation corrections.
8. Consolidation and compaction.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 02 32 00 – Geotechnical Investigation.
3. Section 31 05 16 – Aggregates for Earthwork: Aggregate backfill materials.
4. Section 31 22 13 - Rough Grading: Topsoil and subsoil removal from site surface.
5. Section 31 23 17 – Site Excavation, Backfill, and Compaction: Excavation and backfill for utility trenches.
6. Section 31 23 22 – Construction Site Dewatering: Dewatering excavations and water control.
7. Section 31 25 13 – Erosion and Sediment Controls.
8. Section 32 91 19 - Landscape Grading: Topsoil placement.
9. Section 31 62 16 – Steel Piles.
10. Section 31 63 36 – Rammed Aggregate Piers.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation (WISDOT):
1. Standard Specifications for Highway and Structure Construction, Current Edition. State of Wisconsin DOT Standard Specifications

B. ASTM International (ASTM):
1. ASTM D698 - Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft.-lbf/ft^3 (600 kN-m/m^3)).

C. 211 S. Livingston Street Material Management Plan (June 2017).

1.3 REGULATORY REQUIREMENTS

A. Contractor shall comply with all local, state, and federal regulations applicable to Work of this Section.

B. Contractor shall comply with and be solely responsible for compliance with U.S. Department of Labor OSHA Part 1926 Safety and Health Regulations for Construction for this Work.

C. Contractor performing Work of this Section shall be solely responsible for identifying, furnishing, installing, and maintaining equipment and materials required by state and federal regulations to establish safe working conditions during Work of this Section.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 NOTIFICATION

A. All soil excavated from the site shall be hauled and disposed of at once of two (2) WDNR-licensed landfills: the first ~5000 tons will be hauled to WM's Madison Prairie Landfill in Sun Prairie, WI and all remaining excavated soil will be hauled to WIM's Deer Track Park in Watertown, WI. Excavation and hauling shall be paid for by the contractor. Landfill tipping fees will be paid for directly by the City of Madison, not the Contractor.

B. The City shall be responsible for all waste profiling and provide signed manifests to the Contractor to take with each load to the landfill. Perform this work in accordance to the 211 S. Livingston Street Materials Management Plan (June 2017) and with pertinent parts of Chapters NR 700-754 of the Wisconsin Administrative Code, as supplemented herein. Per NR 718.07, a solid waste collection and transportation service-operating license is required under NR 502.06 for each vehicle used to transport contaminated soil.

C. Contractor, prior to any excavation work, shall notify (1) a designated locating service; (2) all utilities, governmental agencies, entities, known to, or which can reasonably be assumed to have above or below ground pipe, conduit cables, structures, or similar items within limits of project; to locate and mark location of such items.

D. In accordance with Wisconsin Statute 182.0175, "Damage to Transmission Facilities," Excavator, as defined in 182.0175(1)(bm), shall be solely responsible to provide advance notice to "One-Call System - Diggers Hotline" (811) or (800) 242-8511, not less than three (3) working days prior to commencement of any Excavation, as defined in the statute, required to perform work contained in this Project, and further, Excavator shall comply with all other requirements of this Statute relative to Excavation.
Wisconsin Statute 182.0175 - Damage to Transmission Facilities

E. Boring logs indicate that the top 4 to 6 feet of the site was historically filled with a range of industrial materials, including cinders, coal, foundry sand, and bricks. The City has completed soil testing and concluded two types of contamination impact all on-site soil: petroleum and non-petroleum. Zones of known petroleum-contamination are shown on Figure 2 of the Materials Management Plan. All other excavated soil shall be assumed to be non-petroleum-contaminated.

F. There is potential that additional petroleum-contaminated soil and/or underground storage tanks (USTs) may be encountered at other locations within the construction limits. If contaminated soils—based on unusual odor, presence of cinders, staining, etc.—are encountered elsewhere on the project, terminate excavation activities in the area and notify the Environmental Consultant or

Engineer. If needed, Contractor shall assist the Environmental Consultant in collecting soil samples for evaluation using excavation equipment.

G. Perform this work in accordance with the 211 S. Livingston Street Materials Management Plan (June 2017), which was developed in cooperation with the WDNR. For a copy of the Materials Management Plan or further information regarding on site contamination, contact:
Brynn Bemis
City of Madison Engineering
210 Martin Luther King, Jr. Blvd., Rm 115
Madison, WI 53703
608.267.1986
bbemis@cityofmadison.com

H. The Environmental Consultant will be available to evaluate soil excavated to determine if soil is petroleum-contaminated using field screening results, visual observations, and soil analytical results from previous environmental investigations. Assist the environmental consultant in collecting soil samples for evaluation using excavation equipment.

I. While excavating, only excavate contaminated soils as required by the construction plan set. Do not over-excavate contaminated soils, unless directed by the Environmental Consultant or Engineer.

J. Directly load and haul soils designated in the construction plan set or by the Environmental Consultant for offsite landfill. Excavated contaminated soils may be temporarily stockpiled as permitted by the construction schedule. Stockpile requirements for contaminated materials are specified in NR 718.05. Place petroleum-contaminated soil on base material impervious to the contaminant and to water, such as concrete, asphalt, or plastic sheeting. Cover petroleum-contaminated piles with impervious material, such as plastic sheeting, to prevent infiltration of precipitation and to inhibit volatilization of soil contaminants.

K. Use loading and hauling practices that are appropriate to prevent any spills or releases of contaminated soils or residues. If spills or releases occur, immediately notify the Environmental Consultant and Engineer. Immediately recover all contaminated soil, residue, and any new contamination that was caused by the spill or release. Prior to transport, sufficiently dewater soils designated for off-site disposal so as not to contain free liquids.

L. The contractor shall be responsible for hauling excavated soil to the following WDNR-approved disposal facilities:

Soil Contamination	Allowable Soil Volume (tons)	Disposal Facility	Notes
Petroleum	All (estimated 500-1000 tons)	WM Madison Prairie Landfill 3490 Nelson Road Sun Prairie, WI 53590 608.837.9031 *Contact: Tim Nelson, 608.535.3011*	All petroleum-impacted soil will go to the Madison Prairie bioremediation facility.
Non-petroleum	4500 tons	WM Madison Prairie Landfill 3490 Nelson Road Sun Prairie, WI 53590 608.837.9031 *Contact: Tim Nelson (608.535.3011)*	The first 4500 tons of non-petroleum soil shall be hauled to Mad Prairie Landfill.
Non-petroleum	All remaining excavated soil (no cap)	WM Deer Track Park Landfill N6756 Waldmann Lane Watertown, WI 53094 608.699.3475 *Contact: Tim Nelson (608.535.3011)*	Any remaining non-petroleum soil shall be hauled to Deer Track Park Landfill.

M. All petroleum-contaminated soil will be disposed of at the bioremediation facility at the WM Madison Prairie Landfill.

N. Non-petroleum-contaminated soil will be disposed of at one of two landfills:
   1. The first 4500 tons will be hauled to the WM Madison Prairie Landfill.
   2. All remaining excavated soil will be hauled to the WM Deer Track Park Landfill.

O. Tipping fees at both facilities will be paid for by the City of Madison.
   1. Construction and demolition debris (such as clean soil, boulders, concrete, reinforced concrete, bituminous pavement, bricks, building stone, unpainted or untreated wood, etc.), which under NR 500.08 are exempt materials, are not covered under this section.

3.2 SITE VERIFICATION

A. Verify that survey benchmark and intended elevations for Work are as indicated.

3.3 PREPARATION FOR EXCAVATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Notify utility company to remove and relocate utilities that interfere with Work.

D. Protect above and below grade utilities indicated to remain.

E. Protect plant life, lawns, and other features remaining as portion of final landscaping.

F. Protect benchmarks, survey control points, paving, and curbs from excavating equipment and vehicular traffic.

3.4 EXCAVATION

A. Fully excavate ATC conduit prior to driving piles within 20 feet of conduit.

B. Underpin adjacent structures that may be damaged by excavation work, including utilities and pipe chases.

C. On site materials have contamination, materials removed from site will need to go to landfill.

D. Minimize excavation. Disturbed materials will need to be replaced with engineered fill.

E. Excavated thermal sand at ACT conduit may be reused at the conduit site.

F. Excavate subsoil required to accommodate building foundation, slabs-on-grade and site structures and construction operations.

G. Excavate to working elevations for piling work.

H. Machine slope banks to angle of repose or less, until shored.

I. Excavate cut to not interfere with normal 45 degree bearing splay of foundation.

J. Grade top perimeter of excavation to prevent surface water from draining into excavation.

K. Hand trim excavation. Remove loose matter.

L. Remove lumped subsoil, boulders, and rock.

M. Notify Owner’s Representative of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

N. Correct unauthorized excavation at no extra cost to Owner.

O. Correct areas over-excavated in error.

P. Remove excavated material from site.

3.5 COORDINATION

A. Coordinate work under this contract with the City of Madison Environmental Consultant:
Brynn Bemis
City of Madison Engineering
210 Martin Luther King, Jr. Blvd., Rm 115
Madison, WI 53703
608.267.1986
bbemis@cityofmadison.com

B. The role of the Environmental Consultant will be limited to:
1. Providing required analytical reports to the approved disposal facilities for proper profiling.
2. Providing hauling manifests for disposal facilities.
3. Assisting with determining the location and limits of petroleum-contaminated soil to be excavated based on soil analytical results, visual observations, and/or field screening instruments.
4. Coordinating response measures for unknown contamination encountered.
5. Documenting that activities associated with management of contaminated soil are in conformance with the contaminated soil management methods for this project as specified herein.
6. Notifying the Contractor when the soil volume cap has been met at the WM Madison Prairie Landfill.

C. The City of Madison will provide an Environmental Consultant (staff member or hired consultant) should unknown contamination be encountered. Contact Brynn Bemis, City of Madison Engineering Department at (608) 267-1986 to coordinate onsite activities and testing.

D. At the preconstruction conference, provide a schedule for all excavation activities in the areas of contamination to the Environmental Consultant. Notify both the Environmental Consultant and Project Engineer at least five (5) calendar days prior to commencement of excavation activities. Do not transport contaminated soil offsite without prior approval from the Environmental Consultant.

3.6 FIELD QUALITY CONTROL FOR EXCAVATION

A. Field inspection and testing will be performed under provisions of Division 01 – General Requirements.

B. Provide for visual inspection of bearing surfaces.

3.7 PROTECTION

A. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

3.8 EXAMINATION PRIOR TO BACKFILLING

A. Verify fill material to be reused are acceptable. Except thermal sand, none is expected to be reused.

B. Verify foundation perimeter drainage installation has been inspected.

3.9 PREPARATION FOR BACKFILLING

A. Generally, compact subgrade to density requirements for subsequent backfill materials.

B. Cut out soft areas of subgrade not capable of establishing compaction. Backfill with Type A2 fill as specified in Section 31 05 16 – Aggregates for Earthwork, and compact to density equal to or greater than requirements for subsequent backfill material.

C. Where side wall material is loose or unstable, place geotextile cloth material over sidewall prior to backfilling.

3.10 BACKFILLING

A. Backfill areas to contours and elevations with unfrozen materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.

C. Employ a placement method that does not disturb or damage foundation perimeter drainage foundation waterproofing utilities in trenches.

D. Maintain optimum moisture content of backfill materials to attain required compaction density.

E. Backfill against supported foundation walls that have a basement or underground parking area. Do not backfill against unsupported foundation walls that have a basement or underground parking area.

F. Backfill simultaneously on each side of unsupported non-basement foundation walls.

G. Slope grade away from building minimum two (2) inches in 10 feet, unless noted otherwise.

H. Make grade changes gradual. Blend slope into level areas.

I. Leave fill material stockpile areas completely free of excess fill materials.

J. Remove surplus backfill materials from site.

3.11 TOLERANCES FOR BACKFILL

A. Top Surface of Backfilling under Paved Areas: Plus or minus one (1) inch from required elevations.

3.12 FIELD QUALITY CONTROL FOR BACKFILL

A. Field inspection and testing will be performed under provisions of Division 01 – General Requirements.

B. Testing and analysis of fill material will be performed in accordance with ASTM D698 and Division 01 – General Requirements.

C. Compaction testing will be performed in accordance with ASTM D6938 and Division 01 – Quality Requirements.

D. If tests indicate Work does not meet specific requirements, remove Work, replace, and retest at no cost to Owner.

3.13 PROTECTION OF FINISHED BACKFILL

A. Protect finished Work under provisions of Division 01 – General Requirements.

B. Re-compact fills disturbed by vehicular traffic.

3.14 SCHEDULE OF BACKFILL

A. Section 31 05 16 – Aggregates for Earthwork defines "A" designated fill materials and Section 31 05 13 – Soils for Earthwork defines "S" designated fill materials.

B. Building Foundations:
1. Aggregate Type A2 fill. Place materials in continuous loose lifts layers not exceeding seven (7) inch depth, compacted to 95 percent modified Proctor density.

C. Interior Slab-On-Grade:
1. Aggregate Type A1 fill. Place materials in continuous loose lifts layers not exceeding seven (7) inch depth, compacted to 95 percent modified Proctor density.

D. Foundation Drainage - Stone Cover:
1. Aggregate Type A5 fill. Place materials in continuous loose lifts layers not exceeding nine (9) inch depth, compacted to 95 percent modified Proctor density.

E. Fill to Correct Over-Excavation:
1. Aggregate Type A2 or A9 fill, flush to required elevation, compacted to 90 percent modified Proctor density.

F. Frequency of Compaction Tests:
1. General Excavation and Fill: One (1) Test for Every 1000 Cubic Yards.
2. Excavation and Backfill for Trenches (Gravel): One (1) Test for Every 300 Cubic Yards.
3. Excavation and Backfill for Trenches (Spoil): One (1) Test for Every 750 Cubic Yards.
4. Undercut Excavation: One (1) Test for Every 1000 Cubic Yards.

3.15 HEALTH AND SAFETY REQUIREMENTS

A. During excavation activities, expect to encounter soil contaminated with gasoline, diesel fuel, fuel oil, or other petroleum-related products, PCBs, metals, and PAHs. Site workers taking part in activities that will result in the reasonable probability of exposure to safety and health hazards associated with hazardous materials shall have completed health and safety training that meets the Occupational Safety and Health Administration (OSHA) requirements for Hazardous Waste Operations and Emergency Response (HAZWOPER), as provided in 29 CFR 1910.120.

B. Prepare a site-specific Health and Safety Plan, and develop, delineate and enforce the health and safety exclusion zones for each contaminated site location as required by 29 CFR 1910.120.

Submit the site-specific health and safety plan and written documentation of up-to-date OSHA training to the engineer prior to the start of work.

END OF SECTION

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SECTION 31 23 17

SITE EXCAVATION, BACKFILL, AND COMPACTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Verification of subsurface conditions and utilities prior to excavation.
2. Saw cutting of pavements prior to excavation.
3. Excavation for utility structure foundation.
4. Bioretention Infiltration Area.
5. Excavation of trenches for sanitary sewer collection system.
6. Excavation of trenches for storm sewer collection system.
7. Excavation of trenches for water distribution system.
8. Backfill requirements for utility trenches.
9. Backfill for over-excavation corrections.
10. Consolidation and compaction.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 31 05 17 – Aggregates for Site Earthwork: Aggregate backfill materials.
3. Section 31 22 13 - Rough Grading: Topsoil and subsoil removal from site surface.
4. Section 31 25 13 – Erosion and Sediment Controls.
5. Section 32 11 23 – Aggregate Base Course: Preparation for aggregate base course.
6. Section 32 91 13 – Soil Preparation.
7. Section 33 11 00 – Site Water System: Installation of site water lines for private use.
8. Section 33 31 00 – Site Sanitary Sewer System: Installation of sanitary sewer system
9. Section 33 41 00 – Site Storm Sewer System: Installation of storm sewer system.

1.2 REFERENCES

A. City of Madison Standard Specifications for Public Works Construction, 2017 Edition, (SSPW).

B. State of Wisconsin Department of Transportation (WISDOT):
1. Standard Specifications for Highway and Structure Construction, Current Edition. State of Wisconsin DOT Standard Specifications

C. 211 S. Livingston Street Material Management Plan (June 2017).

D. ASTM International (ASTM):
1. ASTM C518 - Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
2. ASTM C578 – Specification for Rigid, Cellular Polystyrene Thermal Insulation.
3. ASTM D1557 - Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft.-lbf/ft^3.
4. ASTM D1621 - Test Method for Compressive Properties of Rigid Cellular Plastics.

5. ASTM D2842 - Test Method for Water Absorption of Rigid Cellular Plastics.
6. ASTM D2487 - Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
7. ASTM D6072 - Practice for Obtaining Samples of Geosynthetic Clay Liners.
8. ASTM D6938 – Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Provide certified analysis of material(s) to Engineer prior to any use on Work.

1.4 REGULATORY REQUIREMENTS

A. Contractor shall comply with all local, state, and federal regulations applicable to Work of this Section.

B. Contractor shall comply with and be solely responsible for compliance with U.S. Department of Labor OSHA Part 1926 Safety and Health Regulations for Construction for this Work.

C. Contractor performing Work of this Section shall be solely responsible for identifying, furnishing, installing and maintaining equipment and materials required by state and federal regulations to establish safe working conditions during Work of this Section.

PART 2 - PRODUCTS

2.1 BEDDING AND BACKFILL MATERIALS

A. Water Main Bedding: Type as defined in SSPW Article 703.6.1.

B. Sewer Bedding: Type as defined in SSPW Article 502.1(d).

C. Water Main Backfill: Type as defined in SSPW Article 703.6.2.

D. Sewer Backfill: Type as defined in SSPW Article 502.1(e).

E. Imported Subsoil Material Backfill: Type S2 as defined in Section 31 05 13 – Soils for Earthwork.

2.2 AGGREGATE SLURRY BACKFILL

A. Place materials in a clean cement mixer truck and thoroughly mixed in following quantities:

1,350 lbs.	sand
775 lbs.	1-1/4 Inch stone
1,150 lbs.	3/4 Inch stone
25 gals.	(+0 to –0.5) water/cu.yd.

B. Lean concrete backfill shall conform to above with addition of a minimum of one bag of cement per cubic yard.

2.3 CLAY LINER

A. Material for clay liner for on-site bioretention infiltration area shall be inorganic clay conforming to group CL in accordance with ASTM D2487.

B. Take samples of clay liner material for testing in accordance with ASTM D6072.

2.4 PIPE INSULATION

A. Extruded polystyrene board to ASTM C578, Type V, rigid, closed cell type, with integral high density skin.
   1. Thermal Resistance: Typical 5 year aged value of R-5 per 1 inch of thickness per ASTM C518.
   2. Board Size: 24 x 96 x 2-inch thick. Square edges.
   3. Compressive Strength: Minimum 100 psi per ASTM D1621.
   4. Water Absorption: 0.7 percent by volume maximum per ASTM D2842.
   5. Insulation shall be:
      a. Dow Chemical Company STYROFOAM™ Highload 100; Dow Chemical Styrofoam Highload 100 Insulation.
      b. Or Approved Equal.

PART 3 - EXECUTION

3.1 NOTIFICATION

A. Contractor, prior to any excavation work, shall notify (1) a designated locating service; (2) all utilities, governmental agencies, entities, known to, or which can reasonably be assumed to have above or below ground pipe, conduit cables, structures, or similar items within limits of project; to locate and mark location of such items.

B. In accordance with Wisconsin Statute 182.0175, "Damage to Transmission Facilities," Excavator, as defined in 182.0175(1)(bm), shall be solely responsible to provide advance notice to “One-Call System - Diggers Hotline” (811) or (800) 242-8511, not less than three (3) working days prior to commencement of any Excavation, as defined in the statute, required to perform work contained in this Project, and further, Excavator shall comply with all other requirements of this Statute relative to Excavation.
Wisconsin Statute 182.0175 - Damage to Transmission Facilities

C. All soil excavated from the site shall be hauled and disposed of at once of two (2) WDNR-licensed landfills: the first ~5000 tons will be hauled to WM’s Madison Prairie Landfill in Sun Prairie, WI and all remaining excavated soil will be hauled to WIM’s Deer Track Park in Watertown, WI. Excavation and hauling shall be paid for by the contractor. Landfill tipping fees will be paid for directly by the City of Madison, not the Contractor.

D. The City shall be responsible for all waste profiling and provide signed manifests to the Contractor to take with each load to the landfill. Perform this work in accordance to the 211 S.

Livingston Street Materials Management Plan (June 2017) and with pertinent parts of Chapters NR 700-754 of the Wisconsin Administrative Code, as supplemented herein. Per NR 718.07, a solid waste collection and transportation service-operating license is required under NR 502.06 for each vehicle used to transport contaminated soil.

E. Boring logs indicate that the top 4 to 6 feet of the site was historically filled with a range of industrial materials, including cinders, coal, foundry sand, and bricks. The City has completed soil testing and concluded two types of contamination impact all on-site soil: petroleum and non-petroleum. Zones of known petroleum-contamination are shown on Figure 2 of the Materials Management Plan. All other excavated soil shall be assumed to be non-petroleum-contaminated.

F. There is potential that additional petroleum-contaminated soil and/or underground storage tanks (USTs) may be encountered at other locations within the construction limits. If contaminated soils—based on unusual odor, presence of cinders, staining, etc.—are encountered elsewhere on the project, terminate excavation activities in the area and notify the Environmental Consultant or Engineer. If needed, Contractor shall assist the Environmental Consultant in collecting soil samples for evaluation using excavation equipment.

G. Perform this work in accordance with the 211 S. Livingston Street Materials Management Plan (June 2017), which was developed in cooperation with the WDNR. For a copy of the Materials Management Plan or further information regarding on site contamination, contact:

Brynn Bemis
City of Madison Engineering
210 Martin Luther King, Jr. Blvd., Rm 115
Madison, WI 53703
608.267.1986
bbemis@cityofmadison.com

H. The Environmental Consultant will be available to evaluate soil excavated to determine if soil is petroleum-contaminated using field screening results, visual observations, and soil analytical results from previous environmental investigations. Assist the environmental consultant in collecting soil samples for evaluation using excavation equipment.

I. While excavating, only excavate contaminated soils as required by the construction plan set. Do not over-excavate contaminated soils, unless directed by the Environmental Consultant or Engineer.

J. Directly load and haul soils designated in the construction plan set or by the Environmental Consultant for offsite landfill. Excavated contaminated soils may be temporarily stockpiled as permitted by the construction schedule. Stockpile requirements for contaminated materials are specified in NR 718.05. Place petroleum-contaminated soil on base material impervious to the contaminant and to water, such as concrete, asphalt, or plastic sheeting. Cover petroleum-contaminated piles with impervious material, such as plastic sheeting, to prevent infiltration of precipitation and to inhibit volatilization of soil contaminants.

K. Use loading and hauling practices that are appropriate to prevent any spills or releases of contaminated soils or residues. If spills or releases occur, immediately notify the Environmental Consultant and Engineer. Immediately recover all contaminated soil, residue, and any new contamination that was caused by the spill or release. Prior to transport, sufficiently dewater soils designated for off-site disposal so as not to contain free liquids.

L. The contractor shall be responsible for hauling excavated soil to the following WDNR-approved disposal facilities:

Soil Contamination	Allowable Soil Volume (tons)	Disposal Facility	Notes
Petroleum	All (estimated 500-1000 tons)	WM Madison Prairie Landfill 3490 Nelson Road Sun Prairie, WI 53590 608.837.9031 *Contact: Tim Nelson, 608.535.3011*	All petroleum-impacted soil will go to the Madison Prairie bioremediation facility.
Non-petroleum	4500 tons	WM Madison Prairie Landfill 3490 Nelson Road Sun Prairie, WI 53590 608.837.9031 *Contact: Tim Nelson (608.535.3011)*	The first 4500 tons of non-petroleum soil shall be hauled to Mad Prairie Landfill.
Non-petroleum	All remaining excavated soil (no cap)	WM Deer Track Park Landfill N6756 Waldmann Lane Watertown, WI 53094 608.699.3475 *Contact: Tim Nelson (608.535.3011)*	Any remaining non-petroleum soil shall be hauled to Deer Track Park Landfill.

M. All petroleum-contaminated soil will be disposed of at the bioremediation facility at the WM Madison Prairie Landfill.

N. Non-petroleum-contaminated soil will be disposed of at one of two landfills:
1. The first 4500 tons will be hauled to the WM Madison Prairie Landfill.
2. All remaining excavated soil will be hauled to the WM Deer Track Park Landfill.

O. Tipping fees at both facilities will be paid for by the City of Madison.
1. Construction and demolition debris (such as clean soil, boulders, concrete, reinforced concrete, bituminous pavement, bricks, building stone, unpainted or untreated wood, etc.), which under NR 500.08 are exempt materials, are not covered under this section.

3.2 COORDINATION

A. Coordinate work under this contract with the City of Madison Environmental Consultant:
Brynn Bemis
City of Madison Engineering
210 Martin Luther King, Jr. Blvd., Rm 115

Madison, WI 53703
608.267.1986
bbemis@cityofmadison.com

B. The role of the Environmental Consultant will be limited to:
   1. Providing required analytical reports to the approved disposal facilities for proper profiling.
   2. Providing hauling manifests for disposal facilities.
   3. Assisting with determining the location and limits of petroleum-contaminated soil to be excavated based on soil analytical results, visual observations, and/or field screening instruments.
   4. Coordinating response measures for unknown contamination encountered.
   5. Documenting that activities associated with management of contaminated soil are in conformance with the contaminated soil management methods for this project as specified herein.
   6. Notifying the Contractor when the soil volume cap has been met at the WM Madison Prairie Landfill.

C. The City of Madison will provide an Environmental Consultant (staff member or hired consultant) should unknown contamination be encountered. Contact Brynn Bemis, City of Madison Engineering Department at (608) 267-1986 to coordinate onsite activities and testing.

D. At the preconstruction conference, provide a schedule for all excavation activities in the areas of contamination to the Environmental Consultant. Notify both the Environmental Consultant and Project Engineer at least five (5) calendar days prior to commencement of excavation activities. Do not transport contaminated soil offsite without prior approval from the Environmental Consultant.

3.3 HEALTH AND SAFETY REQUIREMENTS

A. During excavation activities, expect to encounter soil contaminated with gasoline, diesel fuel, fuel oil, or other petroleum-related products, PCBs, metals, and PAHs. Site workers taking part in activities that will result in the reasonable probability of exposure to safety and health hazards associated with hazardous materials shall have completed health and safety training that meets the Occupational Safety and Health Administration (OSHA) requirements for Hazardous Waste Operations and Emergency Response (HAZWOPER), as provided in 29 CFR 1910.120.

B. Prepare a site-specific Health and Safety Plan, and develop, delineate and enforce the health and safety exclusion zones for each contaminated site location as required by 29 CFR 1910.120. Submit the site-specific health and safety plan and written documentation of up-to-date OSHA training to the engineer prior to the start of work.

3.4 SITE VERIFICATION

A. Verify that survey benchmark and intended elevations for Work are as indicated.

3.5 FIELD MEASUREMENTS

A. Verify that survey benchmark and intended elevations for the Work are as shown on Drawings.

B. Primary line and grade will be furnished by Owner and will be established by Contractor.

C. Contractor shall employ a Registered Land Surveyor, registered in the State of Wisconsin to perform all survey work related to primary line and grade for project utilities.

D. Contractor shall check accuracy of line and grade stakes by means of visual and taping checks and shall be responsible for protection and preservation of such stakes established by Registered Land Surveyor.

E. Contractor shall bear sole responsibility for correct transfer of all construction lines and grades from primary line and grade points and for correct alignment and grade of finished structure, based upon primary line and grade established by Registered Land Surveyor.

F. Except for those lot corners and survey monuments that fall within trench excavation, Contractor shall be solely responsible for protection and/or replacement of all survey corners that exist throughout work area.

G. Corners will be located and marked by Owner, upon request by Contractor, prior to commencing its work.

H. A Registered Land Surveyor shall replace damaged corners at Contractor's expense.

3.6 SAWING AND BREAKING PAVEMENT

A. Saw concrete pavement, slabs, or bases to full-depth, slab, or base prior to removal.

B. Saw cut asphalt surface course and asphalt binder course full depth before removal.

C. Cut pavements evenly along edges of excavation prior to their removal in such a way as to avoid excessive removal or ragged, uneven edges.

D. A drop weight or other type of machinery for breaking pavement when approved by Engineer may be used when such usage does not become a nuisance or a source of damage to underground or adjacent structures.

E. Prior to employing a drop weight, Contractor shall verify that there are no nearby underground structures that would be injured by its use.

F. Contractor shall be solely responsible for any damage caused thereby.

G. Engineer or Owner's Representative reserves right to order discontinuance of use of such drop weight at any time.

3.7 PREPARATION FOR EXCAVATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Notify utility company to remove and relocate utilities that interfere with Work.

D. Protect above and below grade utilities indicated to remain.

E. Protect plant life, lawns and other features remaining as portion of final landscaping.

F. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

G. Cut out soft areas of subgrade not capable of in situ compaction. Backfill with Type A2 or A9, as specified in Section 31 05 17 – Aggregates for Site Earthwork, fill and compact to density equal to or greater than requirements for subsequent backfill material.

3.8 FIELD QUALITY CONTROL FOR EXCAVATION

A. Field inspection will be performed under provisions of Division 01 – General Requirements.

B. Provide for visual inspection of bearing surfaces.

3.9 UTILITY STRUCTURE EXCAVATION

A. Underpin adjacent structures that may be damaged by excavation work, including utilities and pipe chases.

B. Excavate subsoil required to accommodate site structures for construction operations.

C. Machine slope banks to angle of repose or less, until shored.

D. Excavation cut not to interfere with normal 45 degree bearing splay of foundation.

E. Grade top perimeter of excavation to prevent surface water from draining into excavation.

F. Hand trim excavation. Remove loose matter.

G. Remove lumped subsoil, boulders, and rock.

H. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

I. Correct unauthorized excavation at no extra cost to Owner.

J. Correct areas over-excavated in error.

K. Remove excavated material from site in accordance with soils management plan.

3.10 BIORETENTION INFILTRATION AREA CONSTRUCTION

A. Site Preparation:
   1. Dispose of all cleared and grubbed material outside and below limits of embankment and reservoir.
   2. Stockpile a sufficient quantity of topsoil in a suitable location for use on embankment.

B. Excavate subsoil required to accommodate volume.

C. Machine slope banks.

D. Grade top perimeter of excavation to prevent surface water from draining into excavation.

E. Hand trim excavation. Remove loose matter. Remove lumped subsoil, boulders, and rock.

F. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

G. Correct unauthorized excavation at no extra cost to Owner. Correct areas over-excavated in error.

H. Earth Fill Placement:
1. Scarify areas for fill placement before placement.
2. Place fill material in maximum eight (8) inch thick layers (before compaction), continuous over entire length of fill.
3. Place most permeable material in downstream portions of embankment. Install principal spillway concurrently with fill placement

I. Compaction:
1. Compact fill material with appropriate compaction equipment such as a sheepsfoot, rubber-tired or vibratory roller.
2. Number of required passes by compaction equipment over fill material may vary with soil conditions.
3. Fill material should contain sufficient moisture such that equipment used obtains required degree of compaction.
4. Minimum required density is 95 percent modified Proctor density with moisture content within plus or minus two (2) percent of optimum.
5. Compact each layer of fill as necessary to obtain minimum density and Engineer should certify that each fill layer meets minimum density requirement.

J. Excavate cutoff trench into impervious material along or parallel to centerline of embankment. Govern bottom width of trench by equipment used for excavation, with minimum width being four (4) feet. Obtain depth of at least four (4) feet below existing grade. Side slopes of trench should be 1H:1V or flatter. Compact backfill with construction equipment, rollers, or hand tampers to assure maximum density and minimum permeability.

K. Place a minimum of two (2) feet of suitable clay to form liner and compact to 95 percent modified Proctor density.

3.11 EXPOSING EXISTING SANITARY SEWER, STORM SEWER, AND WATER MAIN

A. Before excavation of trench is begun, Contractor shall uncover stub end of existing utility to which new utility is to be connected. This will permit adjustments in line and grade and verify connection required.

B. Securely plug existing terminations in manholes to which new utilities are to be connected to prevent entry of construction water and debris into active system.

C. Contractor shall be responsible to verify that plug(s) are in place at end of each workday.

D. Contractor shall remove any water or debris from terminal manhole as required but not less than once a week.

3.12 TRENCH EXCAVATION

A. Excavate subsoil required for installation of utility.

B. Excavate trenches at top of pipe to a maximum width based on dimension of outside diameter of pipe plus 24 inches to enable installation of pipe and to allow inspection.

C. Width at top of pipe may be increased with prior approval of Engineer to allow for stringers and sheathing when required.

D. Provide pipe laid in open-cut trench with six (6) inch minimum clearance between outside face of pipe barrel and face of sheathing or sidewall of trench.

E. Maximum width of trench at ground surface shall not exceed width of trench at top of pipe by more than two (2) feet without prior request to Engineer, unless it is specifically allowed on Drawings.

F. Place excavated material stored along trench excavation a minimum distance back from edge of trench. Determine distance by angle of repose of trench material to prevent surcharging of trench wall material leading to potential shearing of trench wall and collapse of trench.

G. Store excavated material to be used for trench backfilling so that it will not interfere with:
   1. Public travel.
   2. Adjacent property owners or tenants.
   3. Other Contractors.

H. Contractor shall immediately remove and dispose of excavated material which is not to be used as trench backfill, unless directed otherwise by Contract Documents.

I. Contractor shall maintain all finished excavations free of water or sewage during Work.

J. Hand trim excavation. Remove loose matter.

K. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard, measured by volume.

L. Correct unauthorized excavation and over-excavated areas at no cost to Owner.

M. Excavate no more trench in advance of completed pipe laying operations than can be completed and backfilled by end of workday.

N. Do not obstruct more than one street crossing by same trench at any one time.

3.13 TRENCH BEDDING

A. Keep trench bottom free of water prior to placement of bedding and laying of pipe.

B. Place and shape bedding material to pipe in accordance with SSPW.

C. Support pipe during placement and compaction of bedding material.

D. Bring bedding and cover material over top of pipe to a minimum compacted depth in accordance with SSPW.

3.14 PIPE INSULATION

A. Insulate water pipes with less than six (6) foot of cover with a minimum four (4) inch thick sheet of extruded polystyrene insulation.

B. Laterals with less than 42-inch cover shall have a minimum four (4) inch thick sheet of extruded polystyrene insulation.

C. Extend insulation a minimum of two (2) feet each side of pipe centerline.

D. Sheet insulation shall be minimum two (2) feet each side of pipe centerline and in addition shall have four (4) inches of insulation board placed vertically at end of horizontal board to bottom of excavated trench.

3.15 PROTECTION

A. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

3.16 EXAMINATION PRIOR TO BACKFILLING

A. Verify fill material to be reused are acceptable.

B. Verify foundation perimeter drainage installation has been inspected.

3.17 BACKFILLING

A. Backfill with materials and to contours and elevations shown on Drawings. Generally, compact subgrade to density requirements for subsequent backfill materials.

B. Place specified backfill in loose lift layers. Use compaction equipment that will achieve desired compaction requirements.

C. Systematically backfill to allow for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

D. Where sidewall material is loose or unstable, place geotextile cloth material over sidewall prior to backfilling.

E. Employ a placement method that does not disturb or damage pipe in trench.

F. Maintain optimum moisture content of backfill materials to attain required compaction density.

G. Slope grade away from building.

H. Make grade changes gradual. Blend slope into level areas.

I. Leave fill material stockpile areas completely free of excess fill materials.

J. Remove surplus backfill materials from site.

3.18 MECHANICAL COMPACTION

A. Mechanically compact backfill by means of a tamping roller, sheepsfoot roller, pneumatic tire roller, vibrating roller, or other mechanical tampers. Impact, free-fall, or "stomping" type compaction equipment shall not be allowed.

B. Flooding or jetting of backfill for compaction purposes shall not be allowed.

C. Contractor shall furnish written notification to Engineer prior to start of work as to size and type of mechanical compaction equipment to be used.

D. Place material for mechanically compacted backfill in lifts, which, prior to compaction, shall not exceed thickness specified below for type of compaction equipment used:
   1. Vibratory equipment including vibratory plate, vibratory smooth-wheel rollers, and vibratory pneumatic-tired rollers: maximum lift thickness two (2) feet.
   2. Rolling equipment, including sheepsfoot (both vibratory and non-vibratory), grid, smooth-wheel (non-vibratory), pneumatic-tired (non-vibratory), and segmented wheels: maximum lift thickness one (1) foot.
   3. Hand-directed mechanical tampers: maximum lift thickness of six (6) inches.

3.19 TOLERANCES FOR BACKFILL

A. Top Surface of Backfill: Plus or minus 1 inch from required elevations.

3.20 COMPACTION REQUIREMENTS

A. Granular Material shall be compacted to 95 percent of modified Proctor density.

B. Excavated Material to be used for backfill shall be compacted to a density equal to adjacent undisturbed trench wall or as specified.

3.21 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 01 – General Requirements.

B. Testing and analysis of fill material will be performed in accordance with ASTM D1557 and Division 01 - General Requirements.

C. Compaction and moisture testing will be performed in accordance with ASTM D6938 and Division 01 – General Requirements.

D. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest at no cost to Owner.

3.22 PROTECTION OF FINISHED WORK

A. Reshape and recompact fills subjected to vehicular traffic.

B. Contractor shall have available a supply of steel plates with minimum dimensions of four (4) feet by eight (8) feet by one (1) inch.

C. Use plates to bridge open trenches crossing roadways and secure against possibility of shifting or dropping into excavation.

D. During winter months, do not leave plates in roadway overnight.

3.23 SCHEDULE OF BACKFILL

A. Section 31 05 17 – Aggregates for Site Earthwork defines "A" designated fill materials and Section 31 05 13 – Soils for Earthwork defines "S" designated fill materials.

B. Fill to Correct Over-Excavation:
1. Aggregate Type A2 fill, flush to required elevation, compacted to 90 percent modified Proctor density.
2. Lean concrete to minimum compressive strength of 1000 psi.

C. Utility Structure Foundations:
1. Aggregate Type A1 fill. Place materials in continuous loose lifts layers not exceeding seven (7) inch depth, compacted to 95 percent modified Proctor density.

D. Exterior Slab-On-Grade:
1. Aggregate Type A1, A2, or A3 fill. Place materials in continuous loose lifts layers not exceeding seven (7)-inch depth, compacted to 95 percent modified Proctor density.

E. Utility Trench – Backfill in Paved Areas:
1. Aggregate Type A1 fill. Place materials in continuous loose lifts layers not exceeding 12-inch depth, compacted to 95 percent modified Proctor density.

F. Utility Trench – Backfill in Non-paved Areas:
1. Subsoil Type S1 or S2 fill, to six (6) inches below finish grade. Place materials in continuous loose lifts layers not exceeding 12-inch depth, compacted to 90 percent modified Proctor density.

G. Fill Under Driveways:
1. Aggregate Slurry Fill placed to 12 inches below finish grade, placed in continuous applications.

H. Fill Under Grass Area:
1. Subsoil Type S1 or S2 fill, to six (6) inches below finish grade. Place materials in continuous loose lifts layers not exceeding 12-inch depth, compacted to 90 percent modified Proctor density.

I. Fill Under Landscaped Areas:
   1. Subsoil Type S2 fill, to 18 inches below finish grade. Place materials in continuous loose lifts layers not exceeding 12-inch depth, compacted to 85 percent modified Proctor density.

END OF SECTION

SECTION 31 23 22
CONSTRUCTION SITE DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Labor, materials, equipment and services necessary to control, handle, and dispose of ground and surface water encountered on site and affecting project construction.
2. Repair or replacement of property damaged due to failure to properly execute requirements of this Section.
3. Treatment of ground or surface water prior to disposal.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 02 32 00 – Geotechnical Investigation.
3. Section 31 23 15 - Excavation, Backfill, and Compaction for Buildings and Structures.
4. Section 31 23 17 – Site Excavation, Backfill, and Compaction.

1.2 REGULATORY REQUIREMENTS

A. Contractor shall comply with applicable rules and regulations for dewatering operations in accordance with:
1. State of Wisconsin Department of Natural Resources - Storm Water Construction and Post-Construction Technical Standards.
2. WDNR - Conservation Practice Code No. 1061 - Dewatering.

3. Contractor shall comply with other local, state, or federal agencies having jurisdiction related to Work of this Section.

B. Contractor shall obtain permits applicable to work of this Section as required by regulatory agencies.

C. Comply with City of Madison Erosion Control Ordinance to control, handle, and dispose of ground and surface water.

1.3 PERFORMANCE REQUIREMENTS

A. Provide continuous control of water during course of construction.

B. Provide adequate backup systems to accomplish control of water.

C. Provide method of control, handling, and disposal of ground and surface water by whatever means necessary and in conformance with this Section, to obtain satisfactory working conditions and maintain progress of Work.

D. Perform drainage, pumping, and disposal without damage to adjacent property or structures, without interference with operation of other contractors or rights of public or private owners, or pedestrian and vehicular traffic.

E. Contractor shall modify water control system at its own expense if, after installation and while in operation, it causes or threatens to cause damage to adjacent property or to existing buildings, structures, or utilities.

1.4 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Submit for information purposes only, working drawings and description of proposed ground and surface water control facilities including but not limited to:
1. Methods, equipment, and power supply.
2. Pollution control facilities and discharge locations to be utilized.
3. Method of monitoring groundwater levels and drawdown.
4. Construction details of dewatering wells.
5. Schedule of installation and operation.
6. Copies of permits obtained.

C. Submittal shall be made thirty days prior to installation of water control system.

D. Resubmittals shall be made during course of construction if system is modified during installation or operation.

1.5 EXISTING CONDITIONS

A. Soil borings and related information would indicate that the water table at Project Site is approximately at Elevation 843.5, but may fluctuate.

B. Contamination exists on Project Site which could affect the quality of the groundwater and necessity for treatment.

C. Information relative to soil borings and expected contamination are included in Bidding Documents.

D. The Madison Metropolitan Sewerage District (MMSD) Sewer Ordinance under Part 4.7.5 restricts the discharge of groundwater into the sanitary sewer system, and any clearwater discharge is a violation of the Sewer Ordinance.

1.6 WARRANTY

A. Loss or damage arising from removal or disturbance of groundwater, including but not limited to claims for subsidence and loss of structure support that may occur in prosecution of Work of this Section, shall be sole responsibility of Contractor.

B. If Contractor fails to correct damage resulting from its operations, Owner may, after giving Contractor 30-day written notice, proceed to repair, rebuild, or otherwise restore such damaged

property, and cost thereof will be deducted from any compensation which may be or become due Contractor under this Contract.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Selected by Contractor to accomplish Work of this Section.

2.2 EQUIPMENT

A. Utilize equipment specifically applicable to dewatering work.

B. Operate and maintain equipment in an efficient manner to produce acceptable results.

PART 3 - EXECUTION

3.1 SUBDRAINAGE

A. Intercept and divert surface drainage away from work sites by use of dikes, curb walls, ditches, sumps, or other means.

B. Design surface drainage systems so that they do not cause erosion on or off site.

C. Control surface runoff to prevent entry of water into excavations.

D. Remove surface drainage systems when no longer needed.

3.2 WATER CONTROL IN EXCAVATIONS

A. Use water control methods which are appropriate to ground conditions, construction operations, and requirements of these documents.

B. Methods shall involve removal of water within excavations and may involve removal of water outside excavations or construction of facilities to control water movement into excavation.

C. Water control measures shall minimize adverse effects of elevated or reduced water pressure on Work, surrounding ground, and adjacent facilities and structures.

D. Design and operate water control measures to prevent removal of in-situ materials, or loosening or softening of in-situ materials within excavations.

E. Contractor shall control groundwater and surface water so that construction of tunnels, shafts, trenches, and other structures will be performed without adverse effects of water, and to prevent hydrostatic uplift pressures until construction has been completed.

F. Control water during periods when concrete is being placed, pipe is being laid, and at such other times as is necessary for efficient and safe execution of Work.

G. Where groundwater is removed from ground, install piezometers and monitor groundwater levels as necessary to evaluate effect of dewatering on structures.

H. Preparation and procedures shall be in place to take immediate steps to control large amounts of water inflow into an excavation.
   1. A large amount of inflow into an excavation requiring immediate control shall be defined as that which adversely affects performance of the Work or has potential of causing loss or damage to adjacent property or structures.

I. Structures including, but not limited to, buildings, bridges, streets, and utilities that become unstable or vulnerable to settlement due to removal or disturbance of groundwater shall be supported immediately.

J. Structure support shall include, but not be limited to, bracing, shoring, underpinning, or compaction grouting.

3.3 DEWATERING WELLS

A. Contractor shall obtain a permit for dewatering wells that singly or in aggregate produce in excess of 70 gallons per minute from;
   1. State of Wisconsin Department of Natural Resources (DNR), Bureau of Drinking Water and Groundwater.

B. Permits shall be obtained prior to installation of wells. Provide two copies of permits to Engineer.
   1. Wells shall be constructed, operated and abandoned in accordance with;
   2. State of Wisconsin Department of Natural Resources.

C. Dewatering wells shall be constructed and operated to prevent removal of fines.

3.4 DISPOSAL OF WATER

A. Due to low-grade petroleum contamination, all dewatering shall be discharged into the City of Madison sanitary sewer. The contractor shall obtain a City of Madison Permit to Discharge to the Sanitary Sewer compliant with all local ordinances and state statutes. The permit will require that the Contractor monitor the volume of total water discharged into the sanitary sewer and will determine the necessary reporting frequency. The contact for obtaining this permit is:
   Megan Eberhardt
   City of Madison Engineering
   608.266-6432
   meberhardt@cityofmadison.com

B. The City's Environmental Consultant will be responsible for obtaining the necessary approvals from the Madison Metropolitan Sewerage District (MMSD) for disposal of potentially contaminated groundwater. This approval will be issued at the same time as the Permit to Discharge to the Sanitary Sewer. Submit a dewatering plan to the City of Madison for approval with the application for Permit to Discharge to the Sanitary Sewer. The City of Madison will pay for any disposal fees for the discharge of water to the sanitary sewer system.

C. Water removed from construction site shall be discharged through pipe or hoses.

D. Conveying of water in open ditches or trenches will not be allowed.

E. Water shall be discharged in a manner that will not cause soil erosion at discharge point, or cause siltation or flooding in any stream or storm sewer, or on any adjacent property.

F. Permits to use storm or sanitary sewers for water disposal shall be obtained from authority having jurisdiction of facilities.

G. Contractor shall not cause flooding by overloading or blocking flow in drainage facilities and shall leave facilities unrestricted and clean upon completion of use.

H. Contractor shall repair or replace any damage to facilities as a result of its operations as directed by Owner or authority having jurisdiction at Contractor's sole expense.

I. If free phase petroleum product, such as gasoline floating on the water, is observed during dewatering activities, terminate dewatering activities and notify the Engineer or the Environmental Consultant.

3.5 TREATMENT OF WATER

A. Contractor shall obtain a permit from;
   1. City of Madison Permit to discharge to the sanitary sewer.
   2. Provide two copies of permit to Engineer prior to installation of treatment facility.

B. Treatment of water to remove contaminants shall be by use of settling basins, or other approved means.

C. Obtain approval of submittals prior to installation of treatment and discharge systems.

D. Comply with State of Wisconsin Department of Natural Resources requirements for treatment of discharges are dependent upon quantity of daily discharge and sediment content of discharge.
   1. Oil and grease content are additional criteria.
   2. Effluent limits are based upon daily average.
   3. Sampling frequency is dependent upon contaminant levels and discharge rates.
   4. State of Wisconsin Department of Natural Resources restrictions may vary and it shall be Contractor's responsibility to satisfy requirements.

E. Provide copies of records required by State of Wisconsin Department of Natural Resources in accordance with Division 1 – General Requirements.

END OF SECTION

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SECTION 31 25 13

EROSION AND SEDIMENT CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Equipment and materials for erosion and sediment control to minimize erosion and siltation during construction.
2. Erosion and sediment control provisions detailed on Drawings and specified herein are minimum requirements for erosion control program.
3. Contractor to provide additional erosion and sediment control materials and methods required by state or local ordinances, whichever is more stringent.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 32 91 13 – Soil Preparation.
3. Section 32 93 00 – Plantings.

1.2 REFERENCES

A. ASTM International (ASTM):
1. ASTM D4355 – Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
2. ASTM D4491 – Test Methods for Water Permeability of Geotextiles by Permittivity.
3. ASTM D4632 - Test Method for Grab Breaking Load and Elongation of Geotextiles.
4. ASTM D4751 - Test Method for Determining Apparent Opening Size of a Geotextile.
5. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

B. State of Wisconsin Department of Natural Resources (WDNR):
1. Storm Water Construction Technical Standards, Models and Best Management Practices (BMP's):
WDNR Storm Water Construction Technical Standards Webpage

2. Storm Water Post-Construction Technical Standards:
WDNR Storm Water Post-Construction Technical Standards Webpage

C. State of Wisconsin Department of Natural Resources – Conservation Practice Standards (WDNR - CPS);
1. Non-Channel Erosion Mat: WDNR – CPS 1052.
2. Silt Fence: WDNR – CPS 1056.
3. Stone Tracking Pad and Tire Washing: WDNR – CPS 1057.
4. Storm Drain Inlet Protection for Construction Sites: WDNR – CPS 1060.
5. Dust Control on Construction Sites: (WDNR – CPS 1068).

D. State of Wisconsin Department of Transportation (WisDOT):
   1. Standard Specifications for Highway and Structure Construction, Current Edition.
   2. Erosion Control Product Acceptability Lists for Multi–Modal Applications. (PAL)

E. U.S. Environmental Protection Agency (USEPA):
   1. Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites. http://www.epa.gov/npdes/pubs/sw_swppp_guide.pdf

F. City of Madison, Wisconsin
   1. Ordinance for Construction Site Erosion Control.

1.3 DEFINITIONS

A. Definitions shall be in accordance with Wisconsin Department of Natural Resources – Construction Practice Standards, as defined by each standard.

1.4 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Provide erosion control plan indicating proposed methods, materials, and schedule for effecting erosion and siltation control to prevent erosion damage to site and adjacent area.

C. Plan shall include following:
   1. Proposed methods for erosion and siltation control.
   2. Erosion plan scale of 1 inch equals 40 feet, indicating location of erosion control materials, siltation basins, etc.
   3. Schedule for implementation of plan.
   4. Provision for maintenance and upkeep of erosion control and siltation materials, identifying persons responsible for said maintenance.

1.5 REGULATORY REQUIREMENTS

A. Comply with City of Madison ordinance for construction site erosion control.

B. Comply with applicable state and federal rules and regulations governing erosion and siltation on construction sites.

C. Permit
   1. Apply for, pay fee, and obtain State stormwater discharge permit.
   2. Prepare construction site erosion control plan, Consolidated Permit form, and submit form and current fee to Wisconsin Department of Natural Resources at least 14 working days prior to commencing land disturbing construction activities.
   3. At completion of construction activity, file Notice of Termination.

1.6 EROSION CONTROL PRINCIPLES

A. Keep disturbed area small.

B. Stabilize disturbed areas with mechanical or structural and vegetative methods.

C. Keep runoff low through use of short slopes, low gradients, and preservation of natural vegetative cover.

D. Protect disturbed areas from storm water runoff.

E. Retain sediment within site boundaries.

F. Implement a thorough maintenance and follow-up program.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Non-Channel and Channel Erosion Matting: (WDNR CPS 1052 and 1053)
   1. Select erosion mats that last long enough for grass or other vegetation to become densely established.
   2. Class I, short-term duration (6 months or less), light duty, organic, "Erosion Control Revegetative Mat", (ECRM). Non-organic, photodegradable or biodegradable netting allowed; Types as follows;
      a. Type A, netted product for use on slopes 2.5:1 and flatter. Not to be used in channels, with a minimum product permissible shear stress of 1.0 lbs/ft².
      b. Type B, double netted product for use on slopes 2:1 or flatter, or, in channels where the calculated (design) shear stress is 1.5 lbs/ft² or less.
      c. Urban Type: Short term duration (6 months or greater), light duty, organic, "Erosion Control Revegetative Mat", (ECRM), meant for use in urban areas, or lawns, where mowing may be accomplished within two to three weeks without snagging of the netting or mat. This matting type shall not be used in channels.
      d. Urban type mats shall conform to the following requirements;
         1) Shall be 100 percent biodegradable, including parent material, stitching and netting.
         2) Class 1, Type B Urban mats may be single, double or no netted products.
         3) Minimum mat thickness shall be 3/8-inch as measured in place.
         4) WISDOT PAL approved products in the Urban Type A category will be allowed on slopes up to 4:1.
         5) Slopes that are between 4:1 and 2.5:1 are required to use mats in the Urban Type B category.
         6) Netting shall be stitched to prevent separation of the net from the parent material.
         7) Netting shall be capable of withstanding moderate foot traffic without tearing or puncturing, and shall be in accordance with Section 628 of the WisDOT Standard Specifications.
   3. Class II, long-term duration (3 years or greater), Coconut Fiber, "Erosion Control Revegetative Mat" (ECRM), Types as follows:
      a. Type A – Jute Fiber only, conforming to Section 628.2.2 of the WisDOT Standard Specifications. This matting shall be used for reinforcing sod.
      b. Type B, for use on slopes 2:1 or flatter, or in channels when the calculated (design) shear stress is 2.0 lbs/ft² or less. Non-organic, photodegradable or biodegradable netting allowed.
      c. Type C, For use on slopes 2:1 or flatter, or in channels when the calculated (design) shear stress is 2.0 lbs/ft² or less. Only 100 percent organic fibers allowed. Woven mats

are allowed with a maximum opening of 1/2-inch. Recommended for use in environmentally sensitive areas that have a high probability of entrapping animals in plastic netting.

4. Documentation of materials used, monitoring logs, project diary, and weekly inspection forms including erosion and stormwater management plans, should be submitted to Engineer.
5. Use U-shaped wire staples, metal pins or wooden stakes to anchor mats and blankets to ground surface.
6. Staples shall be made of 0.12 inch steel wire and shall be U-shaped with 8-inch legs and 2-inch crown.
7. Wire staples shall be minimum of 11 gauge.
8. Metal stake pins shall be 0.188-inch diameter steel with a 1.5 inch steel washer at head of pin.
9. Staples or stakes shall be driven flush to soil surface.
10. Anchors shall have sufficient ground penetration to resist pullout by wind.
11. Loose soils may require longer anchors.

B. Silt Fence: (WDNR – CPS 1056)
1. Provide temporary silt fencing designed to intercept and slow the flow of sediment-laden sheet flow runoff from areas of disturbed soil.
2. Fence Geotextile Fabric:
   a. Geotextile fabric shall consist of either woven or non-woven polyester, polypropylene, stabilized nylon, polyethylene or polyvinylidene chloride.
   b. Non-woven fabric may be needle punched, heat bonded, resin bonded of a combination of.
   c. All silt fence geotextile fabric shall meet the following requirements;

Test Requirement	Method	Value
Minimum Grab Tensile Strength In the Machine Direction	ASTM D4632	120 lbs.
Minimum Grab Tensile Strength In the Cross Machine Direction	ASTM D4632	100 lbs.
Maximum Apparent Opening Size Equivalent (Standard Sieve)	ASTM D4751	No. 30
Minimum Permittivity	ASTM D4491	0.05 scc^{-4}
Minimum Ultraviolet Stability Percent of Strength Retained after 500 Hours of Exposure.	ASTM D 4355	70%

   d. Silt fence shall have a maximum flow rate of 10 gallons/minute/square foot at 50mm constant head as determined by multiplying permittivity in 1/second as determined by ASTM D4491 by a conversion factor of 74.
3. Silt Fence Supports: Silt fences shall be supported by either steel or wood supports specified as follows;

a. Steel Supports:
   1) The full height of the silt fence shall be supported by steel posts at least 5 feet long with a strength of 1.33 pounds per foot and have projections for the attachment of fasteners.
b. Wood Supports:
   1) The full height of the silt fence shall be supported by 1-1/8 inch by 1-1/8-inches air or kiln-dried posts of hickory or oak.

C. Stone Tracking Pad and Tire Washing: (WDNR – CPS 1057)
1. Tracking Pad:
   a. Tracking pad shall be installed prior to any construction traffic leaving the site.
   b. Aggregate for tracking pads shall be 3 to 6 inch clear or washed stone. All material to be retained in a 3-inch sieve.
2. Tire Washing:
   a. Tire wash rack shall consist of a heavy grating over a lowered area. The rack shall be strong enough to support the vehicles that will cross it.

D. Storm Drain Inlet Protection for Construction Sites: (WDNR – CPS 1060)
1. Inlet protection products are intended to intercept, pond and filter sediment-laden runoff. Protection systems include geotextile fabric and fabric hold-down systems.
2. Materials:
   a. Fabric Material: Type FF, Woven polypropylene.
   b. Physical Properties:

Test	Method	Value[1]
Grab Tensile Strength, (lb.)	ASTM D4632	200 lbs
Puncture Strength, (lb.)	ASTM D4833	105 lbs (Min.)
Apparent Breaking Elongation Machine Direction, %	ASTM D4632	24 (Min.)
Apparent Breaking Elongation Cross Direction, %	ASTM D4632	10 (Min.)
Apparent Opening Size	ASTM D4751	600 (Max.)
Permittivity	ASTM D4491	1.9 (Min.)

(1) All numerical values represent minimum/maximum average roll values (i.e., the average of minimum test results on any roll in a lot should meet or exceed the minimum specified values).

3. Contractor shall have the responsibility of providing identification of the fabric supplied for inlet protection units. Types of inlet protection systems include the following;
   a. Type A, shall be utilized around field inlets until permanent stabilization methods have been established. Type A inlet protection shall be utilized on pavement inlets prior to installation of curb and gutter or pavement.
   b. Type B, shall be utilized on street inlets without curb head, once surrounding surfaces are in place.
   c. Type C, shall be utilized on street inlets with curb heads. Provide a 2 inch x 4 inch minimum, piece of wood and wrap and attach fabric to wood. Place wood blocking and fabric over inlet with wood straddling inlet opening a minimum of 8 inches in each direction. Secure 2 x 4 inch board to grate with wire or plastic ties. Verify and secure

wood blocking to rest on inlet grate and that fabric covers remaining curb head opening. Wood blocking shall not block entire inlet curb opening.

4. Manufactured bags, such as sand bags used as inlet protection devices shall conform the following minimum criteria:
   a. Minimum Size = 14 x 26 inches.
   b. Grab Tensile Strength of Fabric (ASTM D4632) = 95 lbs. minimum.
   c. UV Stability (ASTM D4355) = 70 percent minimum.
   Note: To provide sufficient strength, fabric shall be sewn together with double stitching.

E. Dust Control on Construction Sites: (WDNR – CPS 1068)
   1. Provide one of or a combination of one of the following dust control practices for the duration of the project or until site is fully vegetated or paved.
      a. Asphalt and petroleum-based products shall not be used for project dust control.
      b. Provide mulch or seed and mulch to protect exposed site soil from both wind and water erosion. Reference WDNR – CPS 1058 and 1059 specified previously in this section.
      c. Provide water applications until surface is wet and repeat as necessary. Water shall be applied so it does not cause runoff.
      d. Provide tilling of soil with chisel type plows on exposed soils. Tillage shall be utilized only on flat areas of the project site.
      e. Provide tackifiers and soil stabilizers, Type A – Products shall be selected from and installed at rates in accordance with WisDOT Erosion Control PAL.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Non-Channel Erosion Matting: (WDNR CPS 1052 and 1053)
   1. Install erosion mats and blankets in accordance with manufacturer's instructions.
   2. ECRMs shall be installed after all topsoiling, fertilizing, liming and seeding are complete.
   3. Erosion matting shall extend for whichever is greater:
      a. Upslope one foot minimum vertically from the ditch bottom; or 6 inches higher than the design flow depth.
   4. Matting shall be in firm and intimate contact with the soil. Matting shall anchored in accordance with matting manufacturer’s written instructions.
   5. TRM shall be installed in conjunction with the topsoiling operation and shall be followed by ECRM installation.

B. Silt Fence: (WDNR – CPS 1056)
   1. When silt fence is installed as a stand-alone practice on a slope, silt fence shall be placed on the contour.
   2. The parallel spacing shall not exceed the maximum slope lengths for the appropriate slope as follows:

Slope	Fence Spacing
<2%	100 feet
2 to 5%	75 feet
5 to 10%	50 feet
10 to 33%	25 feet
>33%	20 feet

3. Silt fences shall not be placed perpendicular to the contour.
4. The ends of the silt fence shall be extended upslope to prevent water from flowing around the ends of the fence.
5. Installed silt fences shall be a minimum 14 inches high and shall not exceed 28 inches in height measured from the installed ground elevation.
6. Steel Supports:
    a. The full height of the silt fence shall be supported by steel posts at least 5 feet long with a strength of 1.33 pounds per foot and have projections for the attachment of fasteners.
    b. Silt fence shall be attached in at least 3 places on the support, on the upslope side with 50 pound plastic tie straps or wire fasteners.
    c. To prevent damage to the fabric from wire fastener, the protruding ends shall be pointed away from fabric.
7. Wood Supports:
    a. The full height of the silt fence shall be supported by 1-1/8 inch by 1-1/8-inches air or kiln-dried posts of hickory or oak.
    b. Silt fence fabric shall be stapled, using at least 0.5-inch staples, to the upslope side of the posts in at least 3 places.
    c. Wood posts shall be a minimum of 3 feet long for 24-inch high silt fence, and a minimum of 4 feet for 36-inch silt fence fabric.
8. The maximum spacing of posts for non-woven silt fence shall be 3 feet and for woven fabric, 8 feet.
9. Silt fence shall have a support cord.
10. Where joints are required to join the ends of fabric, each end of the fabric shall be securely fastened to a post. Posts shall then be wrapped around each other to produce a stable, secure joint or shall be overlapped the distance between two posts.
11. A minimum of 20 inches of the post shall extend into the ground after installation.
12. Silt fence shall be anchored by spreading at least 8 inches of the fabric in a 4-inch wide by 6-inch deep trench, or 6-inch deep V-trench on the upslope side of the fence.
13. Backfill anchoring trench and compact.
14. On the terminal ends of silt fence the fabric shall be wrapped around the post such that the staples are not visible.
15. Silt fencing shall at a minimum be inspected by the Contractor weekly and within 24 hours after every rain event that produces 1/2-inch of rain or more during a 24-hour period.
16. Damaged or decomposed fences, undercutting, or flow channels around the ends of silt fencing shall be repaired immediately after discovery.
17. Silt fencing and all accessories shall be removed completely once the disturbed area is permanently stabilized and no longer susceptible to erosion.

C. Stone Tracking Pad and Tire Washing: (WDNR – CPS 1057)
1. Tracking Pad:
    a. Tracking pad shall be installed prior to any traffic leaving the site.
    b. Aggregate shall be placed in a layer at least 12 inches thick. Contractor shall supplement additional aggregate over life of project for repair or replenish aggregate to maintain functional tracking pad as specified.
    c. For sites with high water tables, or where saturated conditions are expected throughout the duration of the project, stone tracking pads shall be underlain with a WisDOT Type R Geotextile Fabric to prevent migration of underlying soil into the stone.
    d. Tracking pad shall be the full width of the egress point and a minimum 50 feet long.

e. Contractor shall prevent surface water from passing through the tracking pad.
f. Surface water flow shall be diverted away from tracking pads or conveyed under and around the tracking pad by Contractor's selected method of conveyance or diversion.

2. Tire Washing:
   a. If tracking pad does not remove sediment from tires prior to entering roads or streets, Contractor shall provide pressurized water removal operation to wash tires clean prior to entering streets or roads.
   b. Rocks lodged between the tires of dual wheel vehicles shall be removed prior to leaving the construction site.

D. Storm Drain Inlet Protection for Construction Sites: (WDNR – CPS 1060)
1. Inlet protection devices are for drainage areas of one acre or less. Runoff from areas larger than one acre should be routed through a designed sediment trapping or settling practice upstream of the inlet.
2. Type A, shall be utilized around field inlets until permanent stabilization methods have been established. Type A inlet protection shall be utilized on pavement inlets prior to installation of curb and gutter or pavement.
3. Type B, shall be utilized on street inlets without curb head, once surrounding surfaces are in place.
4. Type C, shall be utilized on street inlets with curb heads. Provide a 2 inch x 4 inch minimum, piece of wood and wrap and attach fabric to wood. Place wood blocking and fabric over inlet with wood straddling inlet opening a minimum of 8 inches in each direction. Secure 2 x 4 inch board to grate with wire or plastic ties. Verify and secure wood blocking to rest on inlet grate and that fabric covers remaining curb head opening. Wood blocking shall not block entire inlet curb opening.
5. For all inlet protection devices ponding water to settle sediment is encouraged, however ponding shall not interfere with the flow of traffic, create a safety hazard, or cause property damage.
6. All inlet protection devices shall have provisions such as weep holes or emergency spillways to safely pass water if inlet protection device becomes clogged.
7. Other than the Type D inlet protection device, no gaps shall be left in the material used that would allow the flow of water to bypass the inlet protection device.
8. Manufactured bags used for inlet protection shall be installed along a level contour. Turn ends of sandbag row up slope to prevent flow around ends.
9. Stack sandbags to required height. Upper rows of sandbags shall overlap joints in lower rows.
10. Construct sandbag barriers with a setback of at least 3 feet from toe of slope. Where it is determined to be not practicable due to specific site conditions, sandbag barrier may be constructed at toe of slope, but shall be constructed as far from toe of slope as practicable.

E. Dust Control on Construction Sites: (WDNR – CPS 1068)
1. Provide one of or a combination of one of the following dust control practices for the duration of the project or until site is fully vegetated or paved.
   a. Asphalt and petroleum-based products shall not be used for project dust control.
   b. Provide mulch or seed and mulch to protect exposed site soil from both wind and water erosion. Reference WDNR – CPS 1058 and 1059 specified previously in this section.
   c. Provide water applications until surface is wet and repeat as necessary. Water shall be applied so it does not cause runoff.

d. Provide tilling of soil with chisel type plows on exposed soils. Tillage shall be utilized only on flat areas of the project site.
e. Provide tackifiers and soil stabilizers, Type A – Products shall be selected from and installed at rates in accordance with WisDOT Erosion Control PAL.

3.2 MAINTENANCE

A. Inspect erosion control devices within 24 hours after each rainfall or daily during periods of prolonged rainfall.

B. Repair or replace damaged or defective materials or installation immediately.

C. Remove sediment deposits within 24 hours after each storm event or when deposits reach one-half height of fence or barrier, whichever occurs first.

D. Apply replacement bales or additional mulch, netting, or matting immediately to maintain suitable cover.

E. Where vegetative cover has been placed, inspect until vegetative cover is established and functioning as intended.

3.3 REMOVAL OF EROSION CONTROL DEVICES

A. Maintain erosion control measures disturbed earth has been paved or vegetated.

B. Remove erosion control devices prior to final inspection and acceptance of Project site by Owner.

C. Restore or replace areas disturbed or damaged by removal of erosion control devices to satisfaction of Engineer.

END OF SECTION

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SECTION 31 62 16

STEEL PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rolled steel section piles.

B. Related Sections:
1. Section 02 32 00 – Geotechnical Investigation.
2. Section 03 31 00 - Structural Concrete: Concrete requirements for placement of pile caps and grade beams.
3. Section 31 05 16 - Aggregates for Earthwork.
4. Section 31 09 16 - Pile Load Tests: Requirements for pile load tests.
5. Section 31 22 13 - Rough Grading.
6. Section 31 23 15- Excavation, Backfill, and Compaction for Buildings and Structures: Excavating for pile work.
7. Section 31 23 17 - Site Excavation, Backfill, and Compaction: Excavating for pile work.

1.2 UNIT PRICES - MEASUREMENT AND PAYMENT

A. Actual Piles:
1. Actual Pile Quantity: Determined by number of piles identified in Project Record Documents.
2. Actual Pile Length: Determined by length of piles identified in Project Record Documents.

1.3 REFERENCES

A. ASTM International (ASTM):
1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A572 - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
3. ASTM A588 - Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4-in. (100-mm) Thick.
4. ASTM A690 - Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments.
5. ASTM A913 - Standard Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process (QST).
6. ASTM A992 - Standard Specification for Structural Steel Shapes.

B. American Welding Society (AWS):
1. AWS D1.1 - Structural Welding Code - Steel.
2. AWS D1.5 - Bridge Welding Code.

C. SSPC: The Society for Protective Coatings (SSPC):

1. SSPC PA 2 - Measurement of Dry Coating Thickness with Magnetic Gages.
2. SSPC SP 5 - White Metal Blast Cleaning.

1.4 PERFORMANCE REQUIREMENTS

A. Provide Pile Dynamic Analysis (PDA) to confirm pile capacities during driving of test piles.

B. Drive piles to defined load supporting capacity. Refer to Geotechnical Investigation Report for further information.

1.5 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. PDA testing report confirming that 2.5 factor of safety for pile design. Report shall be stamped by a Professional Engineer licensed in Wisconsin.

C. Shop Drawings: Indicate details and schedule of pile installation sequence. Identify recommended pile length and shapes to suit design loads.

D. Product Data: Submit details of collars, tips, splices, and cushion blocks.

E. Manufacturer's Mill Certificate: Certify steel casings, reinforcement, meets or exceeds specified requirements.

1.6 SUSTAINABLE DESIGN SUBMITTALS

A. Division 01 – General Requirements: Requirements for sustainable design submittals.

B. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.
   1. Materials Resources Certificates:
      a. Certify recycled material content for recycled content products.
      b. Certify source for regional materials and distance from Project site.

C. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.
   1. Provide cost data for the following products:
      a. Products with recycled material content.
      b. Regional products.

1.7 CLOSEOUT SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Project Record Documents: Accurately record the following:
   1. Sizes, lengths, and locations of piles.
   2. Sequence of driving.
   3. Number of blows per foot for entire length of piles and measured set for last 10 blows.
   4. Identify piles requiring drilling, and hole diameters.

5. Final base and top elevations.
6. Driving force of each hammer blow.

1.8 QUALIFICATIONS

A. PDA Testing: Company specializing in performing work of this section with minimum five (5) years documented experience.

B. Monitor pile driving operations by Geotechnical Engineer, hired by Contractor, experienced in this Work and licensed in the State of Wisconsin.

C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.9 PRE-INSTALLATION MEETINGS

A. Division 01 – General Requirements: Pre-installation meeting.

B. Convene minimum one (1) week prior to commencing Work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Division 01 – General Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Protect shop coated piles from damage to applied coating. Use nylon slings to handle coated piles.

1.11 SCHEDULING

A. Schedule Work to perform driving per City of Madison requirements.

B. Complete test piles and PDA testing prior to ordering pile materials.

C. Do not drive piles until excavation or filling of area surrounding piles is completed to design grades indicated on Drawings.

D. Do not drive piles until mud-line is clear of debris or other material interfering with pile driving.

E. When concrete is less than seven days old, do not drive piles closer to concrete than distance computed by formula below.

D = 1/7 \/E
Where:
E = Energy of pile hammer in foot-pounds
D = Distance in feet

F. Do not drive piles within 20’ of ATC conduit without exposing conduit.

PART 2 - PRODUCTS

2.1 MATERIALS

A. 40 Ton Piles: ASTM A572; structural steel, rolled HP 10X42 sections, minimum 50 ksi yield strength; sizes and lengths as required to achieve design loads.

B. 90 Ton Piles: ASTM A252; structural steel, oil field pipe sections, grade 3 minimum 85 ksi yield strength; sizes and lengths as required to achieve design loads.

C. Accessories: Points, driving cap; to suit pile shape.

2.2 SUSTAINABILITY CHARACTERISTICS

A. Division 01 – General Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:
1. Recycled Content Materials: Furnish materials with maximum available recycled content.
2. Regional Materials: Furnish materials extracted, processed, and manufactured within 500 miles of Project site.

2.3 SOURCE QUALITY CONTROL

A. Division 01 – General Requirements: Testing, inspection and analysis requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Division 01 – General Requirements: Verification of existing conditions before starting work.

3.2 PREPARATION

A. Obtain prior approval of hammer type to be used.

B. Use driving method which will not cause damage to nearby structures.

C. Notify adjacent and affected land owners and building occupants notice before proceeding with the Work.

D. Protect structures including overhead and buried utilities near the Work, from damage.

E. Prepare to place piles from excavated working elevation.

3.3 PILE HAMMER

A. Use pile hammer complying with requirements indicated on Drawings.

B. Keep hammer in good mechanical condition.

C. Operate hammer at speed and pressure recommended by manufacturer.

D. During pile driving operations, Owner's Representative may make occasional measurements of velocity of hammer ram. Furnish Hammer Performance Analyzer (radar gun device), as manufactured by Pile Dynamics, Inc., or approved equal, for Owner's Representative's use.

E. When energy per blow is less than 80 percent of rated energy per blow as specified by manufacturer of pile hammer, make necessary repairs to improve energy output to value of at least 80 percent of rated energy per blow, or replace pile hammer.

3.4 INSTALLATION

A. Drive piles only in presence of Owner's Representative.

B. Install pipe pile end plates.

C. Use rigid frame, fixed lead type driving equipment capable of supporting pile firmly in vertical position or to required batter.

D. Align top of pile normal to driving force of pile, hammer and leads to minimize bowing of pile during impact of hammer ram.

E. Where groups of piles are required, drive center pile of group first and then drive remaining piles in group progressing outward from center.

F. Drive piles to minimum tip penetration and to driving resistance indicated on Drawings. Take corrective action, when required, to prevent observable impact bowing of pile at final driving resistance.

G. When driving resistance prohibits advancing pile to required minimum tip penetration, spud, jet, jet and drive, or use other means as necessary to advance pile to required minimum tip penetration. Then drive pile to required resistance indicated on Drawings. After jetting pile, re-drive adjacent piles to required resistance.

H. Pre-drilling or pre-augering hole of maximum diameter two (2) inches smaller than pile flange dimension may be used to advance pile to penetration no deeper than required minimum tip penetration. Then drive pile to required resistance indicated on Drawings. In granular soils below ground water level, stabilize hole by use of drilling fluids.

I. Protect pile head during driving, using cap-block cushion consisting of alternate plates of phenolic laminate and aluminum designed to prevent damage to piles while transmitting required hammer energy to pile top as indicated on Drawings, with full bearing on pile butt for even distribution of hammer blow.

J. Deliver hammer blows to central axis of pile.

K. When driving is interrupted before refusal, drive an additional 12 inches before resuming recording of performance data.

L. Re-drive piles which have lifted due to driving adjacent piles, or by soil uplift.

M. Do not damage piles during driving operations.

N. Cut off tops of piles to elevations indicated and prepare pile top to receive pile caps and grade beams.

O. Fill pipe piles with concrete.

3.5 WELDING AND SPLICING

A. Perform welding in accordance with AWS D1.1 for shielded metal arc welding.

B. Only use welders qualified in accordance with AWS D1.1.

C. Reinforce pile tips, as indicated on Drawings.

D. Splice pile sections with one of the following:
1. Complete penetration butt weld of flanges and web.
2. Splicer sleeve with flanges welded with full penetration groove welds.

E. Use jig or alignment device during welding to maintain required specified.

F. For splices made during pile installation, rigid frame pile leads may be used as jig.

G. Use only butt weld splices within 20 feet from pile cut-off elevation or design grade, whichever is lower.

H. Comply with the following for number, type and location of splices:
1. No more than three splices for piles over 100 feet long.
2. No more than two splices for piles up to 100 feet long.
3. No splice closer than 25 feet from tip.

3.6 ERECTION TOLERANCES

A. Division 01 – General Requirements: Tolerances.

B. Maximum Variation from Vertical for Plumb Piles: 1 in 48.

C. Maximum Variation from Required Angle for Batter Piles: 1 in 24.

D. Maximum Variation from Pile Cut-Off Elevation: Four (4) inches.

E. Maximum Out-of-Position: Two (2) inches.

F. Maximum Variation in Centerline after Splicing: 3/8 inch in 40 feet for undriven portion.

3.7 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform inspection of foundations in accordance with applicable code.

C. Test Piles: Same diameter and type as specified for other piling, placed in same manner.

D. Accepted test piles may be used in the Work.

E. Unacceptable Piles: Piles that fail tests, are placed out of position, are below cut-off elevations, or are damaged.

F. Provide additional piles or replace piles to conform to specified requirements.

END OF SECTION

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SECTION 31 63 36

RAMMED AGGREGATE PIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Designing, furnishing, and installing aggregate pier elements to lines and grades designated on Drawings and as specified.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 02 32 00 – Geotechnical Investigation.
3. Section 31 05 16 - Aggregates for Earthworks: Aggregate backfill materials.
4. Section 31 10 00 – Site Clearing.
5. Section 31 23 15 – Excavation, Backfill, and Compaction for Buildings and Structures.
6. [Section 31 23 19 – Construction Site Dewatering.] [Section 31 23 22 – Site Dewatering.]
7. Section 31 62 16 – Steel Piles.

1.2 REFERENCES

A. American Society of Civil Engineers (ASCE):
1. Control of Settlement and Uplift of Structures Using Short Aggregate Piers. ASCE. Proceedings of In-Situ Deep Soil Improvement, ASCE National Convention, Atlanta, GA, 1994.
2. Settlement of Structures Supported on Marginal or Inadequate Soils Stiffened with Short Aggregate Piers, American Society of Civil Engineers, 2, 962-74.
3. ASCE Geotechnical Special Publication No. 40 - Vertical and Horizontal Deformations of Foundations and Embankments.

B. ASTM International (ASTM):
1. ASTM D422 – Test Method for Particle-Size Analysis of Soils.
2. ASTM D1143 – Test Methods for Deep Foundations Under Static Axial Compressive Load.
3. ASTM D1241 – Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses.
4. ASTM D3441 - Test Method for Mechanical Cone Penetration Tests of Soil.
5. ASTM-D3689 – Test Methods for Deep Foundations Under Static Axial Tensile Load.

C. Geopier Foundation Company (GFC):
1. Geopier Reference Manual.
2. Technical Bulletin No. 1 - Behavior of Geopier-Supported Foundation Systems During Seismic Events.
3. Technical bulletin No. 2 - Bearing Capacity of Geopier-Supported Foundation Systems.
4. Technical Bulletin No. 3 - Geopier® Uplift Resistance.
5. Technical bulleting No. 4 - Geopier® Lateral Resistance.

6. Technical Bulletin No 5 - Geopier® Shear Reinforcement for Global Stability and Slope Stability.
7. Technical Bulletin No. 0 – Structural Design Considerations for Uniformly Loaded Floor Slabs Supported by Rammed Aggregate Piers.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Installer shall submit one (1) set of detailed design calculations, FEA of slab on grade design, proposed construction drawings, and shop drawings for approval at least two (2) week(s) prior to beginning of construction.

C. A detailed explanation of design parameters for settlement calculations shall be included in design submittal.

D. Additionally, quality control test program for aggregate piers, meeting these design requirements, shall be submitted.

E. Computer-generated calculations and drawings shall be prepared and sealed by a Professional Engineer licensed in State of Wisconsin.

F. Aggregate pier Design Engineer shall have Errors and Omissions design insurance for the Work. Insurance policy should provide a minimum coverage of $2 million per occurrence.

G. Modulus and Uplift Test Data:
1. Installer shall furnish Contractor a description of installation equipment, installation records, complete test data, analysis of test data, and recommended design parameter values based on modulus test results.
2. Report shall be prepared under supervision of a licensed Professional Engineer licensed in State of Wisconsin.

H. Daily Aggregate Pier Progress Reports:
1. Installer shall furnish a complete and accurate record of aggregate pier installation to Contractor.
2. Record shall indicate pier location, length, average lift thickness, and final elevations of base and top of piers.
3. Record shall also indicate type and size of densification equipment used. Installer shall immediately report any unusual conditions encountered during installation to Contractor, Designer, and Testing Agency.

1.4 QUALITY CONTROL

A. Installer shall have a full-time Quality Control (QC) representative to verify and report QC installation procedures.

B. Installer shall immediately report any unusual conditions encountered during installation to Owner’s Representative, Contractor, and Testing Agency. QC procedures shall include preparation of Aggregate Pier Progress Reports completed during each day of installation and containing the following information:

1. Footing and aggregate pier location.
2. Aggregate pier length and drilled diameter.
3. Planned and actual aggregate pier elevations at top and bottom of element.
4. Average lift thickness for each aggregate pier.
5. Soil types encountered at bottom of aggregate pier and along length of element.
6. Depth to groundwater, if encountered.
7. Documentation of any unusual conditions encountered.
8. Type and size of densification equipment used.

C. Independent Engineering Testing Agency:
   1. Contractor shall retain an independent engineering testing agency to provide Quality Assurance services. Testing agency shall be Geotechnical Engineer of Record.
   2. Responsibilities of Independent Engineering Testing agency:
      a. Testing agency shall monitor modulus and uplift test(s) when modulus or uplift test(s) are to be performed. Installer shall provide and install dial indicators and other measuring devices.
      b. Testing agency shall monitor installation of aggregate pier elements to verify that production installation practices are similar to those used during installation of modulus test elements.
      c. Testing agency shall perform Dynamic Cone Penetrometer tests as described herein.
      d. Testing agency shall report any discrepancies to Installer and Contractor immediately.

1.5 QUALIFICATIONS

A. Installers of aggregate pier foundation systems shall have a minimum of five (5) years of experience with installation of aggregate piers and shall have completed at least 50 projects.

B. Aggregate pier Installer shall be approved by Owner's Representative and must be approved two weeks prior to bid opening.

C. Installer shall adhere to methods and standards described in this Specification.

PART 2 - PRODUCTS

2.1 AGGREGATE PIER DESIGN

A. Design aggregate pier elements to support slab on grade without cracking.

B. Design aggregate piers for live loading as shown on plans and dead load of slab on grade.

C. Verify stiffness modulus value by results of aggregate pier modulus test, described in this Section.

D. Design aggregate piers in accordance with accepted engineering practice and methods described in these Specifications.

E. Design shall meet the following criteria:
   1. Maximum Allowable Bearing Pressure for Aggregate Pier Reinforced Soils: 6,000 psf.

2. Minimum Aggregate Pier Area Coverage (for Square Spread Footings): Greater than 30 percent.
3. Minimum FS = 1.5 Against Tensile Failure (Modulus of Rupture for Unreinforced Slab)
4. Estimated Total Long-Term Settlement for Footings: Less than 1-inch.
5. Estimated Long-Term Differential Settlement of Adjacent Footings: Less than 1/2-inch.

F. Design shall consider bearing capacity and settlement of footings supported by aggregate piers, and shall be in accordance with acceptable engineering practice and these specifications.

G. Consider total and differential settlement. Structure design life shall be 75 years.

H. Design aggregate pier system to preclude plastic bulging deformations at top-of pier design stress and to preclude significant tip stresses as determined from shape of telltale test curve from telltales installed in modulus test piers.

I. Use results of modulus test to verify design assumptions.

J. Aggregate pier Installer shall demonstrate that aggregate pier system has been evaluated by International Code Council.

2.2 SLAB ON GRADE DESIGN

A. Design per design loads shown on drawing.

B. Design shall use Finite Element Analysis.

2.3 MATERIALS

A. Aggregate used for piers constructed above water table shall be Type I, Grade B, in accordance with ASTM D1241, or shall be other graded aggregate selected by Installer and successfully used in modulus test.

B. It shall be compacted to a densification and strength, which provides resistance to dynamic penetration test, ASTM D3441, of a minimum average of 15 blows per 1.75-inch vertical movement.

C. Aggregate used for piers constructed below water table shall be same gradation as Type I, Gradation B, except that particles passing No. 40 sieve shall be eliminated.

D. Alternatively, No. 57 stone or other stone selected by aggregate pier installer may be used. Dynamic penetration resistance testing is inappropriate for this material.

E. Use potable water or other suitable source to increase aggregate moisture content where required. Contractor shall provide such water to Installer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Contractor shall locate and protect underground and aboveground utilities and other structures from damage during installation of aggregate pier elements.

B. Fully expose ATC conduit prior to installing rammed aggregate piers within 20’ of conduit.

C. Contractor will provide site to Installer, after earthwork in area has been completed.

D. Contractor shall establish site subgrade within six (6) inches of final design subgrade, as approved by Design Engineer.

E. Contractor shall establish and maintain a working surface to provide wet weather protection of subgrade and to provide access for efficient operation of aggregate pier installation.

F. Contractor shall provide layout, construction staking, of aggregate piers.

G. Contractor shall provide ground elevations in sufficient detail to estimate drilling depth elevations to within two (2) inches.

H. Contractor shall provide adequate and suitable marshalling areas on Project site for use by Installer for storage of aggregate and equipment.

3.2 EXCAVATION

A. Pre-auger aggregate pier elements using mechanical drilling or excavation equipment. Installation of piers without pre-augering shall not be allowed because this technique results in significant disturbance and remolding of matrix soils surrounding piers.

B. If cave-ins occur during excavation such that sidewalls of hole are deemed to be unstable, use steel casing or drilling slurry to stabilize excavation.

C. If cave-ins occur on top of a lift of aggregate such that volume of caved soils is greater than 10 percent of volume of aggregate in lift, then aggregate shall be considered contaminated and shall be removed and replaced with uncontaminated aggregate.

D. Should any obstruction be encountered during drilling or excavation for aggregate piers, Contractor shall be responsible for removing such obstruction, relocating pier, or abandoning pier.

E. Obstructions include, but are not limited to, boulders, timbers, concrete, bricks, and utility lines, that prevent installing aggregate piers to required depth, or cause aggregate pier to drift from required locations.

F. Dense natural rock or weathered rock shall not be deemed obstructions, and piers may be terminated short of design lengths on such materials.

G. If Contractor cannot or does not remove such obstructions within one hour from time Installer reports obstruction to Contractor, Installer may remove such obstructions with his own forces.

H. Should this occur, Installer shall receive an extra to the Contract to account for their additional expenses, including delay time involved to crew and equipment.

3.3 AGGREGATE PIER INSTALLATION

A. Densification:
1. Employ special high-energy impact densification apparatus to densify aggregate pier elements during installation. Apparatus shall apply direct downward impact energy to each lift of aggregate.
2. Energy source shall apply a minimum tamper energy level of 2,000 foot-pounds of force per minute.
3. Densify bottom of excavation prior to placement of aggregate. If wet, soft or sensitive soils are present, place open-graded aggregate, such as No. 57 stone or other, at bottom of excavation and compact to stabilize element bottom and may serve as initial lift.
4. Perform densification using a beveled tamper. Beveled tamper foot is required to adequately increase lateral earth pressure in matrix soil during installation.

B. Apply downward pressure to tamper shaft during tamping.

C. Tamp each lift of aggregate for a minimum of 10 seconds.

3.4 FOOTING BOTTOMS

A. Excavation and surface compaction of footings shall be responsibility of Contractor.

B. Foundation excavations to expose tops of aggregate pier elements shall be made and shall be protected until concrete placement, with procedures and equipment best suited to:
1. Prevent softening of matrix soil between and around aggregate pier elements before pouring structural concrete.
2. Achieving direct and firm contact between dense, undisturbed aggregate pier elements and concrete footing.

C. Recommended procedures for achieving these goals are to:
1. Limit over-excavation below bottom of footing to three (3) inches, including disturbance from teeth of excavation equipment.
2. Prepare compaction of surface soil and top of aggregate pier elements using a motorized impact compactor, Wacker Packer, Jumping Jack, or similar.
3. Sled-type tamping devices shall not be used.
4. Compaction shall be performed over entire footing bottom to compact any loose surface soil and loose surface pier aggregate.
5. Place footing concrete immediately after footing excavation is made and approved, preferably same day as excavation.
6. Footing concrete must be placed on same day if footing is bearing on expansive or sensitive soils.
7. If same day placement of footing concrete is not possible, place a minimum three (3) inch thick lean concrete seal, mud mat, immediately after footing is excavated and approved.

D. The following criteria shall apply, and a written inspection report sealed by project Geotechnical Engineer shall be furnished to Installer to confirm that:
   1. Water, which may soften unconfined matrix soil between and around aggregate pier elements, and may have detrimental effects on supporting capability of aggregate pier reinforced subgrade, has not been allowed to pond in footing excavation at any time.
   2. Aggregate pier elements designed for each footing have been exposed in footing excavation.
   3. Immediately before footing construction, tops of aggregate pier elements exposed in each footing excavation have been inspected and re-compacted as necessary with mechanical compaction equipment, and that tops of any aggregate pier elements which may have been disturbed by footing excavation and related activity have been re-compacted to a dry density equivalent to at least 95 percent of modified Proctor density.
   4. No excavations or drilled shafts have been made after installation of aggregate pier elements within horizontal distance of five feet from edge of any pier without written approval of Installer or Designer.

E. Failure to provide above inspection and certification by Project Geotechnical Engineer, which are beyond responsibility of aggregate pier Installer, may void any written or implied warranty on performance of aggregate pier system.

3.5 TESTING

A. Modulus Test:
   1. Perform modulus test to verify parameter values selected for design.
   2. Modulus tests shall be of type and installed in a manner specified.
   3. Install a telltale at bottom of test pier to determine bottom-of pier deflections. Acceptable performance is indicated when bottom of pier deflection is no more than 20 percent of top of pier deflection at design stress level.
   4. Use ASTM D1143 general test procedures as a guide to establishing load increments, load increment duration, and load decrements.
   5. With the exception of load increment representing approximately 115 percent of design maximum top of aggregate pier stress, hold load increments for a minimum of 15 minutes, a maximum of 1 hour, and until rate of deflection reduces to 0.01 inch per hour, or less.
   6. Hold load increment that represents approximately 115 percent of design maximum stress on aggregate pier for a minimum of 15 minutes, a maximum of four (4) hours, and until rate of deflection reduces to 0.01 inches per hour or less.
   7. Apply a seating load equal to five (5) percent of total load to loaded steel plate prior to application of load increments and prior to measurement of deflections to compensate for surficial disturbance.
   8. Perform aggregate pier modulus testing in accordance with requirements outlined in Design Submittal.
   9. Coordinate location of aggregate pier modulus test with project Geotechnical Engineer of record.

B. Uplift Load Test:
   1. Conduct Uplift Load Test in general accordance with ASTM D3687, as appropriate and except as modified herein.
   2. Perform uplift aggregate-pier testing in accordance with requirements outlined in Design Submittal.
   3. Coordinate location of uplift load test project Geotechnical Engineer of record.

4. Use uplift load test information to verify that aggregate-pier system design is consistent with behavior exhibited during uplift load test.

C. Bottom Stabilization Verification Test:
1. After completion of bottom pier bulb, or at any time during process of constructing pier, energy source may be turned off, and bottom stabilization verification test may be performed.
2. Perform these tests when a new soil formation is encountered, or at beginning of a project to provide quantitative information on pier stabilization.
3. Perform Bottom Stabilization Tests by placing a reference bar over cavity, marking tamper shaft, applying energy to tamper for an additional 15 seconds, and observing downward deflection of tamper shaft by observing deflection of mark on tamper shaft.
4. Acceptable performance is indicated if vertical movement of shaft is less than 150 percent of vertical movement measured for modulus test pier.
5. If measured vertical movement exceeds 150 percent of value achieved during modulus test, apply added energy to re-densify bulb and then repeat procedure for measure.
6. If there is still movement greater than 150 percent of that achieved during modulus test and greater than 1/2-inch, a lift of loose aggregate may be placed on top of compacted aggregate, and verification test may be performed on this next lift after it is densified.
7. If there is excessive movement on this lift, another lift may be placed and tested. Movement must be limited to below 150 percent of values achieved for modulus test before completion of 2/3 of pier depth.

D. Dynamic Cone Penetrometer Test:
1. Test aggregate pier elements by Dynamic Cone Penetrometer method, ASTM D3441, at locations within upper 1/3 of pier shaft length.
2. Minimum acceptable criteria as an indicator of acceptable densification shall be at least 15 blows per 1-3/4-inch penetration.
3. Perform Dynamic Cone Penetrometer testing in each aggregate pier until such time as five (5) consecutive tests indicate that minimum criterion is met.
4. Thereafter, such tests need not be performed on every pier, provided that aggregate used in elements is representative of that previously tested.
5. If average penetration resistances measured exceed 15 blows, and less than 10 percent of tests fall below 15 blows, then testing may be reduced to spot checks. A pattern of successful tests is sufficient to reduce testing to several tests per day.
6. Observation of questionable aggregate moisture content or questionable aggregate gradation appearance may determine need for additional dynamic penetration testing to verify that proper densification is being achieved.
7. Use of Dynamic Cone Penetrometer is not appropriate for use on open-graded aggregate such as No. 57 stone.

3.6 TOLERANCES

A. Center of each pier shall be within six (6) inches of locations indicated in Drawings.

B. Final measurement of top of piers shall be lowest point on aggregate in last compacted lift.

C. Rebuild piers installed outside of above tolerances and deemed not acceptable at no additional expense to Owner, unless mislocated by Engineer/Architect.

D. Abandon aggregate pier elements improperly located or installed beyond maximum allowable tolerances and replace with new piers, unless Designer approves other remedial measures.

E. Provide material and labor required to replace rejected piers at no additional cost to Owner, unless cause of rejection is due to an obstruction or mislocation.

3.7 PROTECTION OF INSTALLED WORK

A. Contractor shall coordinate excavations made subsequent to aggregate pier installations so that at least five (5) feet of horizontal distance remains between edge of any installed aggregate pier and excavation.

B. Protection of completed aggregate pier elements is responsibility of Contractor.

C. In the event that utility excavations are required at horizontal distances of less than five feet from installed aggregate piers, Contractor shall contact aggregate pier Designer to develop construction solutions to minimize impacts on installed aggregate piers.

D. Recommended procedures may include:
   1. Using cement-treated base to construct portions of aggregate piers subject to future excavations.
   2. Replacing excavated soil with compacted crushed stone in portions of excavations where aggregate piers have been disturbed. Placement and compaction of crushed stone shall meet the following requirements.
      a. Crushed stone shall meet gradation specified by Rammed Aggregate Pier Design Engineer.
      b. Place crushed stone in a controlled manner using motorized impact compaction equipment.
      c. Compact aggregate to 95 percent of modified Proctor density.
      d. Testing Agency shall:
         1) Be on site to observe placement, compaction, and provide density testing.
         2) Submit test results to Design Engineer, Contractor and Engineer.
      e. Contractor shall provide notification to Testing Agency and design engineer when excavation, placement, and compaction will occur and arrange for construction observation and testing.

END OF SECTION

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SECTION 32 11 23
AGGREGATE BASE COURSE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Aggregate Materials.
2. Sub-grade Preparation.
3. Test Rolling Equipment and Procedures.
4. Aggregate Installation Requirements.
5. Aggregate Shoulder.
6. Base Course Schedule.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 31 05 17 – Aggregates for Site Earthwork.
3. Section 31 22 13 - Rough Grading: Preparation of site for base course.
4. Section 31 23 15 - Excavation, Backfill, and Compaction for Buildings and Structures.
5. Section 31 23 17 – Site Excavation, Backfill, and Compaction.
6. Section 32 12 16 – Asphalt Paving: Binder and surface asphalt courses.
7. Section 32 13 13 - Concrete Paving: Finish concrete pavement and curb and gutter.
8. Section 32 91 13 – Soil Preparation: Topsoil fill at areas adjacent to aggregate base course.
9. Section 33 11 00 – Site Water System: Adjustment of valve boxes.
10. Section 33 31 00 - Site Sanitary Sewer System: Adjustment of manhole frames in preparation for paving.
11. Section 33 41 00 – Site Storm Sewer System: Adjustment of drainage structure frames in preparation for paving.

1.2 REFERENCES

A. City of Madison Standard Specifications for Public Works Construction, 2017 Edition, (SSPW).

B. State of Wisconsin Department of Transportation
1. Standard Specifications for Highway and Structure Construction, Current Edition. (WISDOT)

C. ASTM International (ASTM):
1. ASTM D698 – Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft.-lbf/ft^3.
2. ASTM D1557 – Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft.-lbf/ft^3.
3. ASTM D6938 – Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

PART 2 - PRODUCTS

2.1 AGGREGATE MATERIALS

A. Aggregate Material: Type A1, A2, or A3 as specified in Section 31 05 17 – Aggregates for Site Earthwork.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify substrate is dry and has been inspected, and gradient and elevation are correct.

3.2 SUBGRADE PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and recompacting.

B. Do not place fill on soft, muddy, or frozen surfaces.

3.3 TEST ROLLING SUBGRADE

A. Test rolling shall be used to verify stability and uniformity of subgrade. Perform this Work in presence of Construction Manager.

B. Use test rolling equipment conforming to following description:
1. Tandem axle, dual wheel dump truck.
2. Tire pressure shall be no less than 90 percent of manufacturer's recommended maximum inflation.
3. Minimum gross weight of loaded truck shall be 60,000 pounds.
4. Provide weigh slip to Construction Manager.

C. Perform test rolling procedure as follows:
1. Operate equipment at a rate not to exceed 3 to 5 mph or a comfortable walking pace. Adjust speed to allow Geotechnical Engineer to measure any deflections and areas of rutting.
2. Operate test rolling equipment in a pattern so that affected areas are loaded with at least one pass.
3. After test rolling, check subgrade for conformance to drawings, and correct any surface irregularities. Re-shape subgrade within tolerances specified.

D. Test Rolling Evaluation:
1. Rutting up to 1-inch is acceptable. Rutting in excess of 1-inch but not more than 6 inches, shall be considered a failure and requires reworking soil and compaction to required density.
2. Deflection (pumping) up to 1-inch is acceptable. Deflection in excess of 1-inch but not more than 2 inches shall be acceptable if there is not substantial cracking or lateral movement of soil.
3. Deflection in excess of 2 inches but not more than 6 inches shall be considered a failure, and requires reworking soil and compaction to required density.

4. Rutting and deflection in excess of 6 inches will require review and recommendation for corrective action by an approved Geotechnical Engineer.
5. After remedial work is performed, a final test roll shall be performed upon completion of work.
6. If remedial work is performed as directed, second test roll may be waived at discretion of Geotechnical Engineer.

3.4 AGGREGATE INSTALLATION REQUIREMENTS

A. Install in accordance with SSPW Article 401.

B. Spread aggregate over prepared substrate to a total compacted thickness as indicated on Drawings.

C. Place aggregate in maximum 7-inch loose lifts and compact to specified density.

D. Level and contour surfaces to elevations and gradients indicated.

E. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

F. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

G. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.5 TOLERANCES

A. Section 31 05 17 – Aggregates for Site Earthwork defines “A” designated base course materials.

B. Flatness: Maximum variation of 1/4-inch measured with 10-foot straight edge.

C. Scheduled Compacted Thickness: Within 1/4-inch.

D. Variation from Design Elevation: Within 1/4-inch.

3.6 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspection.

B. Perform compaction testing in accordance with ASTM D693, and Division 01 - General Requirements.

C. Perform moisture content testing in accordance with ASTM D6938 and Division 01 – General Requirements.

D. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

E. Frequency of Tests: As determined by Geotechnical Engineer.

3.7 BASE COURSE SCHEDULE

A. Section 31 05 17 – Aggregates for Site Earthwork defines "A" designated base course materials.

B. Under Asphalt Pavement:
   1. Aggregate Type A1, A2, or A3, compact to 95 percent modified Proctor density.

C. Under Concrete Pavement and Curb and Gutter:
   1. Aggregate Type A1, A2, or A3, compact to 95 percent modified Proctor density.

D. Under Sidewalk:
   1. Aggregate Type A1, compact to 95 percent modified Proctor density.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Asphalt Paving Mix.
2. Asphalt Materials.
3. Aggregate Base Course.
4. Primer Preparation.
5. Tack Coat Preparation.
6. Asphalt Pavement - Single Course Installation.
7. Placing Asphalt Pavement - Two Course Installation.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 31 05 17– Aggregates for Site Earthwork: Product requirements for aggregate for placement by this section.
3. Section 32 11 23 - Aggregate Base Course: Compacted granular base for paving.
4. Section 32 13 13 – Concrete Paving: Concrete pavement, base, curb and gutter, approaches, and sidewalks.
5. Section 32 17 23 - Pavement Markings: Painted parking stall, crosswalk, and ADA pavement markings.
6. Section 33 11 00 - Site Water System: Final adjustment of valve boxes.
7. Section 33 31 00 - Site Sanitary Sewer System: Final elevation adjustment of manhole frames.
8. Section 33 41 00 – Site Storm Sewer System: Final elevation adjustment of drainage structure frames.

1.2 REFERENCES

A. City of Madison Standard Specifications for Public Works Construction, 2017 Edition, (SSPW).

B. State of Wisconsin Department of Transportation
1. Standard Specifications for Highway and Structure Construction, Current Edition. (WISDOT)

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Product Data: Submit product information and mix design.

C. Certification: Provide Manufacturer’s Certification Report that indicates Products and Materials meet or exceed all specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Wisconsin Department of Transportation Standards.

B. Mixing Plant: Conform to WISDOT Section 450.

C. Obtain materials from same source throughout.

1.5 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this section with minimum five years experience.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Division 01 – General Requirements: Environmental conditions affecting products on site.

B. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or if surface is wet or frozen.

C. Install Work in accordance with SSPW Article 402.

PART 2 - PRODUCTS

2.1 ASPHALT PAVING MIX

A. Use dry material to avoid foaming. Mix uniformly.

B. Provide Asphaltic Concrete Binder Course Mixtures as specified below:
1. Asphaltic Concrete Binder Course: WISDOT Section 460, Type E-1, 19.0 mm, in accordance with Table 460-1 and Table 460-2.

C. Provide Asphaltic Concrete Surface Course Mixtures as specified below:
1. Asphaltic Concrete Surface Course: WISDOT Section 460, Type E-1, 12.5 mm, in accordance with Table 460-1 and Table 460-2.

D. Recycled Asphalt Pavement (RAP) shall not be used.

2.2 ASPHALT MATERIALS

A. Tack Coat: SS-1, SS-1h, CSS-1, or CSS-1h in accordance with:
1. WISDOT Section 455.

2.3 SOURCE QUALITY CONTROL AND TESTS

A. Division 01 – General Requirements: Testing, inspection and analysis requirements.

B. Submit proposed mix design for review prior to beginning of Work.

C. Perform Asphaltic Concrete Testing in accordance with WISDOT Section 460.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Division 01 – General Requirements: Verification of existing conditions before starting work.

B. Verify compacted subgrade and aggregate base are acceptable and ready to support paving and imposed loads.

C. Verify gradients and elevations of base are correct.

3.2 AGGREGATE BASE COURSE

A. Section 32 11 23 - Aggregate Base Course forms base course construction for Work of this section.

3.3 TACK COAT APPLICATION

A. Apply tack coat in accordance with WISDOT Section 455.

B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd.

C. Apply tack coat to contact surfaces of curbs, gutters, medians, and other elements as necessary.

D. Coat surfaces of manhole, catch basin, inlet, and utility frames with oil to prevent bond with asphalt pavement. Do not tack coat these surfaces.

3.4 PLACING ASPHALT PAVEMENT - TWO COURSE INSTALLATION

A. Install asphalt pavement in accordance with SSPW Article 402.

B. Place asphalt binder course within 24 hours of applying primer or tack coat.

C. Place binder course to thickness shown on Drawings.

D. Place surface course within 24 hours of placing and compacting binder course. When binder course is placed more than 24 hours before placing surface course, clean surface and apply tack coat before placing surface course.

E. Place surface course to thickness shown on Drawings.

F. Install utility grilles and frames in correct position and elevation prior to installation of pavement.

G. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

H. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.5 TOLERANCES

A. Division 01 – General Requirements: Tolerances.

B. Flatness: Maximum variation of 1/8-inch measured with 10-foot straight edge.

C. Scheduled Compacted Thickness: Within 1/4-inch.

D. Variation from Indicated Elevation: Within 1/4-inch.

3.6 PROTECTION OF FINISHED WORK

A. Division 01 – General Requirements: Protecting finished work.

B. Immediately after placement, protect pavement from mechanical injury for 12 hours or until surface temperature is less than 140 degrees F, whichever occurs first.

END OF SECTION

SECTION 32 12 43

POROUS FLEXIBLE PAVING

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. Turf reinforced porous flexible pavement system.

B. Related Sections:
1. Section 31 10 00 “Site Clearing” for topsoil stripping and stockpiling.
2. Section 31 22 13 “Rough Grading” for rough grading of site.
3. Section 31 23 17 “Site Excavation, Backfill, and Compaction” for excavation, filling, and subgrade preparation.
4. Section 31 25 13 “Erosion and Sediment Control” for products and practices to control surface water runoff, soil and sediment control.
5. Section 32 91 13 “Soil Preparation” for suitable topsoil and amendments.
6. Section 32 92 00 “Turf and Grasses” for seeding.

1.3 SUBMITTALS

A. Product Data:
1. Manufacturer’s cut sheet including installation instructions.
2. Manufacturer’s maintenance guide for lawn and snow removal maintenance of installed product.
3. Manufacturer signed certificate stating the product is made in the USA.
4. Material Certificates for base course and sand (or USGA mix) fill materials.
5. Product certificates signed by the manufacturer certifying material compliance of polyethylene used to make porous flexible paving units.
6. ISO Certificate certifying manufacturer’s quality management system is currently registered to ISO 9001:2008 quality standards.

B. Shop Drawings:
1. Submit shop drawings only if a modification or revision to the Contract Documents is being proposed for the porous flexible paving system cross section based on site conditions.

C. Samples for Verification:
1. Submit one 10” x 10” section of porous flexible paving unit material.

1.4 SUBSTITUTIONS

A. Product substitutions may be considered as an equivalent only if proposed substitution meets all areas of this specification without exception. Manufacturers seeking consideration as an equivalent product must submit product data, records, test results, samples, certifications and any additional documentation deemed necessary by Owners project representative to prove equivalency. Owners project representative must review and approve proposed substitutions prior to their ordering and use.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. All porous flexible paving units shall be produced by a single manufacturer with a minimum of thirty (30) years proven production of porous pavement systems.
   2. Provide certification of compliance with all applicable testing procedures and related specifications upon written request. Request for certification shall be submitted by the purchasing agency no later than the date of order placement.
   3. ISO Certification certifying manufacturer's quality management system for its porous flexible paving system is currently registered to ISO 9001:2008 quality standards. Any alternate materials submitted shall provide a certification that their porous flexible pavement system manufacturing process is part of an ISO program and a certification will be required specifically stating that their testing facility is certified and in accordance with ISO.

B. Installer Qualifications:
   1. A minimum of ten (10) years experience with municipal, commercial or institutional paving projects utilizing turf reinforced porous flexible paving systems.
   2. Furnish a list of three (3) references for comparable projects including information on the year installed, total square footage of turf reinforced porous flexible paving, type of installation, and contact information for the client. Contractor qualifications are subject to review and approval before authorized to work on this project.

1.6 MOCK-UP

A. Prior to start of porous flexible paving work, construct mock-up to verify appropriate cross section and to set quality standards for materials and execution. Mock-ups shall demonstrate the finished product including all base materials and adjacent surfaces.

B. Provide a minimum mock-up area of 50 square feet for review by Owners project representative. The mock-up must be approved by the Owner prior to proceeding with any future installations. Approved mock-ups may become a part of the completed work if undisturbed at the time of substantial completion.

1.7 DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect porous flexible paving units/rolls from damage during delivery and store rolls upright, under tarp, to protect from sunlight, when time for delivery to installation exceeds one week.

C. Store turf conditioner in a dark and dry location.

D. Protect materials during handling and installation to prevent damage.

1.8 MAINTENANCE SERVICE

A. Provide maintenance services for turf reinforced porous flexible paving in accordance with manufacturers maintenance guide and Section 32 92 00, “Turf and Grasses”.

B. Maintenance period and guarantee of turf grass to coincide with all other turf grasses on site.

1.9 PROJECT CONDITIONS

A. Maintain environmental conditions within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Do not begin installation of flexible porous pavement until all adjacent hard surface paving, including concrete walks and asphalt paving, is completed.

C. In cold weather, do not use frozen materials or materials mixed or coated with ice or frost, and do not build on frozen base or wet, saturated or muddy subgrade.

D. Protect partially completed paving against damage from other construction traffic when work is in progress.

E. Adequately water grass seed to assure germination of seed and growth of root system.

F. Grass coverage on the sand-filled pavement unit rings must be completed within one week: See *Part 3 Execution*.

G. DO NOT DRIVE, PARK ON, or use turf reinforced porous flexible pavement system for two or three mowing cycles until grass root system has matured, approximately 6 to 8 weeks. Any barricades constructed must still be accessible by emergency and fire equipment during and after installation.

1.10 LIMITED WARRANTY

A. Include manufacturer’s standard five (5) year warranty.

PART 2 - PRODUCTS

2.1 POROUS FLEXIBLE PAVING

A. “GrassPave2” by Invisible Structures, Inc., 1-800-233-1510, www.invisiblestructures.com or approved equal.

B. Description:

1. High density polyethylene (HDPE): 100 percent recycled materials.
2. Color: black
3. Color Uniformity: Uniform color throughout all unit rolls.
4. Carbon black for ultraviolet light stabilization
5. Turf conditioner soil amendment and fertilizer, provided by manufacturer

C. Performance Properties:
1. Maximum Loading Capability: 15,940 psi (2.29 million psf, 109,906 kPa) when filled with sand.
2. Wheelchair Access testing for ADA Compliance: Passing ASTM F 1951-08.
3. Wheelchair Access testing for ADA Compliance: Passing Rotational Penetrometer testing.
4. Tensile strength, pull-apart testing: 458 lbf/in from ASTM D638 Modified.
5. System Permeability (porous flexible pavement unit, sand, base course): 2.63 to 38.55 inches of water per hour.
6. Effective Imperviousness (E.I.): 10%.

D. Dimensions (individual units are assembled and distributed into rolls):
1. Roll area: From 108 sq ft (10 sq m) to 538 sq ft (50 sq m), in 108 sq ft (10 sq m) increments
2. Roll Widths: From 3.3 ft (1 m) to 8.2 ft (2.5 m), in 1.6 ft (0.5 m) increments.
3. Roll Lengths: From 32.8 ft (10m) to 65.6 ft (20 m), in 3.3 ft (1 m) increments.
4. Roll Weights: From 41 lbs (19kg) to 205 lbs (93kg), in 41 lbs (19 kg) increments.
5. Unit Nominal Width by Length: 20 inches by 20 inches (0.5 m by 0.5 m) or 40 inches by 40 inches (1 m by 1 m).
6. Nominal Depth: 1 inch (2.5 cm) – for rolls and individual units.
7. Unit Weight: 18 oz (510 g) or 5 lbs. (2.27 kg).
8. Volume Solid: 8 percent.

2.2 BASE COURSE

A. Sandy gravel material from local sources commonly used for road base construction (recycled materials such as crushed concrete or crushed asphalt are NOT acceptable).

B. Conforming to the following sieve analysis and requirements:
1. 100 percent passing sieve size 1 inch (25 mm)
2. 99-100 percent passing sieve size 3/4 inch (19 mm)
3. 70-80 percent passing sieve size 3/8 inch (9 mm)
4. 55-70 percent passing sieve size #4
5. 45-55 percent passing sieve size #10
6. 25-35 percent passing sieve size #40
7. 3-8 percent passing sieve size #200

C. Provide a base course material nearly neutral in pH (range from 6.5 to 7.2) to provide adequate root zone development for turf.

D. Material may be either "pit run" or "crusher run." Avoid using clay based crusher run/pit run. Crusher run material will generally require coarse, well-draining sand conforming to AASHTO M6 or ASTM C 33 to be added to mixture (20 to 30 percent by volume) to ensure long-term porosity.

E. Alternative materials such as crushed shell, limerock, or crushed lava may be used for base course use, provided they are mixed with sharp sand (20 to 30 percent) to ensure long-term porosity, and are brought to proper compaction. Without added sand, crushed shell and limerock set up like concrete and become impervious.

F. Alternative size and/or composition of base course materials should be submitted to Manufacturer for approval.

2.3 SAND FILL

A. Fill for Rings and Spaces Between Rings

B. Clean sharp sand (washed concrete sand). Choose one of the following:
1. Coarse, well-draining sand, such as washed concrete sand conforming to AASHTO M6 or ASTM C-33.
2. United States Golf Association (USGA) greens, section - sand mix “The Root Zone Mixture.”

2.4 TURF CONDITIONER

A. Hydrogrow a proprietary soil amendment manufactured by Invisible Structures, Inc. and provided with Grasspave2 units.

B. No Substitutions.

2.5 TURF GRASS SEED

A. Provide No-Mow Fescue Lawn Seed (Seed Mix B) in accordance with Section 32 92 00, “Turf and Grasses”.

2.6 TOPSOIL

A. Provide in accordance with Section 32 91 13, “Soil Preparation”.

B. Approved topsoil for a light “dusting” (no more than ½” or 13mm) above rings filled with sand for seeding germination.

2.7 MULCHES & STABILIZERS

A. Provide in accordance with Section 32 92 00, “Turf and Grasses”.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine subgrade and base course installed conditions. Do not start porous flexible paving system installation until unsatisfactory conditions are corrected. Check for improperly compacted trenches, debris, and improper gradients.

B. Start of installation constitutes acceptance of existing conditions and responsibility for satisfactory performance. If existing conditions are found unsatisfactory, contact Construction Representative for resolution.

3.2 PREPARATION

A. Ensure that subbase materials are structurally adequate to receive designed base course, wearing course, and designed loads. Generally, excavation into undisturbed normal strength soils will require no additional modification. Fill soils and otherwise structurally weak soils may require modifications, such as geotextiles, geogrids, and/or compaction (not to exceed 90%). Ensure that grading and soil porosity of the subbase will provide adequate subsurface drainage.

B. Subgrade Preparation:
1. Prepare subgrade as specified in Section 31 23 17 Site Excavation, Backfill and Compaction.
2. Verify subgrade in accordance with flexible porous paving system manufacturer's instructions.
3. Proper subgrade preparation will enable the flexible paving rolls/units to connect properly and remain level and stationary after installation.
4. Excavate area allowing for unit thickness, the engineered base depth, and 0.5 inch (1.25 cm) for topsoil germination area.
5. Provide adequate drainage from excavated area if area has potential to collect water, when working with in-place soils that have poor permeability.
6. Ensure in-place soil is relatively dry and free from standing water.
7. Uniformly grade base.
8. Level and clear base of large objects, such as rocks and pieces of wood.

C. Base Course Preparation:
1. Install Base Course materials as specified in this section.
2. Verify engineered base is installed in accordance with flexible porous paving system manufacturer’s instructions.
3. If required, place a geotextile separation layer between the natural ground and the engineered base.
4. If required, place a 6 mil impermeable liner against adjacent pavements.
5. Place engineered base in lifts not to exceed 6 inches (150 mm), compacting each lift separately to 95 percent Modified Proctor.
6. Leave 1 inch (2.5 cm) of depth below final grade flexible porous paving unit and sand fill and 0.5 inch (1.25 cm) for depth of topsoil germination area.

3.3 TURF CONDITIONER INSTALLATION

A. Spread all turf conditioner mix provided (spreader rate = 4.53 kg per 100 m2 (10 lbs per 1076 ft2)) evenly over the surface of the base course with a hand-held, or wheeled, rotary spreader.

B. The turf conditioner mix should be placed immediately before installing the porous flexible paving units.

3.4 POROUS FLEXIBLE PAVING UNIT INSTALLATION

A. Install the porous flexible paving units by placing units with rings facing up, and using snap-fit connectors, pegs and holes, provided to maintain proper spacing and interlock the units. Units can be easily shaped with pruning shears or knife. Units placed on curves, slopes, and high traffic areas shall be anchored to the base course, using 40d common nails with fender washer, as required to secure units in place. Tops of rings shall be between 6 mm to 13 mm (0.25" to 0.5") below the surface of adjacent hard-surface pavements.

B. Install sand in rings as they are laid in sections by "back-dumping" directly from a dump truck, or from buckets mounted on tractors, which then exit the site by driving over rings already filled with sand. The sand is then spread laterally from the pile using flat bottomed shovels and/or wide "asphalt rakes" to fill the rings. A stiff bristled broom should be used for final "finishing" of the sand. The sand must be "compacted" by using water from hose, irrigation heads, or rainfall, with the finish grade no less than the top of rings and no more than 6 mm (0.25") above top of rings.

3.5 TURF INSTALLATION

A. Grass coverage on the sand-filled rings must be completed within one week. Sand must be re-installed and leveled and porous flexible paving units checked for integrity if rings become exposed due to wind, rain, traffic, or other factors.

B. Install seed at rates and methods in accordance with Section 32 92 00, “Turf and Grasses”.

C. Apply a light "dusting" of approved topsoil, not to exceed 1/2" (25 mm), above the rings and seed mix to aid germination rates

3.6 PROTECTION

A. DO NOT DRIVE, PARK ON, or use turf reinforced porous flexible pavement system for two or three mowing cycles until grass root system has matured, approximately 6 to 8 weeks. Any barricades constructed must still be accessible by emergency and fire equipment during and after installation.

3.7 FIELD QUALITY CONTROL

A. Remove and replace segments of porous flexible paving units where three or more adjacent rings are broken or damaged, reinstalling as specified, so no evidence of replacement is apparent.

B. Perform cleaning during the installation of work and upon completion of the work. Remove all excess materials, debris, and equipment from site. Repair any damage to adjacent materials and surfaces resulting from installation of this work.

3.8 MAINTENANACE

A. Maintain turf in accordance with manufacturers maintenance guide and Section 32 92 00, “Turf and Grasses”.

B. Maintenance and warranty period and guarantee to coincide with all other turf grasses on site.

C. Do not aerate turf reinforced porous flexible paving system. Aerator will damage the porous flexible paving units. Aeration is not necessary in a sand root zone.

D. When snow removal is required, keep a metal edged plow blade a minimum of ¾ inch (17 mm) above the surface during plowing operations to avoid causing damage to the porous flexible paving units, or
   1. Use a plow blade with a flexible rubber edge, or
   2. Use a plow blade with skids on the lower outside corners set so the plow blade does not come in contact with the units.

END OF SECTION

SECTION 32 13 13
CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Materials and Installation requirements for exterior concrete components as follows;
   a. Driveway pavement.
   b. Sidewalks.
   c. Combination curb and gutter.
   d. Driveway entrances.
   e. Handicap ramps.
   f. Aggregate base course.
2. Exterior Concrete Design Requirements as follows;
   a. Concrete mix design.
   b. Reinforcement.
   c. Concrete curing and sealing.
   d. Jointing.
   e. Quality control and testing.
   f. Concrete placement and finishing.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 31 22 13 - Rough Grading: Preparation of site for paving and base.
3. Section 31 23 17 – Site Excavation, Backfill, and Compaction: Compacted subbase for paving.
4. Section 32 11 23 - Aggregate Base Course: Compacted granular base for paving.
5. Section 32 12 16 - Asphalt Paving: Asphalt surface course.
6. Section 32 17 23 – Pavement Marking: Painted pavement markings.
7. Section 32 91 13 – Soil Preparation: Preparation of subsoil at pavement perimeter.

1.2 REFERENCES

A. City of Madison Standard Specifications for Public Works Construction, 2017 Edition, (SSPW).

B. American Concrete Institute (ACI)
1. ACI 224.3R, Joints in Concrete Construction, Chapter 6 – Pavements.
2. ACI 301 – Structural Concrete.
3. ACI 304 - Guide for Measuring, Mixing, Transporting and Placing Concrete.
4. ACI 305 – Hot Weather Concreting.
5. ACI 306 – Cold Weather Concreting.
6. ACI 308 – Standard Practice for Curing Concrete.
7. ACI 309 – Guide for Consolidation of Concrete.
8. ACI 325 – Guide for Construction of Concrete Pavements and Concrete Bases.
9. ACI 330 – Guide for Design and Construction of Concrete Parking Lots.

10. ACI 330.1 – Specification for Unreinforced Concrete Parking Lots.
11. ACI 347 – Guide to Formwork for Concrete.

C. ASTM International (ASTM)
1. ASTM A82 – Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A184 - Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
3. ASTM A185 - Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
4. ASTM A497 - Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
5. ASTM A615 - Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
6. ASTM A767 – Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
7. ASTM A775 - Specification for Epoxy-Coated Reinforcing Steel Bars.
8. ASTM A884 - Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.
9. ASTM A934 - Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
10. ASTM C31 – Practice for Making and Curing Concrete Test Specimens in the Field.
11. ASTM C33 - Specification for Concrete Aggregates.
12. ASTM C39 – Test Method for Compressive Strength of Cylindrical Concrete Specimens.
13. ASTM C94 - Specification for Ready-Mixed Concrete.
14. ASTM C143 – Test Method for Slump of Hydraulic-Cement Concrete.
15. ASTM C150 - Specification for Portland Cement.
16. ASTM C172 - Practice for Sampling Freshly Mixed Concrete.
17. ASTM C231 – Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
18. ASTM C260 - Specification for Air-Entraining Admixtures for Concrete.
19. ASTM C309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
20. ASTM C494 - Specification for Chemical Admixtures for Concrete.
21. ASTM C618 - Specification for Fly Ash as Admixture for Concrete.
22. ASTM C1116 - Specification for Fiber-Reinforced Concrete and Shotcrete.
23. ASTM C1193 - Guide for Use of Joint Sealants.
24. ASTM C1602 – Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
25. ASTM D1751 - Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction Nonextruding and Resilient Bituminous Types.
26. ASTM D1752 - Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
27. ASTM D3406 – Specification for Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements.
28. ASTM D5249 - Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints.
29. ASTM D5893 – Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
30. ASTM D6690 – Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

D. United States Access Board:
   1. ADA Accessibility Guidelines for Buildings and Facilities.(ADAAG)

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Submit three (3) proposed mix designs of each class of concrete to Engineer not later than 10 days after Notice to Proceed or 15 days prior to the first concrete placement, whichever comes first.

C. Submit proposed mix design for exposed aggregate concrete paving to Engineer no later than ten (10) days after Notice to Proceed or fifteen (15) days prior to the first concrete placement, whichever comes first.

D. Contractor shall submit a jointing plan for expansion, isolation, contraction and construction joints prior to placing any concrete.

E. Jointing plan shall include details for doweled joints indicating dowel bar size and length, dowel supports, and distance between dowels.

F. Jointing plan shall include details for tie bar joints indicating tie bar size and length, tie bar supports, and distance between tie bars.

G. Include sequence of concrete placement indicating location of construction joints.

H. Jointing plan shall meet the requirements of the referenced ACI Standards.

I. Product Data: Submit data on joint filler, reinforcement, admixtures, and curing compounds.

1.4 EXPOSED AGGREGATE CONCRETE PAVING MOCK-UP

A. Prior to start of exposed aggregate concrete paving work, construct mock-up to verify desired aesthetic appearance and to set quality standards for materials and execution. Mock-ups shall demonstrate the finished product and will be evaluated no earlier than five (5) days after it was poured.

B. Provide a minimum mock-up area of 10 square feet for review by Owner's Project Representative. The mock-up must be approved by the Owner prior to proceeding with any future installations. Approved mock-ups may become a part of the completed work if undisturbed at the time of substantial completion.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with specified ACI requirements.

B. Obtain cementitious materials from same source throughout.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Conform to requirements of Division 01 - General Requirements.

B. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Form Materials: Conform to ACI 301 and 347.

B. Wood or steel form material, profiled to suit conditions.

2.2 REINFORCEMENT

A. Joint Dowel Bars: Smooth formed steel bars, ASTM A615, Grade 60. Cut bars true to length with ends flush and free of burrs.

B. Tie Bars: ASTM A615, Grade 60, deformed.

C. Welded Steel Wire Fabric: Plain type, ASTM A185; in flat sheets; unfinished finish.

D. Reinforcement Supports:
   1. Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire fabric, and dowels in place.
   2. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete.
      a. Provide wire bar supports with plates or horizontal runners where base material will not support chair legs.
      b. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer coated wire bar supports.

2.3 CONCRETE MATERIALS

A. Cement: ASTM C150 Normal – Type 1A, gray color.

B. Fine and Coarse Mix Aggregates: ASTM C33.

C. Water: ASTM C1602, potable, not detrimental to concrete.

D. Air Entrainment: ASTM C260.

E. Flyash: ASTM C618. Class C.

2.4 CHEMICAL ADMIXTURES

A. Chemical admixtures shall be in accordance with ASTM C494.

B. Concrete may contain Type A Water-reducing admixture.

C. Admixtures are to be used in accordance with manufacturer's recommendations.

D. Chemical admixtures containing chlorides, sulfides, or nitrides are not permitted.

E. A single manufacturer shall supply permitted admixtures.

F. Admixture manufacturers are to be approved in writing by Engineer prior to use.

2.5 ACCESSORIES

A. Joint Filler: ASTM D1751, Bituminous fiber, 1/2-inch wide by depth of concrete less 1/8-inch.

B. Form Release Agent: Colorless material which will not stain concrete, absorb moisture or impair natural bonding or color characteristics of coating, intended for use on concrete.

2.6 CURING AND TREATMENT MATERIALS

A. Water: Potable and clean.

B. Membrane Curing Compound: ASTM C309, Type II, Class A, white pigmented.

C. Cold-Applied Joint Sealants
1. Sealant for Concrete: Type NS Silicone Sealant, single-component, low modulus, neutral curing, non-sag complying with ASTM C5893.
2. Round Backer Rod for Cold-Applied Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depths and prevent bottom-side adhesion of sealant.

2.7 CONCRETE MIX

A. Mix concrete in accordance with ASTM C94.

B. Schedule of Mixes:

Class	Name	Maximum Aggregate Size (inch)	Maximum Slump** (inch)	Minimum Cement Sacks/cu.yd.	Minimum Compressive Strength (psi/28 days)	Maximum Water Cement Ratio
8*	Paver Subbase	3/4	3	5.50	3500	0.48
9*	Exterior Walks, Curbs, gutters Drives, Ramps	3/4	3	6.25	4000	0.45

* Air Entrained Concrete Mix. Normal Acceptable range of air content is 5.5-8.5 percent.
** Slump Tolerances Maximum slump of 3-inch plus 1-inch, minus 1-inch.

C. Exposed aggregate concrete paving to include the following fine specialty aggregate as part of the mix design:
   1. Fine specialty aggregates to be a blend of grays with rust coloration.
      a. Color: Gray with rust coloration.
      b. Size: 9/16 inch x 3/16 inch.
      c. Shape: Angular.
      d.

Sieve Size	% Passing
9/16”	98%
3/8”	66%
3/16”	12%
#8	0%

D. Prepare and submit concrete mix designs in accordance with Division 01 – General Requirements, and include as part of cost of this Work.

E. A qualified agency acceptable to Construction Manager shall prepare mix designs. Submit mix designs for Engineer’s review prior to placing any concrete.

F. Mix design shall indicate brands, types, and quantities of admixtures included, compressive strength, slump, sieve analysis for fine and coarse aggregate, quantities of all ingredients, type and brand of cement, source of aggregate, and whether fine aggregate is natural or manufactured.

G. Use accelerating admixtures in cold weather only when approved by Engineer in writing. Use of admixtures will not relax cold weather placement requirements.

H. Use set retarding admixtures during hot weather only when approved by Engineer in writing.

2.8 DETECTABLE WARNING PLATES

A. Detectable warning plates design shall comply with ADA guideline requirements.

B. Manufacturers: (Iron Plates)
   1. Neenah Foundry – Detectable Warning Plates; www.nfco.com; (800) 558-5075.
   2. East Jordan Iron Works, Inc. – Duralast Detectable Warning Plates; www.ejco.com; (800) 626-4653.
   3. Or approved equal.
      a. Iron Plates:
         1) ASTM A48, cast iron.
         2) Plate Size: 12 inches x 24 inches.
         3) Color: Natural iron.

C. Plate Tolerances:
   1. Squareness: 1/8-inch maximum difference in diagonal measurements.
   2. Maximum Deviation From Plane: 1/16-inch in 48 inches.

2.9 SOURCE QUALITY CONTROL AND TESTS

A. Submit proposed mix design of each class of concrete to appointed firm for review prior to commencement of Work.

B. Tests on cement, aggregates, and mixes will be performed to ensure conformance with specified requirements.

C. Test samples in accordance with ACI 301.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Division 01 – General Requirements: Coordination and project conditions.

B. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.

C. Verify gradients and elevations of base are correct.

3.2 SUBBASE

A. Section 32 11 23 - Aggregate Base Course, forms base construction for Work of this section.

3.3 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Coat surfaces of manhole, catch basin, inlet and utility frames with oil to prevent bond with concrete pavement.

C. Notify Construction Manager minimum 24 hours prior to commencing concrete operations.

3.4 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.5 PLACING REINFORCEMENT

A. Place reinforcement as indicated on approved jointing plan.

B. Interrupt reinforcement at isolation and expansion joints.

C. Position the reinforcement on approved chairs securely fastened to the subgrade prior to concrete placement.

D. Mechanically screed concrete after the steel has been placed.

E. Regardless of placement procedure, ensure the reinforcing steel is free from coatings which could impair bond between the steel and concrete, and indicate laps in the reinforcement as indicated.

F. In lieu of the above, automatic reinforcement depressing attachments may be used to position the reinforcement provided the entire operation is approved by Engineer.

G. Regardless of the equipment or procedures used for installing reinforcement, ensure that the entire depth of concrete is adequately consolidated by the mechanical screeding process.

H. The method used in installing and holding dowels in position must ensure that the error in alignment of any dowel from its required horizontal and vertical alignment after the pavement has been completed will not be greater than 1/8 in. per ft.

I. Horizontal spacing of dowels must be within a tolerance of plus or minus 5/8 inch.

J. Do not place dowels and tie bars closer than 0.6 times the bar length to the planned joint line.

K. If the last regularly spaced bar is closer than that dimension, it must be moved away from the joint to a location 0.6 times the bar length.

L. For contraction joints;
1. Hold dowels in longitudinal and transverse contraction joints within the paving area securely in place by means of rigid metal frames or basket assemblies of an approved type.
2. Hold the basket assemblies securely in the proper location by means of pins or anchors.

M. For construction joints in fixed form paving applications;
1. Install dowels and tie bars using the bonded-in-place method. Do not install by removing and replacing in preformed holes.
2. Prepare dowels and tie bars and place across joints where indicated on approved jointing plan, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms.

N. For construction joints in fixed hardened concrete applications;
1. Install dowels in hardened concrete by bonding the dowels into holes drilled into the hardened concrete.
2. Drill holes approximately 1/8 inch greater in diameter than the dowels into the hardened concrete.
3. Repair any damage to the concrete face during drilling as directed.
4. Bond dowels in the drilled holes using epoxy resin.
5. Inject epoxy resin at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Do not apply by buttering the dowel.
6. Hold the dowels in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic grout retention ring fitted around the dowel.

O. Wipe clean the portion of each dowel intended to move within the concrete or expansion cap and coat with a thin, even film of lubricating oil before the concrete is placed.

3.6 PLACING CONCRETE

A. Place in accordance with SSPW Article 301 through 305.

B. Place concrete in accordance with specified ACI Requirements.

C. Concrete may be placed using slip form technique.

D. Ensure reinforcement, inserts, embedded parts, and formed joints are not disturbed during concrete placement.

E. Place concrete continuously over full width of panel and between predetermined construction joints.

3.7 JOINTS

A. Place joints as indicated on approved Jointing Plan.

B. Place contraction joints as follows for identified entities:
1. Curb and Gutter: 10 feet.
2. Sidewalks: 5-6 feet.
3. Area Paving:
   a. 7-inch non-reinforced slabs: 15 foot to 20 foot spacing in each direction.

C. Place expansion joints using joint filler as follows for identified entities:
1. Curb and Gutter: 300 feet.
2. Sidewalks: 100 feet.
3. Area Paving: Areas next to building foundation and fixed components with separate foundations.

D. Align curb, gutter, and sidewalk joints.

E. Recess top of joint filler as shown on details for sealant placement.

F. Jointing shall be performed by hand tools or saw cutting. Jointing tools and equipment must provide minimum joint depth as specified by ACI requirements.

G. If method of jointing is saw cutting, Contractor shall perform saw cutting operations as soon as possible following curing process, without damaging new concrete.

3.8 INSTALLING DETECTABLE WARNING PLATES

A. Reference manufacturer’s installation requirements prior to installing detectable warning plates.

B. Set plates into wet concrete at locations shown on Drawings. Install plates into concrete to match top of concrete elevation. Do not over depress.

C. Clean any wet concrete off panel surface.

3.9 FINISHING

A. Exposed Aggregate Concrete Paving: Before mortar sets, spray the surface with water and brush or lightly broom the surface to expose the aggregate. Before performing the final surface finish, check the sidewalk surface with a 10-foot straightedge, and correct all areas that vary 1/4-inch from the testing edge by adding or removing concrete while the concrete is still plastic. Chemical admixtures may be used to aid finishing only when approved by Engineer in writing.

B. Drive Paving: Broom finish.

C. Sidewalk Paving: Broom finish. Edge sidewalk to 1/2-inch radius.

D. Curbs and Gutters: Broom finish.

E. Direction of Texturing: Transverse to pavement direction.

F. Inclined Garage Approach: Broomed perpendicular to slope.

G. Place curing compound on exposed concrete surfaces immediately after finishing.

3.10 JOINT SEALING

A. Separate pavement from vertical surfaces with 1/2-inch thick joint filler.

B. Place joint filler in pavement pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.

C. Extend joint filler from bottom of pavement to within finished surface as shown on details.

D. Comply with joint sealant manufacturer's written installation instructions applicable to products and applications indicated, unless requirements that are more stringent apply.

E. Comply with recommendations of ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

F. Install backer materials 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 backer materials.
2. Do not stretch, twist, puncture, or tear backer materials.
3. Remove absorbent backer materials that become wet before sealant application and replace them with dry materials.

G. Install sealants by the following techniques at same time backer material is installed:
1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses provided for each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

H. Tooling of Non-Sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below forming smooth, uniform beads; eliminating air pockets; and ensuring contact and adhesion of sealant with sides of joint.
1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

I. Provide joint sealant configuration complying with sealant manufacturer requirements and of depth and at locations indicated.

3.11 TOLERANCES

A. Division 01 - General Requirements: Tolerances.

B. Maximum Variation of Surface Flatness: 1/4-inch in 10 feet.

C. Maximum Variation from True Position: 1/4-inch.

3.12 FIELD QUALITY CONTROL

A. Division 01 - General Requirements: Testing and inspection services.

B. Concrete testing shall be paid for by Contractor.

C. Testing firm will take cylinders and perform slump and air entrainment tests in accordance with ACI 301.

D. Take three concrete test cylinders for every 75 or fewer cubic yards of each class of concrete placed each day.

E. Take one additional test cylinder during cold weather and cure on site under same conditions as concrete it represents.

F. Take one slump test for each set of test cylinders taken.

G. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.13 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit pedestrian traffic over pavement for two (2) days minimum after finishing and vehicular traffic over pavement for seven (7) days minimum after finishing.

END OF SECTION

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SECTION 32 17 23
PAVEMENT MARKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Marking Materials.
2. Marking Material Accessories.
3. Marking Equipment.
4. Marking Preparation.
5. Marking Application.
6. Marking Application Tolerances.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 32 12 16 - Asphalt Paving.
3. Section 32 13 13 - Concrete Paving.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO)
1. AASHTO M248 - Ready-Mixed White and Yellow Traffic Paints.

B. Code of Federal Regulations (CFR)
1. 49 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

C. State of Wisconsin Department of Transportation
1. Standard Specifications for Highway and Structure Construction, Current Edition. (WISDOT)

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for Submittals.

B. Submit manufacturer's technical information, application instructions and samples of materials being furnished.

C. Submit certified report of test or analysis provided by manufacturer indicating that actual results of test made by independent testing laboratory indicating that materials being supplied meet or exceed materials specified.

D. Provide Hazardous Material Data Sheets for materials furnished under this Section.

E. Manufacturer's Installation Instructions: Submit instructions for application temperatures, eradication requirements, application rate, line thickness, and any other data on proper installation.

F. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Wisconsin Department of Transportation standards.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five (5) years experience.

B. Applicator: Company specializing in performing work of this section with minimum five (5) years experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in accordance with Division 01 - General Requirements.

B. Ship components to site in unopened containers, plainly marked with manufacturer's name and address, color of material (colored container lids permitted), date of manufacturer, batch number, and component.

1.7 ENVIRONMENAL REQUIREMENTS

A. Marking materials shall not exude fumes, toxic or injurious, to persons or property during application.

B. Marking paint shall not contain mercury, lead, hexavalent chromium or halogenated solvents. Paint shall comply with 40 CFR 59.

C. Material not used within one year of date of manufacture indicated on container shall be rejected.

D. Application surface shall be dry and free from frost, contaminants, and debris that would prevent proper bonding.

E. Material shall be capable of curing fully under following minimum constant surface temperatures; +40 degrees F. for slow set; +25 degrees F. for regular set; +20 degrees F. for rapid set.

PART 2 - PRODUCTS

2.1 MARKING MATERIALS

A. Cold Paint: Type S or Type N traffic paint in accordance with AASHTO Designation M248. Regular set drying time.

B. Use only lead free paint.

2.2 MARKING EQUIPMENT

A. Continuous Longitudinal Line Application Machine: Use application equipment with following capabilities:
   1. Dual nozzle paint gun to simultaneously apply parallel lines of indicated width in solid or broken patterns or various combinations of those patterns.
   2. Pressurized bead-gun to automatically dispense glass beads onto painted surface, at required application rate.
   3. Measuring device to automatically and continuously measure length of each line placed, to nearest foot.

B. Machine Calibration:
   1. Paint Line Measuring Device: Calibrate automatic line length gauges to maintain specified tolerances.
   2. Cycle Length/Paint Line Length Timer: Calibrate cycle length to maintain tolerance specifications.
   3. Paint Guns: Calibrate to simultaneously apply paint binder at uniform rates as specified with an allowable tolerance of plus or minus 1 mil.

C. Other Equipment:
   1. For application of crosswalks, intersections, stop lines, legends and other miscellaneous items by walk behind stripers, hand spray or stencil trucks, apply with equipment meeting requirements of this section. Do not use hand brushes or rollers.

PART 3 - EXECUTION

3.1 MARKING PREPARATION

A. Maintenance and Protection of Traffic:
   1. Provide short term traffic control in accordance with Division 01 – General Requirements.
   2. Prevent interference with marking operations and to prevent traffic on newly applied markings before markings dry.
   3. Maintain access to existing businesses and other properties requiring access.

B. Surface Preparation.
   1. Clean and dry paved surface prior to painting.
   2. Blow or sweep surface free of dirt, debris, oil, grease, or gasoline.
   3. Spot location of final pavement markings as specified and as indicated on Drawings applying pavement spots 25 feet on center.
   4. Notify Construction Manager after placing pavement spots and minimum 3 days prior to applying traffic lines.
   5. Contractor shall verify that surface upon which materials are to be applied is dry, free from frost, dust, dirt, glaze, oil, grease, debris, or other materials or contaminants which would prevent proper bonding.
   6. Contractor shall remove such materials prior to application.

3.2 MARKING APPLICATION

A. Place pavement markings placed at locations and to dimensions shown on Drawings.

B. Applied lines shall have a uniform cross section.

C. Lines shall have sharp cut-off defined edges on both side and ends.

D. Agitate paint for 5-10 minutes prior to application to ensure even distribution of paint pigment.

E. Apply paint in accordance with manufacturer's recommendations, but not less than 16.5 gallons per mile of 4-inch continuous line at a minimum wet film thickness of 15 mils.

F. Dispense paint at ambient temperature to wet-film thickness of 15 mils.

G. Prevent splattering and over spray when applying markings.

H. Unless material is track free at end of paint application convoy, use traffic cones to protect markings from traffic until track free. If vehicle crosses a marking and tracks it or when splattering or over spray occurs, eradicate affected marking and resultant tracking and apply new markings.

I. Collect and legally dispose of residues from painting operations.

3.3 MARKING APPLICATION TOLERANCES

A. Division 01 - General Requirements: Tolerances.

B. Maximum Variation from Wet Film Thickness: 1-mil.

C. Maximum Variation from Wet Paint Line Width: Plus or minus 1/8-inch.

D. Maximum Variation from Specified Application Temperature: Plus or minus 5 degrees F.

3.4 FIELD QUALITY CONTROL

A. Division 01 - General Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect for incorrect location, insufficient thickness, line width, coverage, retention, uncured or discolored material, and insufficient bonding.

C. Repair lines and markings, which after application and curing do not meet following criteria:
   1. Incorrect Location: Remove and replace incorrectly placed patterns.
   2. Insufficient Thickness, Line Width, Paint Coverage:
      a. Remove defective material by an Engineer approved method of cleaning to remove substantial amount of beads and to roughen marking surface.
      b. Remove loose particles and debris.
      c. Apply new markings on cleaned surface in accordance with this Section.
   3. Uncured or Discolored Material, Insufficient Bonding:

a. Remove defective markings in accordance with this Section and clean pavement surface one foot beyond affected area.
b. Apply new markings on cleaned surface in accordance with this Section.

END OF SECTION

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SECTION 32 31 13

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Fence framework, fabric, and accessories.
2. Excavation for post bases.
3. Concrete foundation for posts and center drop for gates.
4. Manual gates and related hardware.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern all Work under this section.

1.2 REFERENCES

A. ASTM International (ASTM):
1. ASTM A121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
5. ASTM A491 - Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
6. ASTM A817 - Standard Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcelled Tension Wire.
7. ASTM A1011- Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
8. ASTM B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
9. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
10. ASTM F552 - Standard Terminology relating to Chain Link Fencing.
11. ASTM F567 - Standard Practice for Installation of Chain-Link Fence.
12. ASTM F626 - Standard Specification for Fence Fittings.
13. ASTM F668 - Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
14. ASTM F900 - Standard Specification for Industrial and Commercial Swing Gates.
15. ASTM F934 - Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
16. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
17. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
18. ASTM F1183 - Standard Specification for Aluminum Alloy Chain Link Fence Fabric.

19. ASTM F1184 - Standard Specification for Industrial and Commercial Horizontal Slide Gates.
20. ASTM F1345 - Standard Specification for Zinc - 5% Aluminum -Mischmetal Alloy-Coated Steel Chain-Link Fence Fabric.

B. Chain Link Fence Manufacturers Institute (CLFMI):
1. CLFMI - Product Manual.

1.3 SYSTEM DESCRIPTION

A. Fence Height: As indicated on Drawings.

B. Line Post Spacing: At intervals not exceeding 10 feet.

C. Fence Post and Rail Strength: Conform to ASTM F1043 Heavy Industrial Fence quality.

1.4 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.

C. Product Data: Submit data on fabric, posts, accessories, fittings and hardware.

1.5 CLOSEOUT SUBMITTALS

A. Division 01 – General Requirements: Closeout procedures.

B. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines.

C. Maintenance Data: Procedures for submittals.

1.6 QUALITY ASSURANCE

A. Supply material according to CLFMI - Product Manual.

B. Perform installation according to ASTM F567.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five (5) years experience.

B. Installer: Company specializing in performing work of this section with minimum five (5) years experience.

1.8 DELIVERY, STORAGE AND HANDLING

A. Division 01 – General Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.

C. Identify each package with manufacturer's name.

D. Store fence fabric and accessories in secure and dry place.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
1. Anchor Fence Company.
2. Hoover Fence Company.
3. Master Halco.
4. Or Approved Equal.

2.2 MATERIALS AND COMPONENTS

A. Materials and Components: Conform to CLFMI Product Manual.

2.3 MATERIALS

A. Framing (Steel): ASTM F1083; Schedule 40 galvanized steel pipe, welded construction, minimum yield strength of 25 ksi; coating conforming to ASTM F1043 Type A on pipe exterior and interior.

B. Fabric Wire (Steel): ASTM A392 Class 1 Zinc Coated wire.

C. Barbed Wire: ASTM A121 Coating Type Z, galvanized steel; 12 gage thick wire, 3 strands, 4 points at 3 inch oc.

D. Concrete: ASTM C94, Option A; Normal Portland Cement, minimum 2,500 psi strength at 28 days.

2.4 COMPONENTS

A. Line Posts: 1.9 inch diameter.

B. Corner and Terminal Posts: 2.38 inch.

C. Gate Posts: 3.5 inch diameter.

D. Top and Brace Rail: 1.66 inch diameter, plain end, sleeve coupled.

E. Gate Frame: 1.66 inch diameter for fittings and truss rod fabrication.

F. Fabric: 2 inch diamond mesh interwoven wire, 9 gage thick, top selvage knuckle end closed, bottom selvage twisted tight.

G. Tension Wire: 6 gage thick steel, single strand, marcelled, spiraled or crimped, aluminum-coated tension wire conforming to ASTM A824.

H. Tie Wire: Aluminum alloy steel wire.

2.5 ACCESSORIES

A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.

B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; galvanized steel.

C. Extension Arms: Cast steel galvanized, to accommodate 3 strands of barbed wire, single arm, sloped to 45 degrees.

D. Gate Hardware: Fork latch with gravity drop; two 180 degree gate hinges for each leaf and hardware for padlock keyed.

2.6 GATES

A. General:
1. Gate Types, Opening Widths and Directions of Operation: As indicated on Drawings.
2. Factory assemble gates.
3. Design gates for operation by one person.

B. Swing Gates:
1. Fabricate gates to permit 180 degree swing.
2. Gates Construction: ASTM F900 with welded corners. Use of corner fittings is not permitted.

2.7 FINISHES

A. Components and Fabric: Galvanized to ASTM A123 for components; ASTM A153 for hardware; ASTM A392 for fabric; 2.0 oz/sq ft coating.

B. Hardware: Galvanized to ASTM A153, 2.0 oz/sq ft coating.

C. Accessories: Same finish as framing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install framework, fabric, accessories and gates according to ASTM F567.

B. Set intermediate, terminal, and gate posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.

C. Line Post Footing Depth Below Finish Grade: As shown on the Drawings.

D. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: As shown on the Drawings.

E. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.

F. Install top rail through line post tops and splice with 6 inch long rail sleeves.

G. Install center and bottom brace rail on corner gate leaves.

H. Place fabric on outside of posts and rails.

I. Do not stretch fabric until concrete foundation has cured 28 days.

J. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

K. Position bottom of fabric 2 inches above finished grade.

L. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.

M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

N. Install bottom tension wire stretched taut between terminal posts.

O. Install support arms sloped outward and attach barbed wire; tension and secure.

P. Support gates from gate posts. Do not attach hinged side of gate from building wall.

Q. Install gate with fabric and barbed wire overhang to match fence. Install three hinges on each gate leaf, latch, catches, and drop bolt.

R. Connect to existing fence at new terminal post.

S. Install posts with 6 inches maximum clear opening from end posts to buildings, fences and other structures.

T. Excavate holes for posts to diameter and spacing indicated on Drawings without disturbing underlying materials.

U. Center and align posts. Place concrete around posts, and vibrate or tamp for consolidation. Verify vertical and top alignment of posts and make necessary corrections.

V. Extend concrete footings above grade, and trowel, forming crown to shed water.

W. Allow footings to cure minimum 7 days before installing fabric and other materials attached to posts.

3.2 ERECTION TOLERANCES

A. Division 01 – General Requirements: Tolerances.

B. Maximum Variation From Plumb: 1/4 inch.

C. Maximum Offset From Indicated Position: 1 inch.

D. Minimum distance from property line: 6 inches.

END OF SECTION

SECTION 32 32 00

EXTERIOR CUSTOM FABRICATIONS

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. Installation of salvaged railroad materials.

B. Related Sections:
   1. Section 31 05 17 “Aggregates for Site Earthwork” for base course aggregates.
   2. Section 32 11 23 “Aggregate Base Course” for compaction of base course aggregates.
   3. Section 32 13 13 “Concrete Paving” for adjacent paving.
   4. Section 32 93 00 “Plants” for stone products and landscape materials.

1.3 REFERENCES

A. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, current edition.

1.4 QUALITY ASSURANCE

A. Conduct a preinstallation conference at the project site with, at a minimum, the Installer’s project supervisor, the General Contractor, and Engineer present. Review methods and procedures related to all exterior custom fabrications and installations including, but not limited to, the following:
   1. Location(s)
   2. Construction schedule. Verify ability of materials, Installer’s personnel, equipment, and facilities needed to make progress and avoid delays.
   3. Material verification.
   4. Cleaning of salvaged railroad materials.

1.5 SUBSTITUTIONS

A. Product substitutions may be considered as an equivalent only if proposed substitution meets all areas of this specification without exception. Manufacturers seeking consideration as an equivalent product must submit product data, records, test results, samples, certifications and any additional documentation deemed necessary by Owners project representative to prove equivalency. Owners project representative must review and approve proposed substitutions prior to their ordering and use.

1.6 MOCK-UP

A. Prior to installation of salvaged rail assemblies, construct mock-up to verify appropriate cross section and to set quality standards for materials and execution. Mock-ups shall demonstrate the finished product including all rail assembly components, base materials and adjacent surfaces.

B. Provide a minimum mock-up of 5 linear feet of installed salvaged rail assemblies for review by Owners project representative. The mock-up must be approved by the Owner prior to proceeding with any future installations. Approved mock-ups may become part of the completed work if undisturbed at the time of substantial completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver salvaged rail assembly elements in good condition free from damage. At all times handle units to prevent damage and to protect from damage after for the duration of construction.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, and dimensions of exterior custom fabrications and construction contiguous with custom fabrications by field measurements before proceeding with installation work.

B. Protect all adjacent plants, lawns and pavement areas, and other materials, surfaces and finishes from damage at all times. Damaged areas shall be replaced as required to conform to the Contract Documents.

PART 2 - PRODUCTS

2.1 SALVAGED STEEL RAIL ASSEMBLIES

A. Description: Salvaged steel rails and tie plates, wood railroad ties and rail spikes.
   1. Mounting: Surface mount steel tie plates to concrete paving or salvaged wood railroad ties as indicated in the Drawings.
   2. Hardware:
      a. Salvaged steel rail spikes to attach steel tie plates to wooden railroad ties.
      b. Provide Grade 316 stainless steel railroad screw spikes for attaching salvaged steel tie plates to concrete paving.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Contact Owners project representative at least seven (7) working days in advance of installation to finalize all materials and coordinate site layout.

3.3 INITIAL CLEANING OF SALVAGED RAILROAD MATERIALS

A. Salvaged material was buried on site. Power wash salvaged railroad materials to remove dirt prior to installation.

3.4 SALVAGED STEEL RAIL ASSEMBLIES INSTALLATION

A. Unless otherwise indicated, install salvaged steel rail assemblies after paving has been completed.

B. Install level, plumb, true, and securely anchored at locations indicated on Working Drawings.

C. Salvaged steel rail assembly elements shall be handled in a manner that does not damage surrounding pavements, surfaces, and landscapes. Damage to salvaged elements and/or adjacent surfaces and landscapes will not be accepted and replacements of like kind and workmanship will result from damages of any type.

D. Provide aggregate base course for installation of salvaged steel rail assemblies in accordance with Section 31 05 17, “Aggregates for Site Earthwork”. Install and compact base course in accordance with Section 32 11 23, “Aggregate Base Course” to 95% standard proctor density.

E. Place filter fabric on top of aggregate base course and set salvaged wooden railroad ties level.

F. Set salvaged steel tie plates level on wooden railroad ties and attach with steel rail spikes. Set salvaged steel tie plates level on concrete surfaces and surface mount using railroad screw spikes.

G. Set salvaged steel rails across tie plates and attach to tie plates with salvaged steel rail spikes.

H. Ensure all rail assemblies are level and continuous prior to finalizing field assembly. Adjust as necessary prior to securing in place.

I. Place stone ballast within, beneath and around steel rail assemblies as indicated in the Drawings.

J. Re-check all anchoring and fastening mechanisms and entire construction to ensure a grounded, stable installation; rocking, tipping, sinking or other unstable installations will not be accepted. Un-level installations will not be accepted.

3.5 CLEANUP, REPAIR, PROTECTION AND DISPOSAL

A. Clean all installed salvaged steel rail assemblies after installation and inspect for damage. Document any damage to installed elements and provide documentation to Owner; repair damage per manufacturer’s recommendations or replace any element that exceeds small repairs or touch-ups as determined by the Owner.

B. During installation, keep adjacent paving and construction clean and work area in an orderly condition.

C. Protect adjacent surfaces and areas from damage due to installation operations. Protect custom fabrications from damage due to installation operations of other contractors.

D. Remove any and all surplus and waste material including excess or unsuitable soil, aggregate base, accessories and debris and legally dispose of them off Owners property.

END OF SECTION

SECTION 32 91 13

SOIL PREPARATION

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. Topsoil
2. Inorganic Soil Amendments
3. Organic Amendments
4. Fertilizers
5. Planting Soil for Planting Beds
6. Topsoil for Turfs and Grasses
7. Subgrade Soil Preparation
8. Placing Soil Materials

B. Related Sections:
1. Section 31 10 00 “Site Clearing” for topsoil stripping and stockpiling.
2. Section 31 22 13 “Rough Grading” for rough grading of site.
3. Section 31 23 17 “Site Excavation, Backfill, and Compaction” for excavation and filling of site.
4. Section 31 25 13 “Erosion and Sediment Control” for products and practices to control surface water runoff, soil and sediment control.
5. Section 32 12 43 “Porous Flexible Paving” for placing topsoil for porous flexible paving system.
6. Section 32 92 00 "Turf and Grasses" for placing topsoil for turf grass and native seeding areas.
7. Section 32 93 00 “Plants” for placing planting soil for plantings.
8. Section 32 91 34 “Bioretention Infiltration Area” for bioretention engineered soil profile.

1.3 REFERENCES

A. City of Madison Standard Specifications for Public Works Construction (herein referred to as MSN-SSPWC). Current edition.

B. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction. Current edition.

C. Wisconsin DNR CPS S100 “Compost”.

1.4 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

B. CEC: Cation exchange capacity.

C. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

D. Imported Soil: Soil that is transported to Project site for use.

E. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

F. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

G. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

H. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

I. SSSA: Soil Science Society of America.

J. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

K. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

L. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

M. USCC: U.S. Composting Council.

1.5 SUBMITTLAS

A. Product Data: For each type of pre-packaged or bulk soil amendment product used.

B. Submit a one-page typewritten document for coordinating soil sample collection at least ten (10) working days in advance of topsoil sample collection. The document shall include the name of the contractor, the date, the name of the quarry or property owner where topsoil will be mined if using mined material, the source of the topsoil stockpile if using stockpiled material, the location

within the project site where topsoil will be obtained for any stripped and salvaged topsoil, the current and historic use of each of the sites/locations where intended topsoil collection will occur, and the approximate quantities the Contractor intends to use from each different source. The document shall include maps of the areas where intended topsoil will be taken from with notation indicating the context as well as the exact locations where topsoil mining or stripping and stockpiling will occur. General sampling instructions can be found online at: learningstore.uwex.edu/Assets/pdfs/A2166.pdf

C. Submit topsoil testing results for individual components listed in paragraph 1.6 E. of this Section.

D. Submit testing results indicating that the compost and sand, if used on this project, meets the individual requirements outlined WDNR CPS 1004 and CPS S100.

1.6 QUALITY ASSURANCE

A. The Contractor is responsible for conducting testing and sending in samples for analysis of salvaged and imported topsoil, reviewing topsoil results, and submitting testing results to Landscape Architect for review and approval before any salvaged or imported topsoil materials can be used independently or as part of any soil mix on the project.

B. Soil-Testing Laboratory: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed. Preferred vendor is the University of Wisconsin Soil Testing Laboratories: uwlab.soils.wisc.edu.

C. The Landscape Contractor is responsible for collection of soil specimens. Collection shall be completed in accordance with accepted industry standards of care and acceptable practices; each separate source or location will require a separate sample and analysis. General sampling instructions can be found online at: learningstore.uwex.edu/Assets/pdfs/A2166.pdf.

D. Soil Analysis: Follow submission form instructions and submit samples for all topsoil intended to be used individually or as a component of a soil mixture for the project to the qualified soil-testing laboratory. Sample forms and instructions can be found at: uwlab.soils.wisc.edu/home-owners/lawn-garden/.

E. Provide results for the following categories for each individual sample submitted:
1. Lawn – New From Seed
2. Mixed Beds – Perennial Flowers & Shrubs
3. Include the following additional tests: Soluble Salts, Texture, Heavy Metals Testing (see list of individual metals below).

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Clean, salvaged, or imported material capable of passing the 1” sieve and meeting the minimum requirements of Section 625.2(1-2) of the Standard Specifications for Highway Construction.

The material shall be free of rocks, gravel, wood, debris, and of noxious weeds and their seeds and within the following acceptable ranges:

1. pH: 5.5 - 7.5
2. USDA soil texture classification: Loam, Sandy Loam
3. Amount of Phosphorous (P): 6 – 10 ppm
4. Amount of Potassium (K): 51 – 100 ppm
5. Percent Organic Matter: 5% – 8%
6. C:N Ratio: 12:1 to 15:1
7. Soluble Salts (in ds/M): 0-2 dS/m
8. Gravimetric Field Moisture Capacity (expressed as grams of water per 100 grams of oven dry soil): >15%
9. Heavy Metal (Cd): 0.01 – 3.0 ppm
10. Heavy Metal (Co): 1.0 – 40.0 ppm
11. Heavy Metal (Cr): 5.0 – 1000.0 ppm
12. Heavy Metal (Cu): 2.0 – 100.0 ppm
13. Heavy Metal (Fe): 10,000 – 50,000 ppm
14. Heavy Metal (Mn): 100 – 4,000 ppm
15. Heavy Metal (Mo): 0.5 – 40.0 ppm
16. Heavy Metal (Ni): 1.0 – 200.0 ppm
17. Heavy Metal (Pb): 2.0 – 200.0 ppm
18. Heavy Metal (Zn): 10 – 300 ppm
19. Heavy Metal (Li):1.2 – 98.0 ppm

B. Of particular importance is the control of invasive species on this project; the Contractor must ensure that topsoil materials used alone or as part of a planting soil blend do not contain any roots, stems, seeds or other parts of any invasive or noxious species. Additional information on invasive species in the State of Wisconsin and additional information on their control can be found at the Wisconsin DNR Invasive Species Web Resource: dnr.wi.gov/topic/invasives

C. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones ½-inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes; grubs; or other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled pore space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

D. Topsoil shall meet all of the requirements outlined in this Section and topsoil results shall be reviewed and approved by the Landscape Architect before topsoil delivery to site or use in any soil mixture for the project.

E. Any adjustments to pH, nutrient content, or soil texture class shall be performed off-site and pre-blended before spreading; re-testing of adjusted topsoil will be required in order to confirm conformance with the ranges outlined in this Section.

F. Final topsoil is subject to approval by Landscape Architect based on laboratory soil test results. Landscape Architect reserves the right to reject any topsoil source that does not meet the specific ranges and requirements listed in this Section or that can be easily amended to fall within the ranges. A different topsoil source may be required if test results indicate that topsoil falls too far outside of acceptable ranges; new sources will require testing, review and approval for use, at no additional cost to the project, prior to acceptance and delivery to the project site or use in any soil mixes.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   1. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.
   2. Provide lime in form of ground dolomitic limestone.
   3. Application amounts of lime will be governed by the recommendations of the independent testing firm's soil testing results.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.
   1. Application amounts of sulfur will be governed by the recommendations of the independent testing firm's soil testing results.

C. Sand: Clean, washed, natural or manufactured, and free of toxic materials. 50% Mineral (SiO2). All sand shall be washed to remove clay and silt particles, and be well-drained prior to mixing. Sand shall meet one of the following gradation requirements:
   1. USDA Coarse Sand (.02-.04 inches).
   2. ASTM C33 (Fine Aggregate Concrete Sand).
   3. WIS DOT Standard & Specifications for Highway and Structure Construction, Current Edition, Section 501.2.5.3.4 (Fine Aggregate Concrete Sand).

2.3 ORGANIC SOIL AMENDMENTS

A. Mycorrhizal Inoculant: CPR #1 Mycorrhizal Root Inoculant from BioGreen LLC, 30937 Gilmer Road, Volo, IL; (847) 740-9637, or approved equal. Rates, method(s), and timing of application shall be per BioGreen's written instructions for this specific site and micro-application based on planting type and locationRetain one of or both "Sulfur" and "Iron Sulfate" paragraphs below if required. Do not use aluminum sulfate. Revise descriptions and insert proprietary products if required.

B. Compost meeting WDNR CPS S100:
   1. Compost is a mixture that consists largely of aerobically decayed organic waste. This specification outlines the minimum material requirements for compost intended to be used in accordance with the criteria WDNR CPS S100. Compost meeting this specification is appropriate for use for compaction mitigation and as a component of planting soil mixtures.
   2. The following material requirement shall be met:
      a. Particle Size: 98% of the compost shall pass through a 0.75-inch screen.
      b. Physical Contaminants: Less than 1% combined glass, metal and plastic.

c. Organic Matter/Ash Content: At least 40% organic matter, less than 60% ash content.
d. Carbon to Nitrogen Ratio: 10-20:1 C:N ratio.
e. pH: Between 6 and 8.
f. Soluble Salts: Electrical conductivity below 10 dS m-1 (mmhos cm-1).
g. Moisture Content: Between 35% and 50% by weight.
h. Maturity: The compost shall be resistant to further decomposition and free of compounds such as ammonia and organic acids, in concentrations toxic to plant growth.
i. Residual Seeds and Pathogens: Pathogens and noxious seeds shall be minimized.
j. Pathogens: The compost shall meet the Class A requirements for pathogens as specified in s. NR 204.07(6)(a), Wis. Adm. Code.
k. Other Chemical Contaminants: The compost shall meet the high quality pollutant concentrations as specified in s. NR 204.07(5)(c), Wis. Adm. Code.

3. Do not use leaf compost

C. Of particular importance is the control of invasive species on this project; the Contractor must ensure that any compost materials used alone or as part of a planting soil blend do not contain any roots, stems, seeds or other parts of any invasive or noxious species. Additional information on invasive species in the State of Wisconsin and additional information on their control can be found at the Wisconsin DNR Invasive Species Web Resource: dnr.wi.gov/topic/invasives.

2.4 FERTILIZERS

A. The use of fertilizer type, composition and application for planting beds and lawn areas for this project will be dictated by the written results of the soil tests and must meet the requirements of the State of Wisconsin Statutes. Fertilizers could include:
1. Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in a composition recommended by the soil test results.
2. Slow-release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in a composition and application rate recommended by the soil test results.

2.5 PLANTING SOIL FOR PLANTING BEDS

A. Planting Soil will be produced by utilizing approved topsoil and amendments and will be used in all planting beds and will be a blend of the following:
1. 6 parts topsoil
2. 1 part sand
3. 2 parts compost
4. Mychorrhizal inoculant
5. Other amendments and fertilizer as recommended by the soil test results specific to establishing plant material.

B. Thoroughly blend Planting Soil off-site before spreading. Any adjustments to pH, nutrient content, or soil texture class shall be pre-blended before spreading.

C. Final Planting Soil mix composition and ratios are subject to modification by the Landscape Architect based on topsoil testing results.

2.6 TOPSOIL FOR LAWNS

A. Provide topsoil meeting the requirements of this section and approved for use on the project and include other amendments and fertilizer as recommended by the soil test results specific to establishing new lawns.

B. Any adjustments to pH, nutrient content, or soil texture class shall be made off-site prior to delivery and installation.

2.7 ENGINEERED SOIL FOR BIORETENTION AREAS

A. See Section 32 91 34 “Bioretention Infiltration Area”

PART 3 - EXECUTION

3.1 SUBGRADE SOIL PREPARATION

A. Remove all vegetation as needed with broad spectrum herbicide such as Round-Up. Remove all rocks, debris, and litter that will prevent compliance with this section and other sections of the Contract. Subgrades are those grades present on-site during construction. Compacted subgrades shall be excavated and removed in order to install soil materials in depths indicated in this Section and to achieve final grades as indicated in Working Drawings. Contractor shall account for settling when determining amounts for initial placement of soil materials; depths indicated in this Section represent final proposed depths after settling has occurred.

B. Rip, fracture, till or disc the subsoil to a minimum depth of 12” to 18” to allow aeration. Remove any and all stones greater than 6” that rise to the surface during subsoil decompaction operations.

C. Excavate subgrades as necessary to provide the depths of soil materials indicated in this section and in coordination with the Civil Engineer’s grading plan. The grading plan indicates final surface grades of soil materials; Contractor shall account for settling when determining quantities of each material to be placed over prepared subgrades

D. Examine all prepared subsoils prior to the delivery or installation of soil materials for any and all detrimental conditions including compaction, contamination by deleterious materials, presence of large construction debris, and/or any other negative conditions. Contractor shall notify General Contractor and Owners project representative of any and all subsoil preparation inadequacies immediately and soil materials shall not be placed until all subsoil deficiencies have been corrected. Contractor will be held responsible for negative results from improper subsoil preparation if soil materials are placed with disregard to inadequately prepared subsoils.

3.2 PLACING SOIL MATERIALS

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by soil material installation operations.

B. Account for settling when determining amounts of soil materials required to meet proposed site grades and spot elevations; depths indicated in this Section represent final proposed depths after settling has occurred.

C. Do not apply any soil materials to saturated or frozen subgrades.

D. Compost may be blended into topsoil prior to placement in lawn areas if initial soil tests indicate low organic matter content of the topsoil intended to be used; compost will be considered incidental to the topsoil. The Contractor may also choose to find a different source for topsoil which meets the requirements of this section without the addition of compost.

E. Install soil materials in 6 inch lifts. After the first lift is installed in all areas, Contractor shall work soil materials into top 2 to 4 inches of decompacted subgrades to blend. Any additional soil materials shall be installed in subsequent lifts of no more than 6 inches.

F. Install soil materials to the following depths over prepared, decompacted subsoils:
   1. Topsoil: Apply a “light dusting” at porous flexible paving system in accordance with Section 32 12 43 “Porous Flexible Paving”
   2. Topsoil: 6” above prepared site subgrades for all areas to receive Bluegrass or No-Mow Fescue Lawn seed except within the limits of the porous flexible paving system.
   3. Topsoil: 12” above prepared site subgrades for all site areas to receive Native seed mix.
   4. Planting Soil for Planting Beds: 18” above prepared site subgrades for all at-grade planting beds.
   5. Engineered Soil for bioretention basin: Place Engineered soil in accordance with the Contract Drawings and with Section 32 91 34 “Bioretention Infiltration Area”.

G. Stockpile any additional amended soil materials on site for fine grading operations, to repair areas which may settle, and to backfill planting holes if additional soil material is needed.

3.3 PROTECTION

A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Vehicle traffic.
   4. Foot traffic.
   5. Erection of sheds or structures.
   6. Impoundment of water.
   7. Excavation or other digging unless otherwise indicated.

B. If soil materials or subgradse are overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.4 FERTILIZER

A. Fertilizer shall be applied only as recommended by the soil tests and only as directed by the Landscape Architect. Fertilizer shall be blended into the entire depth of Topsoil during decompaction operations.

3.5 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owners property unless otherwise indicated.
   1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owners project representative.

END OF SECTION

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SECTION 32 91 34

BIORETENTION INFILTRATION AREA

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe Materials.
2. Aggregate and Soil Materials.
3. Installation.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 31 05 13 – Soils for Earthwork.
3. Section 31 05 17 – Aggregates for Site Earthwork.
4. Section 31 23 17 - Site Excavation, Backfill, and Compaction: Excavating and backfilling for drainage system piping and surrounding filter aggregate.
5. Section 32 93 00 – Plants: Plants, mulch, stone and jute mat.
6. Section 33 41 00 – Site Storm Sewer System.

1.2 DEFINITIONS

A. Bioretention Infiltration Area - A planted depression that allows rainwater runoff from impervious urban areas like roofs, driveways, walkways, parking lots, and compacted lawn areas the opportunity to be absorbed. This reduces rain runoff by allowing stormwater to soak into the ground, as opposed to flowing into storm drains and surface waters which causes erosion, water pollution, flooding, and diminished groundwater.

1.3 REFERENCES

A. ASTM International (ASTM)
1. ASTM D2434 – Standard Test Method for Permeability of Granular Soils (Constant Head).
2. ASTM D2729 - Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
3. ASTM F758 - Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage.

B. Wisconsin Department of Natural Resources: (WDNR)
1. Conservation Practice Standard (1002) – Site Evaluation for Storwater Infiltration.
2. Conservation Practice Standard (1004) – Bioretention for Infiltration.
3. Chapter NR 151 – Runoff Management.

1.4 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Shop Drawings: Indicate dimensions, layout of piping, high and low points of pipe inverts, and gradient of slope between corners and intersections.

C. Product Data: Submit data on pipe drainage products, pipe accessories, and joints.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Division 01 - General Requirements: Closeout procedures.

B. Record location of pipe runs, connections, cleanouts, and principal invert elevations.

1.6 DESIGN REQUIREMENTS

A. Flow Regulation:
   1. Inflow:
      a. Inflow shall be controlled to prevent erosion and achieve uniform distribution across the surface of the bioretention infiltration area.
      b. Outflow shall have a weir or standpipe to regulate the maximum ponding depth. The invert of the overflow structure shall be at the elevation of the maximum ponding depth of the bioretention infiltration area.
      c. Water discharged from the overflow shall be conveyed to a stable outlet leading to a conveyance method such as a swale, storm drain or surface water.
   2. Overflow:
      a. Overflow control structures, such as curtain drains, that bypass the soil planting bed and discharge directly to ground water are allowed only if the sole source of stormwater runoff is from rooftops without significant contamination from industrial activity.
   3. Underdrain:
      a. The perforated underdrain is required unless there is no suitable pipe outlet or interface is minimal.
   4. Ponding Area:
      a. Maximum Design Ponding Depth: The design ponding depth shall not exceed 12 inches.
      b. Drawdown Time: In designing the bioretention infiltration area, the design ponding depth divided by the Design Drawdown Rate shall not exceed 24 hours.
      c. Side Slopes: The side slopes of the berm that forms the ponding area shall be 2H:1V or flatter.
   5. Planting Bed Vegetation and Surface Mulch Area:
      a. Vegetation Plan: A vegetation plan has been prepared by the Landscape Architect.
   6. Engineered Soil Planting Bed:
      a. Surface area shall be as indicated on Drawings.
      b. Surface slope of the device shall not exceed (1) one percent.
      c. The engineered soil depth, after settling, shall have sufficient soil to support the rooting depth of the vegetation. If the storage layer uses 1-1/4 washed stone, a layer of pea gravel not to exceed 4 inches shall separate the engineered soil from the storage layer. The soil layer, including the pea gravel layer shall be at least (3) three feet deep.
      d. The engineered soil mix shall be free of rocks, stumps, roots, brush or other material over (1) one inch in diameter. No other materials shall be mixed with the planting soil that may be harmful to plant growth or prove a hindrance to planting or maintenance.
      e. The planting mixture shall consist of a mixture of 70 percent to 85 percent sand and 15 percent to 30 percent compost. Plant selection shall be selective when the percentage of sand exceeds 75 percent of the engineered soil.

f. The engineered soil mix shall have adequate nutrient content to meet plant growth requirements.
g. Permeability testing shall be performed on the engineered fill prior to use in accordance with ASTM D2434.

7. Underdrain:
   a. A perforated underdrain pipe is required unless there is no suitable pipe outlet or the risk of infiltration failure at the native soil interface is minimal. The risk of infiltration failure is assumed to be minimal if the design infiltration rate of the native soil is determined to be at least 3.6 inches per hour.
   b. Pipe Location:
      1) Underdrain pipe shall be placed at the bottom of the engineered soil layer.
   c. Pipe Size and Material:
      1) Underdrain pipe shall have a minimum diameter as shown on the Drawings.
      2) Underdrain pipe shall be rated to withstand anticipated traffic loads.
   d. Oriface Diameter:
      1) The underdrain orifice shall be restricted as necessary so that the design infiltration rate plus the underdrain flow rate equals the design draw down rate. The restriction shall be achieved by using an adjustable restrictor plate or valve. The restriction device shall be accessible for adjustment.
   e. Perforations:
      1) The total opening area of all perforation holes combined shall be sufficient to allow the underdrain pipe to discharge at full capacity, as would occur if there were no orifice restriction. The amount of perforation shall be increased to provide a margin of safety but shall not be so great as to compromise the structural integrity of the pipe material.
   f. Pipe Protection:
      1) The underdrain be protected from clogging by the use of filter fabric or a filter sock.
      2) If the storage layer is sand, a filter sock shall be used. Pipe may also be covered by pea gravel.
      3) If used, the pea gravel area shall be at least 4 inches thick. Pea gravel shall be washed.
      4) Filter fabric shall be wrapped around pipe and shall not extend laterally from either side of the pipe more than (2) two feet.
      5) Filter sock fabric openings shall be small enough to prevent sand particles from entering into underdrain pipe. The flow rate of the fabric shall be capable of passing water at a rate equal to or greater than the flow rate capacity of the total combined perforations in the underdrain pipe.
   g. Clean-Out Port:
      1) The underdrain pipe shall have a vertical connecting standpipe to serve as a clean-out port for the underdrain pipe.
      2) Clean-out pipe shall be non-perforated Schedule 40 PVC pipe, 6-inches minimum diameter and covered with a watertight cap that is flush with the finished ground elevation.
   h. Overflow Pipe Drainage:
      1) The overflow pipe shall be discharged to an existing drainage system including but not limited to swales, storm sewers, subsurface dispersal fields and surface waters.
      2) A check valve shall be installed when backflow is possible.
      3) Access for maintenance of the check valve shall be provided.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. Polyvinyl Chloride Pipe: ASTM D2729 or ASTM F758; plain end, 6 inch inside diameter; with required fittings.
   1. Pipe shall be perforated with two rows of 1/2-inch diameter hole every 5 inches. Rows shall be parallel to pipe and 120 degrees apart.

B. Filter Fabric Sock Fabric:
   1. Filter sock shall be an approved knitted fabric which completely covers and is secured to perforated plastic underdrain.
   2. Filter sock shall be a continuous one piece material that fits over pipe like a sleeve.
   3. Filter sock shall be knitted of continuous 150 denier yarn and be free from any chemical treatment or coating that might significantly reduce porosity and permeability.
   4. Place knitted fabric sock around pipe in shop to maintain uniformity of pipe coverage.

C. Geotextile Fabric: Use a geotextile fabric of knitted, woven, or non-woven fibers of polyester, polypropylene, stabilized nylon, polyethylene or polyvinyl chloride. Do not use slit film woven fabrics for this work. The fabric shall conform to the following requirements:

Test	Method	Value [1]
Minimum Grab Tensile Strength	ASTM D4632	35 lb.
Apparent Opening Size	ASTM D4751	No. 30-200
Minimum Permittivity		1.35 s_{-1}

2.2 ENGINEERED SOIL

A. Engineered Soil Composition: The engineered soil shall be engineered to the following specifications:
   1. Sand:
      a. The planting mixture shall consist of a mixture of 70 percent to 85 percent sand and 15 percent to 30 percent volume. Special attention should be given to plant selection when the percentage of sand exceeds 75 percent.
      b. The sand shall meet gradations identified in this Section.
      c. The preferred sand component consists of mostly SiO_2, but sand consisting of dolomite or calcium carbonate may also be used. Manufactured sand or stone dust is not allowed.
      d. The sand shall be washed and drained to remove clay and silt particles prior to mixing.
   2. Compost:
      a. Compost material shall meet the following requirements:
         1) Particle Size – 98 percent of the compost shall pass through a 0.75-inch screen.
         2) Physical Contaminants – Less than 1 percent combined glass, metal and plastic.
         3) Organic Matter/Ash Content – At least 40 percent organic matter and less than 60 percent ash content.
         4) Carbon to Nitrogen Ratio – 10-20:1 C:N ratio.
         5) pH – Between 6 and 8.
         6) Soluble Salts – Electrical conductivity below 10 dS m_{-1} (mmhos cm -1)
         7) Moisture Content – Between 35 percent and 50 percent by weight.

8) Maturity – The compost shall be aged and resistant to further decomposition and free of compounds, such as ammonia and organic acids, in concentrations toxic to plant growth.
9) Residual Seeds & Pathogens – Pathogens and noxious seeds shall be minimized.

B. The engineered soil mix shall be free of rocks, stumps, roots, brush or other material over 1 inch in diameter. No other materials shall be mixed with the planting soil that may be harmful to plant growth or prove a hindrance to planting or maintenance.

C. The engineered soil mix shall have a pH between 5.5 and 6.5. The engineered soil mix shall have adequate nutrient content to meet plant growth requirements.

2.3 PEA GRAVEL – FILTER AGGREGATE

A. Aggregate Type A8 (Pea Gravel) as specified in Section 31 05 16 – Aggregates for Earthwork: Fractured, washed, free of clay, shale, organic matter; graded in accordance with the following limits:
1. Minimum Size: 1/4-inch.
2. Maximum Size: 3/8-inch.

2.4 CLAY LINER

A. Clay Liner: Where soil geotechnical results show that a clay liner needs to be laid on the infiltration area floor and internal embankments, the following criteria apply:
1. Permeability must be $\leq 1.0 \times 10^{-9}\ m \cdot s^{-1}$.
2. The material used should be classified as CL, CI, CH, SC or GC under the Unified Soil Classification System.
3. Clay-dominant material should have a Liquid Limit between 30 percent and 60 percent and a Plasticity Index of >10 percent.

2.5 ACCESSORIES

A. Clean Outs:
1. Pipe and Fittings: 6-inch plain PVC, ASTM D2729.
2. Plug: 6-inch adaptor with threaded cover. Solvent weld adaptor to pipe.
3. Frost Sleeve: 8-inch diameter steel pipe.
4. Backfill: Type A5 aggregate as specified in Section 31 05 17 – Aggregates for Site Earthwork.

B. Plant bioretention infiltration area with native plants as specified in Section 32 93 00 - Plants.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Division 01 - General Requirements: Coordination and project conditions.

B. Verify trench cut and excavated base is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 VERIFICATION

A. The bioretention area shall be located a minimum of 50 feet from any Private Onsite Wastewater Treatment System (POWTS) and shall not be hydraulically connected to the POWTS dispersal cell or cause negative impacts such as cross contamination.

B. The bioretention area shall not be hydraulically connected to building or pavement foundations or cause negative impacts to structures.

C. Sloped areas immediately adjacent to the bioretention device shall be less than 20 percent but greater than 0.5 percent for pavement and greater than 1 percent for vegetated areas to ensure positive flow towards the device.

3.3 PREPARATION

A. Contractor shall provide a person trained and experienced in the construction, operation and maintenance of infiltration areas and shall be responsible for construction of the infiltration area.

B. Construction site runoff from disturbed areas shall not be allowed to enter the bioretention area during construction.

C. Runoff from pervious areas shall be diverted from the device until the pervious areas have undergone final stabilization.

D. Construction shall be suspended during periods of rainfall or snowmelt. Construction shall remain suspended if ponded water is present or if residual soil moisture contributes significantly to the potential for soil smearing, clumping or other forms of compaction.

E. Compaction and smearing of the soils beneath the floor and side slopes of the bioretention area, and compaction of the soils used for backfill in the soil planting bed, shall be minimized.

F. During site development, the area dedicated to the bioretention area shall be cordoned off to prevent access by heavy equipment.

G. Acceptable equipment for constructing the bioretention area includes excavation hoes, light equipment with turf type tires, marsh equipment or wide-track loaders.

H. If compaction occurs at the base of the bioretention area, the soil shall be re-fractured to a depth of at least 12 inches.

I. If soil smearing occurs, the smeared areas of the interface shall be corrected by raking or roto-tilling.

3.4 SUBDRAINAGE INSTALLATION

A. Install pipe in conformance with requirements of ASTM D2321 and Section 33 41 00 – Site Storm Sewer System.

B. Place drainage pipe on Type A5 stone bedding, as specified in Section 31 05 17 – Aggregates for Site Earthwork.

C. Lay pipe to slope gradients noted on Drawings; with maximum variation from indicated slope of 1/8-inch in 10 feet.

D. Place pipe with perforations facing down. Join pipe with integral bell gasketed joint.

E. Provide and install pipe couplings as required for specific fitting applications.

F. Install Type A5 stone cover, as specified in Section 31 05 17 – Aggregates for Site Earthwork, at sides, over top of pipe. Install top cover compacted thickness of 12 inches up to bioretention area.

G. In non-paved areas provide and install Type T1 or T2 topsoil fill as specified in Section 31 05 13 – Soils for Earthwork, over geotextile fabric covering stone to prevent migration of soil particles into stone and causing future clogging.

3.5 INSTALLATION

A. The sidewalls of the planting bed area may be sloped as needed to assure a stable configuration.

B. To reduce lateral flow of water from the bioretention area towards pavement foundations, a geotextile fabric may be placed along the side-walls of the device.

C. Placement and Settling of Engineered Soil:
1. Prior to placement in the bioretention area, the engineered soil shall be premixed and the moisture content shall be low enough to prevent clumping and compaction during placement.
2. The engineered soil shall be placed in multiple lifts, each approximately 12 inches in depth.
3. Steps may be taken to induce mild settling of the engineered soil bed as needed to prepare a stable planting medium and to stabilize the ponding depth. Vibrating plate-style compactors shall not be used to induce settling.
4. The entire soil planting bed shall be mulched prior to planting vegetation to help prevent compaction of the planting soil during the planting process. Mulch shall be pushed aside for the placement of each plant.

D. Planting of Bioretention Infiltration Area:
1. Reference Section 32 93 00 - Plants.

3.6 FIELD QUALITY CONTROL

A. A 72-hour time limit is established in this standard for draining water from a fully saturated bioretention device.

B. This limit is established to reduce the risk of declining infiltration caused by persistent saturation at the native soil interface.

C. The maximum allowable thickness of the storage layer will depend on how much time is available to drain water from that layer after time is taken to drain water from the ponding area and engineered soil.

D. The water in the ponding area and the engineered soil exits the bioretention device via the underdrain and the native soil. The water in the storage layer exits only via the native soil.

3.7 PERMEABILITY TESTING

A. Permeability testing shall be conducted in accordance with ASTM D2434.

B. Contractor shall provide and pay for the permeability testing.

C. Description and Test Procedure:
1. The constant head permeability test shall involve the flow of water through a column of cylindrical soil sample under the constant pressure difference.
2. The test shall be carried out in the permeability cell, or permeameter, which can vary in size depending on the grain size of the tested material.
3. The soil sample has a cylindrical form with its diameter being large enough in order to be representative of the tested soil.
4. As a rule of thumb, the ratio of the cell diameter to the largest grain size diameter should be higher than 12.
5. The testing apparatus shall be equipped with a adjustable constant head reservoir and an outlet reservoir which allows maintaining a constant head during the test.
6. Water used for testing is de-aired water at constant temperature.
7. The permeability cell shall be also equipped with a loading piston that shall be used to apply constant axial stress to the sample during the test.
8. Before starting the flow measurements saturate the soil sample.
9. During the test, measure the amount of water flowing through the soil column for given time intervals.
10. Knowing the height of the soil sample column L, the sample cross section A, and the constant pressure difference Δh, the volume of passing water Q, and the time interval ΔT, one can calculate the permeability of the sample as: $K=QL / (A.\Delta h.\Delta t)$.

3.8 OPERATION AND MAINTENANCE

A. Contractor shall provide a 12-month operation and maintenance plan that is consistent with the purposes of bioretention infiltration area, its intended life, safety requirements and the criteria for its design.

B. The plan shall be developed for inspection, operation and maintenance of the bioretention infiltration area at scheduled timeframes during the 6-month period.

C. The plan shall assign responsibility for activities and the qualifications of the personnel performing the work.

D. At a minimum, the plan shall address operation and maintenance of all vegetative and non-vegetative components identified in this standard.

E. At a minimum, the plan shall also include details on the following:
1. Frequency of inspections.
2. Inspecting for sediment buildup and clogging, erosion, trash and debris build-up and plant health.
3. Frequency of sediment removal.

4. Disposal locations for sediment.
5. pH testing of the soil.
6. Frequency of soil, mulch, and plant replacement.
7. Inlet and outlet maintenance, and providing access to perform the operation and maintenance activities.
8. The maintenance activities in the plan shall be as follows:

Activity	Frequency
Water Plants	As necessary during first growing season
Water as necessary during dry periods	As needed after first growing season
Re-mulch void areas	As needed
Treat diseased trees and shrubs	As needed
Inspect soil and repair eroded areas	Monthly
Remove liter and debris	Monthly
Add additional mulch	Once per year

F. Contractor shall notify Owner regarding not allowing snow removal and dumping directly onto the conditioned planting bed. Owner shall notify snow removal providers of this requirement.

G. If Contractor fails to notify Owner in writing of this requirement, the Contractor shall assume all costs of restoring the infiltration area.

H. If the Owner fails to comply with Contractor's written requirements regarding snow removal and dumping on the infiltration area, the Owner shall pay for all restoration of the infiltration area including labor, materials and removal of damaged plantings and components of infiltration area.

I. At end of 12-month operation and maintenance program the Owner shall assume all operations and maintenance of the bioretention infiltration area, if area is functioning as designed and plantings are growing vigorously.

3.9 PROTECTION OF INSTALLED CONSTRUCTION

A. Division 01 - General Requirements: Protecting installed construction.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION

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SECTION 32 92 00

TURF AND GRASSES

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. Seeding for Bluegrass Lawn
2. Seeding for No-Mow Fescue Lawn
3. Native Seeding
4. Mulches and Erosion Control Material
5. Maintenance

B. Related Sections:
1. Section 31 10 00 “Site Clearing” for topsoil stripping and stockpiling.
2. Section 31 22 13 “Rough Grading” for rough grading of site.
3. Section 31 23 17 “Site Excavation, Backfill, and Compaction” for excavation and filling of site.
4. Section 31 25 13 “Erosion and Sediment Control” for products and practices to control surface water runoff, soil and sediment control.
5. Section 32 12 43 “Porous Flexible Paving” for coordination of seeding at turf reinforced porous flexible paving.
6. Section 32 91 13 “Soil Preparation” for suitable topsoil and amendments and for subgrade soil preparation and topsoil depths under lawns.
7. Section 32 93 00 “Plants” for coordination of seeding with plantings and edging methods and materials.

1.3 REFERENCES

A. City of Madison Standard Specifications for Public Works Construction (herein referred to as MSN-SSPWC). Current edition. Article 207 “Seeding”.

B. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, current edition.

1.4 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Division 32 Section “Soil Preparation”.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated:
   1. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

B. Certification of Seed for Bluegrass and No-Mow Fescue Lawn Mixes: From seed vendor showing seed mix composition and a guarantee of germination and the following information:
   1. Scientific name of genus and species (subspecies and varieties, as necessary) for each bluegrass and fescue species.
   2. Calendar year in which seed was collected.
   3. Seed origin.
   4. Proposed seeding rate.

C. Certification of Seed for Native Seed Mix: From seed vendor showing seed mix composition and a guarantee of germination and the following information and/or guarantees:
   1. Scientific name of genus and species (subspecies and varieties, as necessary) and guarantee that seeds are true to species.
   2. Bulk weight of seed.
   3. Pure Live Seed (PLS)
   4. Supplier lot identification.
   5. Calendar year in which seed was collected.
   6. Seed origin (geographical location).
   7. Seed supplier contact information including company name, address, phone number, contact person’s name and e-mail address.

D. Qualification Data: For qualified Landscape Installer whose work has resulted in successful short and long-term establishment and maintenance of lawns and native vegetation.

E. Product Certificates: For fertilizers, from manufacturer.

1.6 QUALITY ASSURANCE

A. Additional Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf grass, no-mow fescue, and native seed establishments from seed on large-scale commercial or municipal projects and with a minimum of five (5) years' experience in turf grass, no-mow fescue, and native seed installation.
   1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   2. Pesticide Applicator: State licensed, commercial.

1.7 SUBSTITUTIONS

A. Product substitutions may be considered as an equivalent only if proposed substitution meets all areas of this specification without exception. Manufacturers seeking consideration as an equivalent product must submit product data, records, test results, samples, certifications and any additional documentation deemed necessary by Owners project representative to prove equivalency. Owners project representative must review and approve proposed substitutions prior to their ordering and use.

1.8 DELIVERY, STORAGE AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable. Store any seed delivered prior to use in a manner safe from damage from heat, moisture, rodents, or other causes of degradation.

B. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

A. Seeding Restrictions for Bluegrass and No-Mow Fescue Lawn Seeding: Seed during one of the following periods. Coordinate seeding with initial maintenance periods to provide required maintenance from date of seeding completion:
   1. Spring Seeding: April 15 – June 15
   2. Fall Seeding: September 1 – October 15

B. Seeding Restrictions for Native Seeding: Seed during one of the following periods. Coordinate seeding with initial maintenance periods to provide required maintenance from date of seeding completion:
   1. Regular Seeding Season: May 1 – June 15
   2. Dormant (fall) Seeding: October 30 to snowfall

C. Weather Limitations: Proceed with seeding only when existing and forecasted weather conditions permit seeding to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

D. No seeding shall occur on frozen ground or at temperatures lower than 32 deg. F.

1.10 MAINTENANCE SERVICE

A. Provide full maintenance by skilled employees of Landscape Installer. Maintain each grass type as required in Part 3, this Section. Begin maintenance immediately after each area is seeded.

B. Maintenance and Warranty Period: The start date for the maintenance and warranty period for all seeded areas is the date (month, day, and year) that all turf grass and native seeding areas are considered substantially complete by the Owners project representative. The maintenance and warranty period shall be for 1 year from the date of substantial completion.

1.11 GUARANTEE

A. The contractor shall guarantee the germination of seed installed during the regular seeding seasons.

B. If seeding occurs late in the season and germination cannot be guaranteed, Contractor shall work to provide erosion control and prevention coverage for any and all bare soil areas over winter and shall re-seed in the spring in accordance with the erosion control permits and requirements for the project.

PART 2 - PRODUCTS

2.1 TURF GRASS SEED

A. Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Mixes:
   a. Bluegrass Lawn (Seed Mix A): “Sun Terrace Mix” in accordance with City of Madison Standard Specifications, Article 207 for material quality and mix composition.
   b. No-Mow Fescue Lawn (Seed Mix B) is an equal 50%/50% blend of the following:
      1) “Bruiser Tall Fescue Blend” by Heritage Seed Company, 1-855-248-3237, http://www.heritage-seed.com/ or approved equal.
      2) “Meadow Fine Fescue Blend” by Heritage Seed Company, 1-855-248-3237, http://www.heritage-seed.com/ or approved equal.

2.2 NATIVE SEED

A. Provide seed of species and varieties, proportions by seed count, and minimum percentages of purity, germination and maximum percentage of weed seed as indicated below.

B. Species composed of pure live seed (PLS) shall contain no named or improved varieties. PLS shall be from Iowa, Wisconsin, Northern Illinois, or Western Minnesota nurseries specializing in growing native species from Illinois genotypes.

C. All seed shall be cold, dry stratified; legumes shall be scarified and inoculated with proper rhizobia immediately prior to planting (three hours or less). Legumes shall be kept out of the forbs mixture until after inoculation. Seed mixture shall be blended by the vendor and ratios of various species shall be guaranteed by the seed vendor in writing as specified. Minimum percent purity for native species is 96 percent. Any substitutions of species due to availability must be approved by Landscape Architect.

D. Native Seed Mix: "Land Restoration for Medium Soils" #50047 by Prairie Nursery, 1-800-476-9453, www.prairienursery.com or approved equal.

2.3 WATER

A. Water free of wastewater effluent or other hazardous chemicals.

2.4 TOPSOIL

A. Provide topsoil for seeded areas in accordance with Section 32 91 13, "Soil Preparation".

2.5 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium.
   1. Provide fertilizer of blend recommended by soil tests for establishing lawns from seed in accordance with all State Statutes and Article 207 of the MSN-SSPWC.

2.6 MULCHES & STABILIZERS

A. Provide mulch and soil stabilizer materials in accordance with Articles 207.2(c) and 207.2(d) of the MSN-SSPWC.

2.7 EROSION CONTROL MATERIALS

A. Provide erosion control materials in accordance with Section 31 25 13, "Erosion and Sediment Controls"

2.8 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be seeded for compliance with requirements and other conditions affecting installation and performance of the Work.
   1. Verify that sufficient Topsoil has been provided both in terms of quality and quantity (depths) as indicated in Section 32 91 13 “Soil Preparation”. If insufficiencies in topsoil occur, Landscape Contractor shall notify Owners project representative immediately and shall not begin any seeding operations until any and all unsatisfactory conditions have been corrected.
   2. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within any seeding areas.
   3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a seeding area, remove the soil and contamination as directed by Engineer and replace with new topsoil meeting the requirements of Section 32 91 13 “Soil Preparation”.

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

D. Suspend seeding operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by seeding operations.

B. Examine in place erosion-control measures and install any additional measures necessary to ensure there will be no erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 PREPARATION FOR SEEDING BLUEGRASS AND NO-MOW FESCUE LAWNS

A. Limit preparation to areas to be seeded. Remove any and all undesirable vegetation that has germinated in the areas to be seeded. Contractor shall evaluate in consultation with the Owners project representative the use of a broad spectrum, non-persistent glyphosate-based herbicide based on site conditions including the presence of specific broadleaf weed species for the optimum control of invasives. The use of methods other than glyphosate is preferred. If determined that glyphosate treatment should be part of initial preparation based on specific site conditions, the following conditions shall be met, at a minimum:

1. Herbicide should be applied when plants are green and actively growing. Do not apply before or after growing season.
2. Do not apply seed until five to seven days after last herbicide treatment.

B. Confirm topsoil has been provided per Specification Section 32 9113 “Soil Preparation” in the areas and depths indicated by the written specifications. If unsuitable topsoil conditions or depths exist, notify General Contractor immediately and do not proceed with seeding operations until any and all unsatisfactory conditions have been corrected.

C. Finish Grading: Grade areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus ½-inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be seeded in the immediate future. Apply additional topsoil if necessary to achieve uniform, smooth surfaces.

D. Moisten prepared area before seeding if soil is dry. Water thoroughly and allow surface to dry before seeding. Do not create muddy soil.

E. Before seeding, obtain Owners acceptance of finish grading; restore seeding areas if eroded or otherwise disturbed after finish grading.

F. No seeding shall occur on frozen ground or at temperatures lower than 32 deg. F.

3.4 SEEDING BLUEGRASS AND FESCUE LAWNS

A. Seed bluegrass lawn (Seed Mix A) at rates and methods in accordance with Article 207.3(a) of the MSN-SSPWC. Include cover crop for late fall seed applications if necessary.

B. Seed no-mow fescue lawn (Seed Mix B) at seed supplier recommended rates and methods.
1. Preferred sowing method at porous flexible paving area: Method B, Hydroseeding/hydro-mulching per seed supplier’s recommendations.

3.5 PREPARTION FOR NATIVE SEEDING

A. For spring planting, mow any undesirable vegetation to 4 inches or less in height 2-4 weeks before seeding. Contractor shall evaluate in consultation with the Owners project representative the use of a broad spectrum, non-persistent glyphosate-based herbicide based on site conditions including the presence of specific broadleaf weed species for the optimum control of invasives. The use of methods other than glyphosate is preferred. If determined that glyphosate treatment should be part of initial preparation based on specific site conditions, the following conditions shall be met, at a minimum:
1. Herbicide should be applied when plants are green and actively growing. Do not apply before or after growing season.
2. Do not apply seed until five to seven days after last herbicide treatment.
3. Ensure that any herbicides used are compatible with and approved for use in the specific application area.

B. For dormant (fall) planting, mow vegetation to 4 inches or less in height 4-6 weeks before seeding. Contractor shall evaluate in consultation with the Owners project representative the use of a broad spectrum, non-persistent glyphosate-based herbicide based on site conditions including

the presence of specific broadleaf weed species for the optimum control of invasives. The use of methods other than glyphosate is preferred. If determined that glyphosate treatment should be part of initial preparation based on specific site conditions, the following conditions shall be met, at a minimum:

1. Herbicide should be applied when plants are green and actively growing. Do not apply before or after growing season.
2. Do not apply seed until five to seven days after last herbicide treatment.
3. Ensure that any herbicides used are compatible with and approved for use in the specific application area.

C. Limit preparation to areas to be immediately seeded.

D. Confirm topsoil has been provided per Specification Section 32 9113 “Soil Preparation” in the areas and depths indicated by the written specifications. If unsuitable topsoil conditions or depths exist, notify General Contractor immediately and do not proceed with seeding operations until any and all unsatisfactory conditions have been corrected.

E. Finish Grading: Grade areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus ½-inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be seeded in the immediate future. Apply additional topsoil if necessary to achieve uniform, smooth surfaces.

F. Moisten prepared area before seeding if soil is dry. Water thoroughly and allow surface to dry before seeding. Do not create muddy soil.

G. Before seeding, obtain Owners acceptance of finish grading; restore seeding areas if eroded or otherwise disturbed after finish grading.

3.6 NATIVE SEEDING

A. Seed native seed mix (Land Restoration for Medium Soils Seed Mix) at seed supplier recommended rates and methods. Include cover crop for late fall seed applications if necessary.
   1. Do not hydroseed native seed mix.

3.7 EROSION CONTROL AND MULCHING

A. Mulch and stabilize all seeded areas in accordance with Articles 207.3(d) and 207.3(f) of the MSN-SSPWC.

B. Water seeded areas immediately after seeding with a fine spray to evenly moisten mulch and top ½” of soil. Do not overwater or create muddy conditions or standing water. Contractor may have to water in increments to reduce chances of ponding and/or erosion.

C. Install erosion control materials as indicated on the Working Drawings in accordance with Section 31 23 17, “Erosion and Sediment Controls”.

3.8 BLUEGRASS LAWN MAINTENANCE

A. Maintain and establish bluegrass lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
   1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
   2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly seeded areas.
   2. Initial watering to be conducted daily for no less than 30 days following seeding to maintain adequate soil surface moisture for proper seed germination.
   3. Water turf with fine spray at a minimum rate of 1/2” inch of water twice weekly, unless rainfall precipitation is adequate, until final acceptance.

C. Mowing: Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Mowing operations include trimming around obstacles and raking of excess grass clippings. String trimmers shall not be used around trees or shrubs. Any plant material damaged at any time during turfgrass maintenance shall be replaced at the original size and species at no cost to the Owner. Schedule initial and subsequent mowings to maintain the following grass heights:
   1. Mow lawn to a height of 2-1/2 inches before June 1 and after September 1 and no less than 3-1/2 inches from June through September.

3.9 NO-MOW FESCUE LAWN MAINTENANCE

A. Maintain and establish fescue lawn by watering, weeding, mowing, trimming, re-seeding, and performing other operations as required to establish a healthy, viable stand of fescue. Roll, re-grade, and re-seed bare or eroded areas and re-mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
   1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
   2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   3. Utilize integrated pest management best management practices to keep turf and soil free of pests and pathogens or disease.
   4. Contractor shall maintain a fescue lawn free of broadleaf or grass-like weeds by hand-pulling or treating any weeds that germinate during the maintenance period.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly seeded areas.
   2. Initial watering to be conducted daily for no less than 30 days following seeding to maintain adequate soil surface moisture for proper seed germination.
   3. Water turf with fine spray at a minimum rate of 1/2" inch of water twice weekly, unless rainfall precipitation is adequate, until final acceptance.

C. Mowing: No-Mow Fescue lawns shall not be mowed shorter than four (4) inches at any mowing. The first mowing shall correspond to the time when the fescue has become fully established, vigorous, and robust. Monitor fescue growth and mow approximately 2 times per growing season, once in the late spring and once in the fall, but only if the fescue reaches more than 12 inches in height and has fully established. Premature mowing of fescue lawns can damage the seed bed.

D. Fertilizer: Do not fertilize fescue lawns unless specifically directed to do so by seed supplier.

E. The contractor will be held fully responsible for evaluating the health and vigor of the fescue lawn during all maintenance activities and shall adjust maintenance practices, in consultation with Owners project representative, to produce a healthy, vigorous and fully-established fescue lawn by the end of the maintenance period.

3.10 NATIVE SEED AREA MAINTENANCE

A. Maintain and establish native seed areas by watering, weeding, mowing, trimming, re-seeding, and performing other operations as required to establish a healthy, viable native seed area. Roll, re-grade, fill and re-seed bare or eroded areas and re-mulch. Provide materials and installation the same as those used in the original installation.
   1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and native seed damaged or lost in areas of subsidence.
   2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   3. Utilize integrated pest management best management practices to keep native seed areas and soil free of pests and pathogens or disease.

B. Weeding: Monitor the establishment of the native seeding and for the presence of weeds. Eradicate any perennial weeds by spot mowing with a string trimmer or by hand applying post-emergent herbicide in accordance with 632.2.12 of the WISDOT State Standard Specifications for Highway and Structures Construction. Treat only on cool windless days using gloved hand wiping method. Do not broadcast herbicide. Do not hand pull weeds.

C. Mowing: Mow all vegetation to a height of 6 inches using a flail type mower once vegetation has reached 10-12 inches in height. If vegetation has reached a height greater than 12 inches prior to mowing, all vegetation cuttings must be raked and removed from the site. Carefully bag and remove all cuttings of seed-bearing weeds from the site to prevent dispersal of weed seeds. Mow approximately 5 times through duration of maintenance and warranty period.

D. Watering: Water native seeding regularly during first 8 weeks after seeding. Following the initial 8 weeks after seeding water only if it does not rain for a week.
   1. Monitor native seeding areas for adequate soil moisture. Water native seeding areas with fine spray just enough to keep soil moist. Water twice weekly, unless rainfall precipitation is adequate.
   2. Water in early morning only, afternoon and evening watering can encourage fungal growth that can kill seedlings.
   3. Do not overwater.

E. Fertilizer: Do not fertilize native seed areas unless specifically directed to do so by seed supplier.

F. The contractor will be held fully responsible for evaluating the health and vigor of the native seed areas during all maintenance activities and shall adjust maintenance practices, in consultation with Owners project representative, to produce a healthy, vigorous and fully-established native seed areas by the end of the maintenance period.

3.11 SATISFACTORY TURF GRASS AND NATIVE SEED INSTALLATIONS

A. Turf grass and native seed installations shall meet the requirements in accordance with Article 207.4(a) of the MSN-SSPWC.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory as set forth in the guidelines above and reviewed by the Owners project representative.

3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owners operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.13 CLEANUP, REPAIR AND PROTECTION

A. Promptly remove soil and debris created by any turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owners property.

C. Repair any additional existing lawn areas disturbed by construction activities with like materials at direction of Owners project representative.

D. Erect temporary fencing or barricades and warning signs as required to protect newly seeded areas from traffic. Maintain fencing and barricades from initial seeding operations throughout the maintenance period and remove after turf areas are established.

E. Remove nondegradable erosion-control measures at the end of the maintenance and warranty period.

END OF SECTION

SECTION 32 93 00

PLANTS

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. Plant Materials
2. Mulches
3. Stone Products
4. Edging
5. Preparation of Planting Beds
6. Planting Trees
7. Planting Mixed Perennial and Shrub Beds
8. Planting Bioretetion Area

B. Related Sections:
1. Section 32 91 13 “Soil Preparation” for preparation of topsoil suitable for planting operations.
2. Section 32 92 00 "Turf and Grasses" for site turf grass seeding.
3. Section 32 91 34 “Bioretention Infiltration Area” for bioretention engineered soil profile.

1.3 REFERENCES

A. *American Standards for Nursery Stock,* ANSI Z60.1, current edition. American Association of Nurserymen, Inc.

B. *Standardized Plant Names, Second Edition* (1942). American Joint Committee on Horticulture Nomenclature, Horace McFarland Company, Harrisburg, PA.

C. *American National Standard for Tree Care Operations* – Tree, Shrub and Other Woody Plant Maintenance – Standard Practices, ANSI A300, current edition.

D. State of Wisconsin Department of Transportation, *Standard Specifications for Highway and Structure Construction,* current edition.

E. State of Wisconsin Department of Natural Resources, *Conservation Practice Standard 1004 Bioretention for Infiltration,* current edition.

1.4 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

C. Finish Grade: Elevation of finished surface of planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Area: Areas to be planted.

G. Planting Soil: Standardized topsoil; existing, on-site soil; imported soil; or manufactured topsoil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

H. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

I. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

J. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.5 COORDINATION

A. Coordination with Turf Areas (Lawns): Install plant materials after finish grades are established and before planting turf areas unless otherwise indicated.
   1. When installing plant materials after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

B. Coordinate all planting operations with other contractors working on site. Contractor shall coordinate specifically to eliminate conflicts in scheduling, materials storage, maintenance and/or other coordination.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated:
   1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials. Provide list(s) for all plant material to Landscape Architect fourteen (14) days in advance of the planting.
   2. Edging Materials and Accessories: Manufacturers cut sheet for specific type of edging specified, including information on staking material and finish color.

B. Samples for Verification: For each type of product indicated:
   1. Mulch: 1 quart min. in sealed plastic bag, labeled with composition of materials by percentage of weight and source of mulch. Sample shall be typical of the lot of material to be furnished and provide an accurate representation of color, texture, and makeup.
   2. Stone Products: 1 quart min. in sealed plastic bag of each type of stone product required, labeled with source of stone product. Sample shall be typical of the lot of material to be furnished and provide an accurate representation of color, texture, and makeup.
   3. Filter Fabric: 12 by 12 inch sample.
   4. Jute Mesh: 12 by 12 inch sample indicative of color, matrix size, and tensile strength.

C. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners contact persons.

D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
   1. Manufacturer’s certified analysis of standard products.
   2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

E. Warranty: All plant material shall be under warranty for one (1) year from date of substantial completion; the warranty shall correspond to the required maintenance period.

F. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of maintenance and warranty period.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants and similarly designed landscapes.
   1. Experience: Three years’ experience in landscape installation in addition to requirements in Division or Section “Quality Requirements”
   2. Installer’s Field Supervision: Require installer to maintain an experienced full-time supervisor on Project site at all times when work is in progress.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

C. All plant material shall be true to species and variety/hybrid/cultivar specified, and nursery grown in accordance with good horticultural practices, and under climatic conditions similar to those of

the site location. Specimens that are nursery-dug to be replanted shall have been freshly dug and properly prepared for planting.

D. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
   1. Plants shall conform to the measurements specified within the contract documents. Specified height and spread dimensions will refer to the main body of the plant, and not from branch tip to branch tip. Plants meeting a specified measurement, but judged to lack the balance between height and spread characteristics of the species will be rejected.
   2. Herbaceous perennials shall be measured by pot size, not by top growth.
   3. All other measurements, such as number of canes, ball sizes, and quality designations, shall conform to *American Standards for Nursery Stock*.

E. Plant Material Observation: Landscape Architect or Project Representative may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect or Project Representative retains right to observe plant material further for size and condition of root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected plant material immediately from Project site.
   1. Notify Landscape Architect of sources of planting materials fourteen days in advance of delivery to site.

F. Preinstallation Conference: Conduct conference at Project site.

G. Plants are to be inspected upon delivery to Project site and the Landscape Architect or Owners project representative may reject any specimens no longer meeting the specified standards or that have been damaged in transit.

H. Planting Layouts:
   1. Contact Project Representative at least five (5) working days in advance of planting operations to coordinate review and approval of staked locations and to coordinate time(s) for planting bed layouts.
   2. Layout all planting beds and obtain approval of the general size, location and herbaceous plant material placement within the beds prior to installation of plant material.

I. Discrepancies:
   1. If discrepancies occur between the written Plant List, Plant Schedule, and/or Plant Palette and the actual plant count from the planting symbols on the plans in the Working Drawing set the plans shall govern over the written schedule, or index of units.

1.8 SUBSTITUTIONS

A. The substitution of plant material is not permitted unless authorized in writing by the Landscape Architect. If written proof is submitted that the plant of the specified species, variety, or size is unavailable, consideration will be given towards the nearest available size or variety, or towards an alternate species selection, with a corresponding adjustment of the contract price.

B. Larger plants than those specified can be used upon approval of the Landscape Architect or Owners project representative. The use of larger plants shall not increase the contract price. The

container size of the larger specimen shall be proportionally increased, relative to the specified size.

C. Landscape product substitutions may be considered as an equivalent only if proposed substitution meets all areas of this specification without exception. Manufacturers seeking consideration as an equivalent product must submit product data, records, test results, samples, certifications and any additional documentation deemed necessary by Owners project representative to prove equivalency. Owners project representative must review and approve proposed substitutions prior to their ordering and use.

1.9 DELIVERY, STORAGE AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball or container.

E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

F. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
1. Do not remove container-grown stock from containers before time of planting.
2. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.10 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of each service or utility.
2. Do not proceed with interruption of services or utilities without Construction Manager's written permission.

C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance and warranty periods to provide required maintenance from date of Substantial Completion.
1. Spring Planting: Approximately April 1st – June 15th. Planting shall not commence in the spring until ground has completely thawed.
2. Fall Planting: September 1st – October 15th

D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

E. Protect all plants, lawns, and grass areas from damage at all times. Damaged plants, lawns or grass areas shall be replaced or treated as required to conform to specifications herein for fresh stock. Work area shall be kept clean and orderly during the installation period. Under no condition shall debris from planting activities result in a safety hazard on-site or to adjacent off-site property. Damage to lawns or grass areas incurred as a result of planting or replacement operations shall be repaired by the Contractor that causes the damage at no cost to the Owner.

1.11 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Death and unsatisfactory growth, except for defects resulting from abuse or incidents that are beyond the Contractor’s control.
   b. Structural failures including plantings falling or blowing over.
   c. Faulty performance of mulches.
2. Warranty Periods stated below are from the date of substantial completion or project acceptance, whichever is later:
   a. Perennials and mulches: 1 year from the date of substantial completion or project acceptance, timed with and as part of the required maintenance service.
3. Include the following remedial actions as a minimum:
   a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
   b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.

1.12 MAINTENANCE SERVICE

A. Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed.

B. Maintenance Period: The start date for the maintenance period for plantings is the date (month, day, and year) that all plantings are considered substantially complete by the Owners project representative. The maintenance period shall be for 1 year from the date of substantial completion.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
   1. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Labeling: Label one plant of each variety and size with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on the Drawings. Remove all tags and labels once Landscape Architect or Project Representative has reviewed all plantings on-site.

C. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread.

2.2 PLANTING SOIL

A. Refer to Section 32 91 13 “Soil Preparation” for planting soil to be used for all planting beds as well as organic and inorganic soil amendments, fertilizers and topsoil testing requirements.

2.3 MULCH

A. Organic mulch free from deleterious materials and suitable as a top dressing and consisting of the following:
   1. Twice Shredded Hardwood Bark Mulch: Size range shall be ½ inch to 2 inches with a maximum size for any single piece of no greater than 3 inches. Color shall be natural brown (no dye).

2.4 STONE PRODUCTS

A. Stone Mulch: Washed, free from dust, dirt and other materials from a single source, of uniform size, texture and color:
   1. Stone mulch to be a blend of grays with rust coloration.
      a. Color: Gray with rust coloration
      b. Size: 1 ½” – 2”
      c. Shape: Angular

B. Stone Ballast: Washed, free from dust, dirt and other materials from a single source, of uniform size, texture and color:
   1. Stone ballast to be a blend of grays with rust coloration.
      a. Color: Gray with rust coloration
      b. Size: 2 ½" – 3"
      c. Shape: Angular

2.5 FILTER FABRIC

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally-encountered chemicals, alkalis, and acids.

2.6 EDGING

A. "Commercial-Grade Steel Landscape Edging" by Col-Met, 1-800-829-8225, www.colmet.com or approved equal.
   1. Standard-profile steel edging
   2. Edging Size: 1/8 inch wide by 6 inches deep.
   3. Stakes: Manufacturer-provided tapered steel, 16 inches long.
   4. Finish and Color: Natural unweathered steel
   5. Accessories: Provide 90-degree corner pieces, end pieces and splicers.

2.7 JUTE MESH

A. "Jute Mesh Erosion Control Mat" by Forestry Suppliers Inc., 1-800-647-5368, www.forestry-suppliers.com or approved equal.
   1. Coarse, open mesh jute erosion control mat, non-synthetic, biodegradable and with a functional life of less than 2 years.
   2. Include manufacturer's biodegradable erosion control stakes for anchoring.

2.8 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions

2.9 PESTICIDES

A. General: Employ integrated pest management best management practices (hand-pulling weeds) throughout installation, establishment and maintenance of plants. Any pesticide or herbicide use must be reviewed and approved by Project Representative.

B. Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides.

C. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

D. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance of the Work.
   1. Verify that sufficient Planting soil has been provided as indicated in Section 32 91 13 “Soil Preparation”. If insufficient depth or material is observed notify the Project Representative immediately to determine course of remedial action. Do not install plantings until all unsatisfactory conditions have been corrected.
   2. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   3. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
   4. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   5. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by the Engineer and replace with new planting soil.

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

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Contact Project Representative at least seven (7) working days in advance of planting to coordinate plant layout, obtain approval of plant locations and plant bed layouts prior to planting or installation of landscape materials.

3.3 EXCAVATION FOR TREES AND SHRUBS

A. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.

B. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.

C. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.

D. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.

E. Maintain supervision of excavations during working hours.

F. Keep excavations covered or otherwise protected when unattended by Installer's personnel. No excavation shall be left overnight or for a period of more than 30 minutes.

G. Subsoil and topsoil removed from excavations may be used as planting soil if they conform to the requirements for Topsoil as outlined in Section 32 91 13, “Soil Preparation”.

H. Obstructions: Notify Owners project representative if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

I. Drainage: Notify Owners project representative if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

J. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.4 TREE AND SHRUB PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements. Plant material planted without root flare visible or planted too low will be re-planted at the request of the Landscape Architect at no additional cost to the Owner.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Remove all twine, string, wire, and other non-biodegradable material from entire root ball area.

D. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.
   1. Use pre-mixed planting soil or suitable topsoil from excavation for backfill.
   2. Carefully cut and remove burlap, rope, and wire baskets from the entire root ball. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
   3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   4. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Set container-grown stock plumb with root flare 1 inch above adjacent planting soil elevations.
   1. Use pre-mixed planting soil or suitable topsoil from excavation for backfill.
   2. Carefully remove root ball from container without damaging root ball or plant.
   3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   4. Continue backfilling process. Water again after placing and tamping final layer of soil.

3.5 TREE AND SHRUB PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Landscape Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

C. Do not apply pruning paint to wounds.

3.6 PERENNIAL PLANTING

A. Dig holes large enough to allow spreading of roots.

B. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

C. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

D. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.7 BIORETENTION AREA PLANTING AND MULCHING

A. Preparation: Provide or confirm that Engineered Soil has been provided in accordance with Section 32- 91- 34 “Bioretention Infiltration Area”.

B. Examine all bioretention areas prior to planting for any and all unsatisfactory conditions that could affect the long-term performance of the bioretention area or the long-term health of the plants. Unsatisfactory conditions include, but are not limited to, presence of debris and trash; soil runoff from adjacent earthwork operations; ponding or puddling present; areas of differential drainage indicated by varying surface soil moisture conditions; unshapely or incorrectly sloped and constructed basins; lack of proper engineered profile as determined by a small shovel test in one area of the basin.

C. Refer to Section 32- 91- 13 “Soil Preparation” for examination and correction of any bioretention areas compromised by runoff or other contaminants prior to planting.

D. Schedule planting operations such that mulching, jute mat installation, planting, watering, and any clean up and repair shall occur within the same work day.

E. Perform the following quality control functions before, during, and after planting:
   1. Inspect bioretention area and surroundings for conformance with contract documents and for contamination by deleterious materials or sediments.
   2. Confirm whether shredded hardwood bark mulch has already been provided at 2-inch depth according to WDNR CPS 1004 “Bioretention for Infiltration”.
   3. Inspect all plant material upon delivery to the site and reject any and all plant material that is damaged, unhealthy, or otherwise unsatisfactory.
   4. Store plant material in shaded location before planting and keep plant material away from exposure to sun, wind, and other desiccating conditions.
   5. Ensure that plant material is well watered at time of delivery and continues to be watered between delivery and planting.

F. Install shredded hardwood bark mulch in accordance with WDNR CPS 1004 “Bioretention for Infiltration” if none has been provided and/or to topdress as necessary to provide a single, continuous 2-inch thick layer over entire surface of bioretention area.

G. Install jute mesh over the top of the shredded hardwood bark mulch, using biodegradable stakes to firmly anchor the mesh to the soil materials

H. Plants specified in bioretention area shall be spaced randomly and intermixed within the planting area defined in the Working Drawings. Plant perennials into prepared bioretention areas by gently moving mulch aside, excavating a hole as deep and as wide as the plant container within the openings of the jute mat matrix, and placing the plug/plant upright in the planting hole. Carefully backfill hole with engineered soil mix and re-place mulch near the base of the plant

I. Minimize compaction of engineered soil profile and shall provide sheets of plywood or other materials to diffuse the weight of installers for all installations. Planting shall start at the center of the bioretention basin and work outward toward the edges; mulching shall occur simultaneously with planting to ensure plants are not adversely affected by plywood or other weight diffusion materials

J. Unless otherwise specified, install plants no closer than 12” to the trunks of trees or shrubs within planting bed, and to within 6” of the edge of the bed.

K. Water plants immediately.

3.8 PLANTING BED & TREE RING MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.
   1. Apply 3-inch average thickness of twice shredded hardwood bark mulch over surfaces of at-grade planting beds as indicated in Working Drawings and finish to 1” below adjacent pavement surfaces.
   2. Apply 3-inch average thickness of shredded hardwood bark mulch to form a 4’ diameter tree ring at the base of each tree in as indicated in Drawings. Do not place mulch within 3 inches of trunk.
   3. Do not place filter fabric beneath areas receiving shredded hardwood bark mulch.

3.9 MAINTENANCE EDGE INSTALLATION

A. Install edging where indicated in the Working Drawings according to manufacturer's written instructions. Anchor with stakes spaced approximately 36 inches apart, driven below top elevation of edging. Utilize corner pieces, end pieces and splicers at all joints. Do not install edging where maintenance edge abuts concrete pavements.

B. Install filter fabric, overlapping joints a minimum of 6 inches and pinning fabric to subgrades with manufacturer-provided pins.

C. Apply 5½ inches average thickness of stone product over filter fabric at the surface areas indicated in the Working Drawings.

3.10 STONE BALLAST INSTALLATION

A. Install filter fabric, overlapping joints a minimum of 6 inches and pinning fabric to subgrades with manufacturer-provided pins.

B. Apply 5½ inches average thickness of stone product over filter fabric at the surface areas indicated in the Working Drawings.

3.11 LANDSCAPE MAINTENANCE

A. Visit the site at least 2 times per month during the months of April to November to perform acceptable and industry-standard landscape maintenance for the entire project for the duration of the stated maintenance period.

B. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

C. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

D. Refresh organic and inorganic mulches on an annual basis or as necessary to maintain installed depths and a clean, finished appearance. In addition, refresh organic mulch just prior to end of the maintenance period.

E. Use integrated pest management practices including physical controls such as hosing off foliage, mechanical controls such as traps and biological control agents.

F. Hand-weed all planting beds to remove germinating annual, biennial and/or perennial weeds. The use of broad-spectrum herbicides must be approved by Project Representative.

G. Replace any and all landscape materials deemed to be damaged or that fail during the maintenance period.

H. Remove all staking, guys and miscellaneous plant staking material at the end of the maintenance period.

3.12 CLEAN-UP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

C. After installation and inspection by Project Representative or Landscape Architect, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.13 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, trash and debris and legally dispose of them off the Owners property.

END OF SECTION

SECTION 33 11 00

SITE WATER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Site Piping.
2. Pipe Fittings.
3. Valves.
4. Fire Hydrants.
5. Domestic Water Services.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 31 05 17 - Aggregates for Site Earthwork.
3. Section 31 23 17 – Site Excavation, Backfill, and Compaction.
4. Section 33 17 00 - Water Main Testing.
5. Division 22 – Plumbing.

1.2 REFERENCES

A. City of Madison Standard Specifications for Public Works Construction, 2017 Edition, (SSPW).

B. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products.

C. American Society of Mechanical Engineers: (ASME)
1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

D. ASTM International: (ASTM)
1. ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes.
2. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
3. ASTM A575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
4. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
5. ASTM C33 - Standard Specification for Concrete Aggregates.
6. ASTM C150 - Standard Specification for Portland Cement.
7. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
8. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
9. ASTM D 3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

10. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
11. ASTM F594 - Standard Specification for Stainless Steel Nuts.

E. American Welding Society: (AWS)
1. AWS A5.8 - Brazing Filler Metal.

F. American Water Works Association: (AWWA)
1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. AWWA C105 - Polyethylene Encasement for Ductile Iron Pipe Systems.
3. AWWA C110 - Ductile Iron and Grey Iron Fittings 3-In. Through 48-In., for Water.
4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C150 – Thickness Design of Ductile-Iron Pipe.
6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
7. AWWA C153 - Ductile-Iron Compact Fittings, 3-In. Through 24-In., for Water Service.
8. AWWA C502 - Dry Barrel Fire Hydrants.
9. AWWA C504 - Rubber Seated Butterfly Valves.
10. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 In. through 24 In. NPS.
11. AWWA C509 - Resilient Seated Gate Valves for Water Supply Service.
12. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
13. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
14. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution.
15. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. Through 3 In., for Water Service.
16. AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In., for Water Transmission and Distribution.
17. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 63 In., for Water Distribution and Transmission.

G. NSF International: (NSF)
1. NSF 14 - Plastics Piping System Components and Related Materials.
2. NSF 61 - Drinking Water System Components - Health Effects.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.

C. Manufacturer's Instructions: Indicate special procedures required to install Products specified.

D. Certificates: Certify that products meet or exceed specified requirements.

1.4 SUBMITTALS AT PROJECT CLOSEOUT

A. Division 01 – General Requirements: Requirements for submittals.

B. Submit Project Record Documents.
   1. Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 REGULATORY REQUIREMENTS

A. Perform Work in accordance with requirements of:
   1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.
   2. City of Madison Standard Specifications for Public Works Construction, 2017 Edition, for materials and installation of the Work in this Section in municipal right-of-way.

1.6 QUALITY ASSURANCE

A. Perform work in accordance with requirements of City of Madison Water Utility for public connections and modifications where applicable.

B. Valves and Hydrants: Mark manufacturer's name and pressure rating on body.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Division 01 – General Requirements.

B. Deliver and store valves and gaskets in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.1 GENERAL

A. An acceptable certifying organization shall evaluate, test, and certify products intended for contact with potable water for conformance with NSF 61 and health effects portion of NSF 14.

B. Pipe, fittings, valves, hydrants, and valve boxes shall be manufactured in the United States of America.

C. Provide materials in accordance with:
   1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

2.2 WATER PIPE

A. Ductile Iron Pipe: AWWA C151, Ductile Iron Pipe for water with AWWA C104 Cement Lining. Thickness Class 52 in accordance with AWWA C150.
   1. Fittings: Ductile iron, AWWA C110 Standard or AWWA C153 Compact.
   2. Joints: AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings Mechanical Joint or Push on Joint.
   3. Corrosion Protection: AWWA C105 polyethylene encasement, half lapped, 8 mil polyethylene.
   4. Ductile Iron Pipe and Fitting Manufacturers:
      a. American Cast Iron Pipe Company.
      b. Griffin Pipe Products Company.
      c. McWane Cast Iron Pipe Company.
      d. Tyler Pipe Company.
      e. U.S. Pipe & Foundry Company Division of Mueller Water Products. Inc.
      f. Substitutions: In accordance with Division 01 – General Requirements.

2.3 GATE VALVES

A. Manufacturers:
   1. American Flow Control.
   2. Kennedy Valve Company, Division of McWane, Inc.
   3. Mueller Company, Division of Mueller Water Products, Inc.
   4. U.S. Pipe and Foundry Company, Division of Mueller Water Products, Inc.
   5. Substitutions in accordance with Division 01 – General Requirements.

B. AWWA C509, Iron body, bronze trim, non-rising stem with square nut, single resilient wedge, mechanical joint ends, control rod, and extension box.

2.4 CAST IRON VALVE BOXES

A. Manufacturers:
   1. Bingham & Taylor Corporation.
   2. Tyler Pipe Company.
   3. Substitutions in accordance with Division 01 – General Requirements.

B. Cast Iron Valve Box: 5-1/4 inch diameter shaft; round base; 5-1/4 inch drop lid marked "WATER"; length of assembly sized to span top of main to finished grade with a minimum adjustment remaining for an additional 3 inches.

2.5 VALVE BOX ADAPTERS

A. Gate Valve Adaptor: Epoxy-coated, 1/4-inch steel with 1/2-inch rubber gasket, size to fit valve. Similar and equal to adaptors manufactured by Adaptor, Inc., West Allis, WI.

2.6 ACCESSORIES

A. Thrust Restraint:
   1. Concrete: ASTM C150 Portland cement and ASTM C33 aggregates, air-entrained concrete with minimum compressive strength of 3000 psi.

2. Wedge-Action Joint Restraints: Cast iron, circular or a pair of semi-circles with wedges that grip ductile iron or PVC pipe. Product shall be Megalug as manufactured by EBAA Iron Sales, Eastland, TX, Uni-Flange as manufactured by Ford Meter Box Company, Inc., Wabash, IN., or an approved equal.
3. Rod Restraints: ASTM A276 stainless steel threaded rods with ASTM F594 nuts.
4. Anchor Pipe: Ductile iron, thickness class 53, mechanical joint.

B. Pipe Location Materials.
1. Identification Warning Tape: Aluminum underground warning tape, 2-inch width. Color-Bright Blue, warning message "Caution Buried WATER MAIN Below" to repeat every 30 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with Type A2 aggregate as specified in Section 31 05 16 – Aggregates for Earthwork.

B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

C. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

D. Remove scale and dirt on inside and outside before assembly.

E. Prepare pipe connections to equipment with flanges or unions.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 31 23 17 – Site Excavation, Backfill, and Compaction for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Form and place concrete for pipe thrust restraints at any change of pipe direction. Place concrete to permit full access to pipe and pipe accessories.

C. Place bedding material in trench bottom, level fill materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent modified Proctor density.

D. Backfill around sides and top of pipe with bedding material to a depth above pipe as noted on the Drawings, and compact to 95 percent modified Proctor density.

E. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Maintain separation of water main from sewer piping in accordance with:
   1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

B. Install pipe to indicated elevation to within tolerance of 5/8-inch.

C. Install ductile iron piping and fittings in accordance with AWWA C600.

D. Route pipe in straight line.

E. Install pipe to allow for expansion and contraction without stressing pipe or joints.

F. Install access fittings to permit disinfection of water system performed under Section 33 13 00 – Water Main Disinfection.

G. Slope water pipe and position drains at low points.

H. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.

I. Establish elevations of buried piping to ensure not less than six foot of cover.

J. Install tracer wire continuous over top of pipe. Secure tracer wire to top of pipe with industrial strength tape; coordinate with Section 31 23 17 – Site Excavation, Backfill, and Compaction.

K. Backfill trench in accordance with Section 31 23 17 – Site Excavation, Backfill, and Compaction. Do not displace or damage pipe when compacting.

3.5 INSTALLATION - VALVES

A. Set valves on solid concrete block bearing.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

3.6 DISINFECTION OF POTABLE WATER SYSTEM PIPING

A. Flush and disinfect system in accordance with Section 33 13 00 – Water Main Disinfection.

3.7 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspection and testing.

B. Request inspection prior to and immediately after placing bedding.

C. Perform moisture content testing and compaction testing in accordance with Section 31 23 17 – Site Excavation, Backfill, and Compaction.

D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

E. Frequency of Tests: As determined by Construction Manager.

F. Pressure Test: Test in accordance with Section 33 17 00 – Water Main Testing and
   1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

3.8 PROTECTION OF FINISHED WORK

A. Division 01 – General Requirements: Protecting installed work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

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SECTION 33 13 00

WATER MAIN DISINFECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Disinfection of Water Mains, Fittings, and Appurtenances.
2. Disinfection Materials.
3. Disinfection Methods.
4. Pipe Filling and Contact.
5. Sampling and Testing.
6. Re-disinfection.
7. Disinfection Procedure for Cutting into Existing Main.
8. Flushing of Main.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 33 11 00 – Site Water System.
3. Section 33 17 00 – Water Main Testing.

1.2 REFERENCES

A. Public Works Industry Improvement Program;
1. City of Madison Standard Specifications for Public Works Construction, 2017 Edition.

B. American Water Works Association: (AWWA)
1. AWWA B300 - Standard for Hypochlorites.
2. AWWA C651 - Standard for Disinfecting Water Mains.
3. Standard Methods for the Examination of Water and Wastewater.

C. NSF International: (NSF)
1. NSF 61 - Drinking Water System Components - Health Effects.

1.3 PERFORMANCE REQUIREMENTS

A. Basic disinfection procedure consists of:
1. Preventing contaminating materials from entering water main during storage, construction, or repair.
2. Removing by flushing or other means materials that may have entered water main.
3. Chlorinating any residual contamination that may remain and flushing chlorinated water from main.
4. Determining bacteriological quality by laboratory test after disinfection.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store calcium hypochlorite in cool, dark, dry environment prior to use to minimize its deterioration.

B. Furnish new, unopened containers for work. Partially filled containers used on previous jobs shall not be allowed.

1.5 QUALITY ASSURANCE

A. Disinfection of water main, sampling, and testing in accordance with local, state, and federal regulatory rules and regulations. Perform disinfection to meet most stringent regulations.

B. Contractor shall take samples of water and deliver samples to an accredited and approved testing agency.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Hypochlorite Powder: Calcium hypochlorite granular powder with 65-70 percent available chlorine in accordance with AWWA B300.

B. Hypochlorite Tablets: 2/3-inch diameter tablets, weighing 5 to 7 grams, containing 73 per cent calcium hypochlorite with a minimum of 70 per cent available chlorine.

C. Hypochlorite Liquid: Bleach with a concentration of 12 per cent sodium hypochlorite.

PART 3 - EXECUTION

3.1 PREPARATION

A. Take precautions to protect interiors of pipes, fittings, and valves against contamination.

B. Pipe delivered for construction shall be laid out and soundly supported above ground surface to minimize entrance of foreign material.

C. Complete pipe joints in trenches before work is stopped. If site water accumulates in trench, plug pipe until trench is dry.

D. Do not use contaminated material or any material capable of supporting prolific growth of microorganisms for sealing joints.

E. Handle sealing material or gaskets in a manner that avoids contamination.

F. Lubricant used in installation of sealing gaskets shall be suitable for potable water usage. Deliver lubricant to job in closed containers and keep clean and free of soil and other contaminants.

G. If soil or debris enters pipe and, in opinion of Engineer, will not be removed by flushing operation, clean interior of pipe by mechanical means and then swab with one percent hypochlorite disinfecting solution.

H. Undertake cleaning using a pig, swab, or "go-devil" only when Engineer determines that such operation will not force mud or debris into pipe joint spaces.

I. If difficulties arise that prevent pipe and fittings from remaining dry during installation, make every effort to assure that any water that enters pipe joint spaces contains an available chlorine concentration of approximately 25 mg/L.

J. If main is flooded during construction, clear main of floodwater by draining and flush with potable water until clean. Fill flooded section with chlorinated potable water which at end of 24 hour holding period will have a free chlorine residual of not less than 25 mg/L.

3.2 CHLORINATION METHODS

A. Place calcium hypochlorite in amounts indicated in this Section. Place calcium hypochlorite at upstream end of first section of pipe, at upstream end of each branch main, in first pipe section past valve, in hydrant leads, and at a minimum 500 foot interval in main.

B. Do not use granules in solvent welded plastic or screwed joint steel pipe due to danger of fire or explosion from reaction of joint compounds with calcium hypochlorite.

Ounces of Calcium Hypochlorite Granules to Be Placed
at Beginning of Main and at Each 500 Foot Interval

Pipe Diameter (Inches)	Calcium Hypochlorite Granules (Ounces)
4	0.5
6	1.0
8	2.0
12	4.0
16 and larger	8.0

C. Tablets may be used if prior approval is obtained from Engineer. Procedure shall be as follows:
1. Place 5-gram calcium hypochlorite tablets in accordance with the following table in each section of pipe.
2. Place one 5-gram calcium hypochlorite tablet in each hydrant, hydrant branch, and other appurtenance.
3. Number of 5-gram Calcium Hypochlorite Tablets to Be Placed in Each Length of Pipe:

Pipe Diameter	Length of Pipe Section (feet)				
(Inches)	<13	18	20	30	40
4	1	1	1	1	1
6	1	1	1	2	2
8	1	2	2	3	4
10	2	3	3	4	5
12	3	4	4	6	7
16	4	6	7	10	13

Note: Based on 3.25 grams available chlorine per tablet, any portion of tablet rounded to next higher integer.

4. Attach tablets to inside and top at each end of newly installed pipe with an NSF 61 approved adhesive such as ITW Redhead A7, or an approved equal.
5. No adhesive shall be on tablet except on broad side to be attached to surface of pipe.
6. If tablets are attached before pipe section is placed in trench, their position shall be marked on section so it can be readily determined that pipe is installed with tablets at top.

3.3 PIPE FILLING AND CONTACT

A. When installation is completed, fill main with water at a rate such that water within main will flow at a velocity no greater than one foot per second.

B. Water for filling and initial flushing of main shall be separately metered and paid for by Contractor. Contractor shall provide labor and material necessary to transfer water from source to main to be tested.

C. Water shall enter main and be tested at low point in system to force entrapped air out at high end through an available hydrant.

D. Close upper end hydrant or valve after air is expelled and chlorinated water discharge is present.

E. Take precautions to assure that entrapped air is eliminated.

F. Water shall remain in pipe for at least 24 hours or as defined by regulatory requirements.

G. If water temperature is less than 40 degrees F, water shall remain in pipe for at least 48 hours.

H. Position valves so that strong chlorine solution in main being treated will not flow into water mains in active service.

3.4 SAMPLING AND TESTING

A. Water from new mains must successfully pass bacteriological test in accordance with requirements of State environmental regulatory agency having jurisdiction over public water supply.

B. Provide access to main for chlorination and sampling as directed by Engineer.

C. Properly and securely brace and maintain excavation until successful testing, flushing, chlorinating, and sampling of main is completed.

D. Contractor shall be responsible for protecting any required excavation by means of proper barricades and lanterns during sampling and testing period.

E. Contractor will take necessary samples of water and obtain laboratory tests of samples.

F. Provide minimum of one sample from new main and one from each branch.

G. Collect samples for bacteriological analysis in sterile bottles treated with sodium thiosulfate as required by Standard Methods.

H. Do not use hoses or fire hydrants in collection of samples.

I. Provide corporation cock installed in main with copper tube gooseneck assembly. After samples have been collected, remove gooseneck assembly and retain for future use.

3.5 RE-DISINFECTION

A. If initial disinfection fails to produce satisfactory bacteriological samples, reflush and resample main.

B. If check samples show presence of coliform organisms, rechlorinate main by continuous feed or slug method of chlorination until satisfactory results are obtained.

C. Contractor shall be responsible for costs of re-chlorination and testing including additional cost of water from Utility for flushing and contact.

3.6 DISINFECTION PROCEDURE FOR CUTTING INTO EXISTING MAIN

A. Disinfect area around existing main at connection or cut-in with hypochlorite powder.

B. Swab or spray interior of pipe and fittings used in making connection with one percent hypochlorite solution just prior to installation.

C. Connect new main to existing main with a minimum of 24 inches of pipe. Clean and disinfect 24-inch section prior to installation and after approved water testing has been performed.

3.7 FLUSHING OF MAIN

A. After required retention period has ended, flush chlorinated water from main until chlorine measurements show no residual chlorine remains.

B. Obtain a minimum flushing velocity of 2.5 feet per second.

Minimum Flushing Rate

Pipe Diameter (inches)	Flow Rate for Flushing (gpm)
4	100
6	220
8	390
10	600
12	870
16	1600
20	2,500
24	3,500
30	5,500
36	8,000

C. Check with local sewer utility for requirements for disposal of heavily chlorinated water to sanitary sewer system.

D. Neutralize chlorine residual of water being disposed by treating with one of the following chemicals:

E. Chemical Amount Required to Neutralize Chlorine Concentration per 100,000 Gallons:

Residual Chlorine Concentration Mg / L	Sulfur Dioxide (SO2) lb	Sodium Bisulfite (NaHSO3) lb	Sodium Sulfite (Na2SO3) lb	Sodium Thiosulfate (Na2S2O3 + 5H2O) lb
1	0.8	1.2	1.4	1.2
2	1.7	2.5	2.9	2.4
10	8.3	12.5	14.6	12.0
50	41.7	62.6	73.0	60.0

END OF SECTION

SECTION 33 17 00
WATER MAIN TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pressure testing of completed water main.
2. Leakage testing of completed water main.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 33 11 00 – Site Water System.
3. Section 33 13 00 – Water Main Disinfection.

1.2 REFERENCES

A. Public Works Industry Improvement Program;
1. City of Madison Standard Specifications for Public Works Construction, 2017 Edition.

B. American Water Works Association: (AWWA)
1. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
2. AWWA C605 – Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.

C. ASTM International: (ASTM)
1. ASTM F2164 - Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Contractor shall submit a testing schedule and procedure to Engineer for review 10 days prior to initiating testing program.

C. Submittal shall include type of equipment and location of its connection to new system.

1.4 QUALITY ASSURANCE

A. Testing shall be in accordance with AWWA C600.

B. Testing of water main shall comply with local and state regulatory agency rules and regulations where applicable.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTS REQUIRED

A. Test new installations of water main for pressure and leakage.

B. Contractor shall notify Engineer and Construction Manager and Utility Owner 48 hours prior to initiation of testing.

C. Contractor shall not perform any testing without Construction Manager and Utility Owner present.

D. New water main shall not be connected to an existing main until after safe water samples have been obtained from new water main system addition.

E. Where a new main is to connect to an existing main, provide the following connection procedure prior to performance of a pressure/leakage test of new main.
   1. Contractor shall install a 2-foot bolted flanged spool piece between existing water main valve and new main.
   2. Prior to testing, remove spool piece and bolt a temporary plug on end of new main for testing purposes.
   3. After specified pressure and leakage tests have been completed on new main, disinfect spool piece, remove plug, and insert spool piece between new main and existing main.
   4. Do not connect new main to existing water main with a valved connection.

3.2 PRESSURE TESTING

A. After pipe has been laid, subject newly laid pipe or any valved section thereof to a hydrostatic pressure of at least 1.5 times working pressure at point of testing.

B. Tests pressures shall:
   1. Not be less than 1.25 times working pressure at highest point along test section.
   2. Not exceed pipe or thrust restraint design pressures.
   3. Be of at least 2-hour duration.
   4. Not vary by more than plus or minus 5 psi for duration of test.
   5. Not exceed twice rated pressure of valves or hydrants when pressure boundary of test section includes closed gate valves or hydrants.
   6. Do not operate valves in either direction at differential pressure exceeding rated pressure.
   7. Not exceed rated pressure of valves when pressure boundary of test section included closed, resilient seated gate valves or butterfly valves.

C. Slowly fill each valved section of pipe and apply specified test pressure, based on elevation of lowest point of line or section under test and corrected to elevation of test gage, by means of a pump connected to pipe acceptable to Engineer.

D. Do not operate valves in either opening or closing direction at differential pressures above rated pressure.

E. Before applying specified test pressure, completely expel air from section of pipe under test.

F. If permanent air vents are not located at all high points, Contractor shall install corporation cocks at such points to expel air as line is filled with water.

G. After all air has been expelled, close corporation cocks and apply test pressure. At conclusion of pressure test, remove corporation cocks and plug or leave in place at discretion of Utility.

H. Carefully examine exposed pipe, fittings, valves, hydrants, and joints during test.

I. Repair or replace any damaged or defective pipe, fittings, valves, or hydrants that are discovered following pressure test with sound material, and repeat test until it is satisfactory to Utility Owner.

3.3 LEAKAGE TESTS

A. Leakage test may be conducted concurrently with pressure test.

B. Leakage shall be defined as quantity of water that must be supplied into newly laid pipe, or any valved section thereof, to maintain pressure within 5 psi of specified test pressure after air in pipeline has been expelled and pipe has been filled with water.

C. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

D. No pipe installation will be accepted if leakage is greater than that determined by following formula:

L = SD times Square Root of P, divided by 133,200

Where L is allowable leakage in gallons per hour; S is length of pipe tested in lineal feet; D is nominal diameter of pipe in inches; and P is average test pressure during leakage test in pounds per square inch gage.

E. Acceptance shall be determined on basis of allowable leakage.

F. If any test of laid pipe discloses leakage greater than that specified, Contractor shall, at its own expense, locate and make repairs or replacement.

END OF SECTION

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SECTION 33 31 00

SITE SANITARY SEWER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Site Piping.
2. Pipe Fittings.
3. Precast Concrete Manholes with internal frame and chimney seals.
4. Cleanouts.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 31 23 17 – Site Excavation, Backfill, and Compaction: For sewerage system piping.
3. Division 22 – Plumbing.

1.2 REFERENCES

A. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products.

B. City of Madison Standard Specifications for Public Works Construction, 2017 Edition, (SSPW).

C. American Association of State Highway and Transportation Officials: (AASHTO)
1. AASHTO Standard Specifications for Highway Bridges.

D. American Concrete Institute: (ACI)
1. ACI 318 - Building Code Requirements for Reinforced Concrete.

E. ASTM International: (ASTM)
1. ASTM A48 - Specification for Gray Iron Castings.
2. ASTM A74 – Specification for Cast Iron Soil Pipe and Fittings.
3. ASTM A240 – Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
4. ASTM A536 - Specification for Ductile Iron Castings.
5. ASTM A615 - Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
6. ASTM A746 - Specification for Ductile Iron Gravity Sewer Pipe.
7. ASTM C12 - Practice for Installing Vitrified Clay Pipe Lines.
8. ASTM C14 - Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
9. ASTM C33 - Specification for Concrete Aggregates.
10. ASTM C76 - Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
11. ASTM C150 - Specification for Portland Cement.

12. ASTM C425 - Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
13. ASTM C443 - Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
14. ASTM C478 - Specification for Precast Reinforced Concrete Manhole Sections.
15. ASTM C564 - Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
16. ASTM C700 - Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
17. ASTM C923 - Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
18. ASTM C990 - Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
19. ASTM C1479 – Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.
20. ASTM D2122 - Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
21. ASTM D2321 – Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
22. ASTM D3034 - Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
23. ASTM D3035 – Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
24. ASTM D3212 - Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
25. ASTM D3261 - Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
26. ASTM D3350 – Specification for Polyethylene Plastics Pipe and Fittings Material.
27. ASTM D4101 - Specification for Polypropylene Injection and Extrusion Materials.
28. ASTM F477 - Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
29. ASTM F593 – Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
30. ASTM F594 – Specification for Stainless Steel Nuts.
31. ASTM F679 - Specification for Poly(VinylChloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.
32. ASTM F714 - Specification for Polyethylene (PE) Plastic Pipe (SDR-DR) Based on Outside Diameter.
33. ASTM F1055 - Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
34. ASTM F1668 - Guide for Construction Procedures for Buried Plastic Pipe.
35. ASTM F2620 - Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

F. American Water Works Association: (AWWA)
   1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   2. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

G. Code of Federal Regulations: (CFR)
   1. 29 CFR 1926.1053 - Ladders.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Product Data: Provide data indicating pipe materials pipe fittings, and precast structures.

C. Submit Structural Design Calculations and detailed Shop Drawings for flattop and special precast concrete manhole structures prepared and sealed by a Professional Engineer licensed in State of Wisconsin.

D. Design of flattop and special precast structures shall be in accordance with ACI 318 and ASTM C478.

E. Submit concrete mix data and test reports from an approved testing laboratory certifying that concrete used in precast structures conforms to specified requirements.

F. Manufacturer's Instructions: Indicate special procedures required to install Products specified.

G. Certificates: Certify that products meet or exceed specified requirements.

1.4 SUBMITTALS AT PROJECT CLOSEOUT

A. Division 01 – General Requirements: Requirements for submittals.

B. Submit Project Record Documents.
1. Record actual locations of pipe runs, connections, clean-outs, control points, and invert elevations.
2. Identify, indicate, and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 REGULATORY REQUIREMENTS

A. Contractor shall comply with applicable rules and regulations of
1. State of Wisconsin Department of Natural Resources (WDNR) and local code if more stringent for materials and installation of the Work of this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 01 – General Requirements.

B. Deliver and store castings and gaskets in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.1 GENERAL

A. Pipes, fittings, and structures shall be manufactured in the United States of America.

B. Materials supplied are to be in accordance with
1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing

Products, and local code if more stringent for materials and installation of the Work of this Section.

2. City of Madison Standard Specifications for Public Works Construction, 2017 Edition, for materials and installation of the Work in this Section in municipal right-of-way.

2.2 PIPE MATERIALS

A. Polyvinyl Chloride (PVC) Pipe:
   1. Pipe: ASTM D3034, Type PSM, polyvinyl chloride (PVC) material; SDR 35, nominal inside diameter as shown on Drawings.
   2. Joint Device: Bell and spigot joint with ASTM F477 gasket. Joint shall conform to ASTM D3212.

2.3 PIPE FITTINGS AND ACCESSORIES

A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tees, bends, elbows, wyes, reducers, traps, and other required configurations.

2.4 PIPE LOCATION MATERIALS

A. Identification Warning Tape: Heavy plastic underground warning tape, 2-inch width. Color-Bright Green, warning message "Caution Buried SANITARY SEWER Below" to repeat every 30 inches.

2.5 PRECAST REINFORCED CONCRETE MANHOLE SECTIONS

A. Precast Concrete Risers and Cone Sections: In accordance with ASTM C478, minimum wall thickness, one twelfth of internal diameter of riser or largest cone diameter plus 1 inch.

B. Precast Concrete Base Section with Integral Floor: In accordance with ASTM C478, minimum floor thickness 6 inches for risers up to 48-inches in diameter, and 8-inches for larger diameters; bench minimum slope 1/2-inch per foot from channel to wall; cast in place pipe sleeves.

C. Concrete Flat Slab Top: In accordance with ASTM C478 and approved Shop Drawings; Minimum thickness 6-inches for 48-inch diameter, 8-inches for larger diameters; equipped with lifting hooks.

D. Minimum access opening in cone or top section: 24-inch diameter.

E. Minimum compressive strength of concrete: 4000 psi.

F. Section shall support its own weight and live load equivalent to AASHTO HS-20 Highway Loading, unless otherwise indicated on Drawings.

G. Design exterior wall for a minimum equivalent fluid pressure of 90 pounds per square foot and consider additional lateral pressure from approaching truck wheels.

H. Form and cast openings with wall sleeves in base sections as required by Drawings.

I. Horizontal wall joints shall not be located within 18 inches of centerline of wall penetration.

J. Precast Section Joints: Reinforced concrete base and riser sections excepting grade rings, designed and formed with tongue and groove ends to produce a continuous, uniform manhole.

K. Identification Markings: Clearly mark on inside of each precast section date of manufacture and name or trademark of manufacturer. Clearly mark on outside of each section structure identification number from Drawings.

L. Precast concrete grade rings shall conform to ASTM C478.

2.6 MANHOLE STEPS

A. Rungs and Steps: Steel reinforced copolymer polypropylene plastic ASTM D4101 PP0344B33534Z02; ASTM A615, Grade 60 steel reinforced 1/2-inch diameter; size, placement and embedment shall conform to OSHA 29CFR 1926.1053 Ladders and ASTM C478; ends of legs tapered with fins for embedment.
1. Rungs and Steps in risers and conical sections: Aligned in each section to form continuous ladder with rungs equally spaced vertically in assembled manhole. Steps shall be 12 inches wide, 16 inches on center vertically, set into manhole wall.

2.7 MANHOLE FRAME AND COVER

A. Manufacturers:
1. Neenah Foundry Company, Neenah, WI.
2. East Jordan Iron Works Inc., East Jordan, MI.
3. U.S. Foundry & Manufacturing Corporation, Miami, FL.
4. Substitutions: In accordance with Division 01 – General Requirements.

B. Manhole Frame and Covers:
1. Gray iron castings; ASTM A48, Class 35B, machined horizontal bearing surface, with concealed pickhole, gasketed, solid lid. Neenah Numbers used for identification.
a. Neenah R-1661 manhole frame with Type B lid.

2.8 PIPE AND JOINT SEALANTS AND GASKETS

A. Pipe Sleeve-Factory Cast in Place: ASTM C923, "Lock Joint Flexible Manhole Sleeve;" "KOR-N-SEAL;" or an approved equal, cast in precast base section.

B. Pipe Sleeve - Field Installed: ASTM C923, "KOR-N-SEAL" or an approved equal.

C. Tongue and Groove Preformed Joint Sealant: ASTM C990, preformed flexible joint sealant, Kent Seal No. 2 as manufactured by Hamilton-Kent; Ram-Nek as manufactured by K.T. Snyder Co.; or an approved equal.

2.9 INTERNAL FRAME/CHIMNEY SEAL

A. Flexible rubber sleeve, extensions and wedge strips shall be extruded or molded from high grade rubber compound conforming to applicable requirements of ASTM C923, with a minimum 1500 psi tensile strength, maximum 18 percent compressions set and durometer hardness of 48 plus/minus 5.

B. Sleeve shall be either double or triple pleated, with a minimum unexpanded vertical height of 8 inches and 10 inches respectively and a minimum thickness of 3/16-inch.

C. Top and bottom section of sleeve shall contain an integrally formed expansion band recess and multiple sealing fins.

D. Top section of extension shall have a minimum thickness of 3/32-inch and be shaped to fit into bottom band recess of sleeve under bottom chimney seal band and remainder of extension shall have a thickness of 3/16-inch.

E. Bottom section of extension shall contain an integrally formed expansion band recess and multiple sealing fins matching that of rubber sleeve.

F. Any splice used to fabricate sleeve and extension shall be hot vulcanized and have strength such that sleeve shall withstand 180 degree bend with no visible separation.

G. Continuous wedge strip used to adapt rubber sleeve to sloping surfaces shall have slope differential needed to provide vertical band recess surface, be shaped to fit into band recess and have an integral band restraint.

H. Length of wedge strip shall be such that, when its ends are butted together, it will cover entire inside circumference of that band recess needing slope adjustment.

I. Expansion bands used to compress sleeve against manhole shall be integrally formed from 16 gage, Type 304 stainless steel conforming to ASTM A240, with no welded attachments and shall have a minimum width of 1-3/4 inches.

J. Bands shall have a minimum adjustment range of 2 diameter inches and mechanism used to expand band shall have capacity to develop pressures necessary to make a watertight seal.

K. Band shall be permanently held in this expanded position with a positive locking mechanism. Any studs and nuts used for this mechanism shall be Type 304 stainless steel conforming to ASTM F593 and F594.

L. Seals shall be similar and equal to those manufactured by Cretex Specialty Products.

2.10 CLEANOUTS

A. Sanitary lateral shall have 6 x 4-inch wye for 4-inch ASTM D3034, SDR-35, cleanout pipe riser.

B. Riser pipe shall end in solvent welded Genova Products 30340 adaptor and Genova Products 31839 threaded plug, or approved equal.

C. Encase top of cleanout assembly in cast iron casting. Top of cleanout assembly shall be 2 inches below bottom of cover to prevent loads being transferred from frame and cover to piping.

D. Casting shall be Neenah Foundry R-1913, or an approved equal, cast into 12 x 12 x 6-inch thick concrete pad set flush with adjacent grade.

E. Cast-in-Place Concrete Pad: ASTM C150, Portland cement, and ASTM C33, 3/4-inch coarse aggregate and small and large grained sands, 6 per cent air-entrained concrete with minimum compressive strength of 3500 psi.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that trench cut and excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with Type A2 aggregate as specified in Section 31 05 16 – Aggregates for Earthwork.

B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

C. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

D. Remove scale and dirt on inside and outside before assembly.

E. Prepare pipe connections to equipment with flanges or unions.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 31 23 17 – Site Excavation, Backfill, and Compaction for Work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Place bedding material at trench bottom in accordance with Section 31 23 17 – Site Excavation, Backfill, and Compaction.

C. Place and shape bedding material to pipe, to a minimum depth of three inches under bell and four inches under spigot and compact to 95 percent modified Proctor density.

D. Backfill around sides and top of pipe with bedding material to a loose lift depth above pipe as shown on the Drawings and compact to 95 percent modified Proctor density.

E. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Install PVC pipe in accordance with ASTM D2321 and ASTM F1668.

B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions.

C. Lay pipe to slope gradients noted on Drawings; with maximum variation from true slope of 1:1000.

D. Backfill trench in accordance with Section 31 23 17 – Site Excavation, Backfill, and Compaction. Do not displace or damage pipe when compacting.

E. Connect to building sanitary sewer outlet and municipal sewer system.

F. Coordinate the Work with termination of sanitary sewer connection outside building, connection to municipal sewer utility service, and trenching.

G. Install colored marker tape continuous over top of pipe; coordinate with Section 31 23 17 – Site Excavation, Backfill, and Compaction.

3.5 WATER AND SEWER SEPARATION

A. Sanitary sewer shall be installed at minimum required distances away from adjacent water mains and services as stipulated by:
   1. State of Wisconsin Department of Natural Resources (WDNR) and local code if more stringent for materials for the Work of this Section.

3.6 PREPARATION FOR STRUCTURES

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.7 INSTALLATION - MANHOLES

A. Excavation and Backfill:
   1. Excavate for manholes and drainage structures in accordance with Section 31 23 17 – Site Excavation, Backfill, and Compaction in location and to depth shown. Provide clearance around sidewalls of structure for construction operations.
   2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes in dry trench.
   3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.
   4. Backfill excavations for manholes and drainage structures in accordance with Section 31 23 17 – Site Excavation, Backfill, and Compaction.

B. Install manholes and drainage structures supported at proper grade and alignment on Type A2 aggregate, as specified in Section 31 05 16 – Aggregates for Earthwork, bedding to a minimum compacted thickness as shown on Drawings.

C. Set base section, align pipe sleeve openings to provide straight alignment of pipe through manhole base, level and plumb sections.

D. Set manhole at a grade to assure that no more than 8 inches of precast concrete rings would be required to bring manhole frame and cover to final grade.

E. Lift precast structures at lifting points designated by manufacturer.

F. When lowering manholes and drainage structures into excavations and joining pipe to units, take precautions to ensure interior of structure remains clean.

G. Place preformed flexible joint sealant on either side of tongue portion of joint in base section to assure filling of entire joint when assembled.

H. Set riser section on base, aligning joint prior to setting, lower riser section level and uniformly on to base to squeeze joint compound throughout tongue and groove joint, visible for inspection both interior and exterior for water tight fit.

I. Trowel excess joint compound material flush at interior and exterior surface after placement.

J. Repeat process for remaining riser sections and top, exercising care to align ladder rungs to form uniform vertical ladder.

K. Section shall be vertical and in true alignment with a maximum 1/4-inch tolerance per section allowed.

L. Allow joints to set for a minimum 24-hour period before backfilling.

M. Plug holes in section required for handling or other purposes with non-shrink grout, finished flush on inside.

N. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.

O. Cut pipe to finish flush with interior of structure.

P. Provide concrete flowline at bottom of lowest structure section to achieve sloped drainage from entering pipe to exiting pipe. Trowel smooth. Perform backfilling carefully, bringing fill up evenly on all sides.

Q. Compact fill around vault with a mechanical hand operated wacker.

3.8 INSTALLATION - PIPE SLEEVES

A. If an additional pipe sleeve is required in base section due to changed conditions, provide hole in section prior to it being set.

B. Core hole in base section of sufficient diameter to accommodate pipe and pipe sleeve, using care not to crack or splay concrete.

C. Install "KOR-N-SEAL" pipe sleeve in accordance with manufacturer's instructions.

D. Extend sanitary sewer pipe through pipe sleeves.

E. Extend minimum of two full lengths of pipe out from centerline of manhole in either direction.

F. Bring bedding material for pipe up to manhole face.

G. Provide a poured concrete bench sloped at 2 inches per foot to flow channel utilizing pipe for form.

3.9 INSTALLATION - MANHOLE FRAME AND COVER

A. Set frames using mortar and precast concrete adjustment rings as required.

B. Place precast concrete rings in full bed of mortar with completely fill joints. Verify maximum height of adjustment rings allowed by code prior to installing.

C. Plaster adjustment rings on both inside and outside of ring cylinder with mortar.

D. Place flexible joint sealant on centerline circumference of slab top or concrete ring with mortar bed placed on interior and exterior of sealant to full width of frame or ring area.

E. Where a bolted down frame is required, set bolts and tighten down nuts, leveling frame to finished grade.

3.10 FRAME/CHIMNEY SEAL INSTALLATION

A. Measure manhole to determine information necessary to order proper size sleeve and extensions.

B. Sealing surfaces shall be reasonably smooth, clean, and free of any form offsets or excessive honeycomb. Top internal portion of cone section shall have a minimum 3-inch high vertical surface.

C. Installation:
1. Install rubber sleeve with printing at top and top edge lined up with alignment marks.
2. Wipe off outside of stainless steel band and apply moderate coating of band lubricant to slot area and a light to moderate coating to remainder of bands outside surface.
3. Install band in appropriate band recess with slotted end against rubber surface.
4. Position expansion tool and expand band until locking tabs pop into tightest slots possible.
5. Loosen tool slowly until tabs are fully engaged in slots, then continue to loosen and remove tool.
6. When installing large diameter band, use auxiliary tool slots to start expansion process.
7. Move one tool leg to primary tool slot if necessary to complete expansion.
8. Lubricate second band and install in other band recess.
9. Attach tool and expand as before, keeping bands parallel.
10. Bands can be put closer together if only limited height is available or if excessive sleeve expansion is desired.
11. If extension is being used, position it such that top portion of extension fits snugly into lower band recess of chimney seal sleeve, prior to installing band.
12. Lubricate and install band inside recess formed by top portion of extension and expand as before, thereby compressing both extension and sleeve against manhole surface.
13. If multiple extensions are required, repeat steps above.
14. Position extension’s bottom sealing surface on vertical surface of cone.

15. Lubricate and install third band in lower band recess of extension and expand as before.
16. Check top and bottom edges of installed sleeve to insure they have been properly compressed against surfaces.

3.11 INSTALLATION OF CLEANOUTS

A. Install cleanouts in accordance with:
   1. State of Wisconsin Department of Natural Resources (WDNR) and local code if more stringent for installation of the Work of this Section.

B. Form and place cast-in-place concrete pad with provision for frame and cover.

C. Establish elevations and inverts for cleanouts as indicated on Drawings.

D. Mount cleanout surface hub level in grout, to elevation indicated.

3.12 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspection and testing.

B. Request inspection prior to and immediately after placing bedding.

C. Perform compaction and moisture testing in accordance with Section 31 23 17 – Site Excavation, Backfill, and Compaction.

D. Sewer System Testing:
   1. Pressure Test in accordance with State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.
   2. Infiltration Test in accordance State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.
   3. Deflection Test: Test in accordance with Section 33 37 00 – Sanitary Sewer and Manhole Testing and ASTM D2122.

3.13 PROTECTION OF FINISHED WORK

A. Division 01 – General Requirements: Protecting installed work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is completed.

END OF SECTION

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SECTION 33 41 00

SITE STORM SEWER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Sewer Pipe Materials.
2. Pipe Fittings and Accessories.
3. Storm Sewer Manholes, including Frames and Covers.
4. Catch Basins and Plant Area Drains, including Frames and Grates.
5. Inlets, including Frames and Grates.

B. Related Sections:
1. Applicable provisions of Division 01 – General Requirements shall govern Work under this Section.
2. Section 31 23 17 – Site Excavation, Backfill, and Compaction: Excavating for storm sewer system piping.
3. Division 22 - Plumbing: Sump pump connection.

1.2 REFERENCES

A. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products.

B. City of Madison Standard Specifications for Public Works Construction, 2017 Edition, (SSPW).

C. American Association of State Highway and Transportation Officials: (AASHTO)
1. AASHTO M36 - Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
2. AASHTO M294 – Corrugated Polyethylene Pipe, 300- to 1200-mm Diameter.
3. AASHTO Standard Specifications for Highway Bridges.

D. American Concrete Institute: (ACI)
1. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.

E. ASTM International: (ASTM)
1. ASTM A48 – Specification for Gray Iron Castings.
2. ASTM A536 - Specification for Ductile Iron Castings.
3. ASTM A615 - Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
4. ASTM C14 - Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
5. ASTM C76 - Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
6. ASTM C270 - Specification for Mortar for Unit Masonry.
7. ASTM C443 - Specification for Joints for Circular Pipe and Manholes, Using Rubber Gaskets.

8. ASTM C478 – Specification for Precast Reinforced Concrete Manhole Sections.
9. ASTM C506 – Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe.
10. ASTM C507 – Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
11. ASTM C1479 – Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.
12. ASTM D2235 – Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
13. ASTM D2321 – Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
14. ASTM D2564 - Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
15. ASTM D2661 - Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
16. ASTM D2665 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent and Vent Pipe and Fittings.
17. ASTM D3034 - Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
18. ASTM D3212 - Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
19. ASTM D3350 – Specification for Polyethylene Plastics Pipe and Fitting Materials.
20. ASTM D3965 - Specification for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings.
21. ASTM D4101 - Specifications for Propylene Plastic Injection and Extrusion Materials.
22. ASTM F477 – Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
23. ASTM F628 - Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core.
24. ASTM F679 - Specification for Poly(VinylChloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.
25. ASTM F1668 - Guide for Construction Procedures for Buried Plastic Pipe.
26. ASTM F2306 - Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
27. ASTM F2648 - Specification for 2 to 60 inch [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.

F. Code of Federal Regulations: (CFR)
1. Title 29, Part 1926 Safety and Health Regulations for Construction, Occupational Safety and Health Administration (OSHA), U.S. Department of Labor.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Product Data: Provide data indicating pipe materials, pipe fittings, and precast structures.

C. Submit Structural Design Calculations and detailed Shop Drawings for flattop and special precast concrete manhole structures prepared and sealed by a Professional Engineer licensed in the State of Wisconsin.

D. Design of flattop and special precast structures shall be in accordance with ACI 318 and ASTM C478.

E. Submit concrete mix data and test reports from an approved testing laboratory certifying that concrete used in precast structures conforms to specified requirements.

F. Manufacturer's Instructions: Indicate special procedures required to install Products specified.

G. Certificate: Certify that Products meet or exceed specified requirements.

H. Project Record Drawings:
1. Record actual locations of pipe runs, connections, structures, control points, and invert elevations.
2. Identify, indicate, and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.4 REGULATORY REQUIREMENTS

A. Contractor shall comply with applicable rules and regulations of
1. State of Wisconsin Department of Natural Resources (WDNR) and local code if more stringent for materials and installation of the Work of this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 01 – General Requirements.

B. Deliver and store castings and gaskets in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.1 GENERAL

A. Pipes, fittings, and structures shall be manufactured in the United States of America.

B. Materials supplied are to be in accordance with:
1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.
2. City of Madison Standard Specifications for Public Works Construction, 2017 Edition, for materials and installation of the Work in this Section in municipal right-of-way.

2.2 PIPE MATERIALS

A. Polyvinyl Chloride (PVC) Pipe:
1. Pipe: ASTM D2665, polyvinyl chloride (PVC) material; inside nominal diameter as shown on the Drawings.

2. Joint Device: Bell and spigot with ASTM D2564 solvent sealed joint.

B. Polyvinyl Chloride (PVC) Pipe:
1. Pipe: ASTM D3034, Type PSM, polyvinyl chloride (PVC) material; inside nominal diameter as shown on the Drawings.
2. Pipe: ASTM F679, polyvinyl chloride (PVC) material, PS 46, nominal inside diameter as shown on the Drawings.
3. Joint Device: Bell and spigot style with ASTM F477 rubber ring sealed gasket. Joint shall conform to ASTM D3212.

2.3 PIPE FITTINGS AND ACCESSORIES

A. Fittings and fitting joints shall be in accordance with:
1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

B. Fittings: Same material as pipe, molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

C. Mortar: ASTM C270, Type S.

D. Filter Fabric: Non-biodegradable, nonwoven:
1. Carthage Mills, HS series.
2. TenCate North American Mirafi N series.
3. Propex, Geotex Nonwoven series.
4. US Fabrics, Medium Weight NW series.

2.4 PIPE LOCATION MATERIALS

A. Identification Warning Tape: Heavy plastic underground warning tape, 2-inch width. Color-Bright Green, warning message "Caution Buried STORM SEWER Below” to repeat every 30 inches.

2.5 PRECAST CONCRETE STRUCTURES INCLUDING FRAMES AND COVERS

A. Precast Concrete Risers and Cone Sections for Manholes and Catch Basins: In accordance with ASTM C478, minimum wall thickness, one twelfth of internal diameter of riser or largest cone diameter plus 1 inch.

B. Precast Concrete Base Section with Integral Floor: In accordance with ASTM C478, minimum floor thickness 6 inches for risers up to 48-inches in diameter, and 8 inches for larger diameters; bench minimum slope 1/2-inch per foot from channel to wall; cast in place pipe sleeves.

C. Concrete Flat Slab Top: In accordance with ASTM C478 and approved Shop Drawings; Minimum thickness 6 inches for 48-inch diameter, 8 inches for larger diameters; equipped with lifting hooks.

D. Minimum access opening in cone or top section: 24-inch diameter.

E. Minimum compressive strength of concrete: 4000 psi.

F. Section shall support own weight and live load equivalent to AASHTO HS-20 Highway Loading unless otherwise indicated on Drawings.

G. Design exterior wall for a minimum equivalent fluid pressure of 90 pounds per square foot and consider additional lateral pressure from approaching truck wheels.

H. Form and cast openings with wall sleeves in base sections as required by Drawings.

I. Section joints: Reinforced concrete base and riser sections excepting grade rings, designed and formed with tongue and groove ends to produce a continuous, uniform manhole.

J. Identification Markings: Clearly mark on inside of each precast section indicating date of manufacture, name or trademark of manufacturer. Clearly mark on outside of each section vault identification number from Drawings.

K. Precast concrete grade rings shall conform to ASTM C478.

L. Mortar: ASTM C270, Type S.

M. Reinforcement: Formed steel wire, galvanized finish.

N. Manhole Steps:
1. Steel reinforced copolymer polypropylene plastic ASTM D4101 PP0344B33534Z02; ASTM A615, Grade 60 steel reinforced 1/2 inch diameter formed; size, placement and embedment shall conform to OSHA 29 CFR 1926.1053 Ladders and ASTM C478; ends of legs tapered with fins for embedment.
2. Rungs and Steps in Risers and Conical Sections: Aligned in each section to form continuous ladder with rungs equally spaced vertically in assembled manhole. Steps shall be 12 inches wide, 16 inches on center vertically, set into manhole wall.

2.6 MANHOLE FRAME AND COVER

A. Manufacturers:
1. Neenah Foundry Company, Neenah, WI.
2. East Jordan Iron Works Inc., East Jordan, MI.
3. U.S. Foundry & Manufacturing Corporation, Miami, FL.
4. Substitutions: In accordance with Division 01 – General Requirements.

B. Manhole Frame and Covers:
1. Gray iron castings; ASTM A48, Class 35B, machined horizontal bearing surface, with concealed pickhole, gasketed, solid lid.
   a. Neenah R-1661 Manhole Frame with Type B lid.

C. Catch Basin Frame and Grate:
1. Gray iron castings; ASTM A48, Class 35B, machined horizontal bearing surface, with concealed pickhole, gasketed, solid lid.

a. Pavement: Neenah R-2502 or equal, with Type C grate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that trench cut and excavation base are ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with Type A2 aggregate as specified in Section 31 05 16 – Aggregates for Earthwork.

B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

C. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

D. Remove scale and dirt on inside and outside before assembly.

E. Prepare pipe connections to equipment with flanges or unions.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 31 23 17 – Site Excavation, Backfill, and Compaction for Work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Place and shape bedding material to pipe, to a minimum depth of three inches under bell and four inches under spigot and compact to 95 percent modified Proctor density.

C. Backfill around sides and top of pipe with bedding material to a loose lift depth above pipe as shown on the Drawings and compact to 95 percent modified Proctor density.

D. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions and
   1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

B. Install PVC pipe in accordance with ASTM D2321 and ASTM F1668.

C. Install pipe, fittings, and accessories in accordance with manufacturer's instructions.

D. Lay pipe to slope gradients noted on Drawings; with maximum variation from true slope of 1:1000.

E. Backfill trench in accordance with Section 31 23 17 - Site Excavation, Backfill, and Compaction. Do not displace or damage pipe when compacting.

F. Connect to building storm sewer outlet and municipal sewer system, through installed sleeves.

G. Coordinate the Work with termination of storm sewer connection outside building, connection to municipal sewer utility service, and trenching.

H. Install colored marker tape continuous over top of pipe; coordinate with Section 31 23 17 – Site Excavation, Backfill, and Compaction.

3.5 PREPARATION FOR STRUCTURES

A. Coordinate placement of inlet and outlet pipe sleeves required by other sections.

B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.6 INSTALLATION - STRUCTURES

A. Excavation and Backfill:
   1. Excavate for manholes and drainage structures in accordance with Section 31 23 17 – Site Excavation, Backfill, and Compaction in locations and to depth shown. Provide clearance around sidewalls of structure for construction operations.
   2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes or drainage structures in dry trench.
   3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.
   4. Backfill excavations for manholes and drainage structures in accordance with Section 31 23 17 - Site Excavation, Backfill, and Compaction.

B. Install manholes and drainage structures supported at proper grade and alignment on Type A2 aggregate bedding, as specified in Section 31 05 17 – Aggregates for Site Earthwork, to a minimum compacted thickness as shown on the Drawings.

C. Set base section, align pipe sleeve openings to provide straight alignment of pipe through manhole base, level and plumb sections.

D. Set manhole at a grade to assure that no more than 8 inches of precast concrete rings would be required to bring manhole frame and cover to final grade.

E. Lift precast structures at lifting points designated by manufacturer.

F. When lowering manholes and drainage structures into excavations and joining pipe to units, take precautions to ensure interior of structure remains clean.

G. Place preformed flexible joint sealant on either side of tongue portion of joint in base section to assure filling of entire joint when assembled.

H. Set riser section on base, aligning joint prior to setting, lower riser section level and uniformly on to base to squeeze joint compound throughout tongue and groove joint, visible for inspection both interior and exterior for water tight fit.

I. Trowel excess joint compound material flush at interior and exterior surface after placement.

J. Repeat process for remaining riser sections and top, exercising care to align manhole ladder rungs to form uniform vertical ladder.

K. Section shall be vertical and in true alignment with a maximum 1/4-inch tolerance per section allowed.

L. Allow joints to set for a minimum 24-hour period before backfilling.

M. Plug holes in section required for handling or other purposes with non-shrink grout, finished flush on inside.

N. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.

O. Cut pipe to finish flush with interior of structure.

P. Provide concrete flowline at bottom of lowest structure section to achieve sloped drainage from entering pipe to exiting pipe. Trowel smooth. Perform backfilling carefully, bringing fill up evenly on all sides.

Q. Compact fill around vault with a mechanical hand operated wacker.

3.7 INSTALLATION - FRAME AND COVER

A. Set frames using mortar and precast concrete adjustment rings as required.

B. Place precast concrete rings in full bed of mortar with completely fill joints. Verify maximum height of adjustment rings allowed by code prior to installing.

C. Plaster adjustment rings on both inside and outside of ring cylinder with mortar.

D. Place flexible joint sealant on centerline circumference of slab top or concrete ring with mortar bed placed on interior and exterior of sealant to full width of frame or ring area.

E. In non-pavement areas set frame and cover two inches above finished grade for manholes and other structures with covers to allow area to be graded away from cover beginning 1-inch below top surface of frame.

3.8 FIELD QUALITY CONTROL

A. Division 01 – General Requirements: Field inspection and testing.

B. Perform compaction and moisture content testing in accordance with Section 31 23 17 - Site Excavation, Backfill, and Compaction.

C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Tests: As determined by Construction Manager.

E. Deflection Test: Deflection tests shall be performed for all polyvinyl chloride (PVC) pipe installations.
   1. Deflection test shall be performed using a rigid ball or mandrel without a mechanical pulling device.
   2. If deflection testing occurs within 30 days of placement of final backfill, deflection shall not exceed 5 percent.
   3. When deflection testing occurs more than 30 days after placement of final backfill, maximum deflection shall not exceed 7.5 percent.

3.9 PROTECTION OF FINISHED WORK

A. Division 01 – General Requirements: Protecting installed work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is completed.

END OF SECTION

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