



RFB NO. 320038

CONSTRUCTION DOCUMENTS PROJECT MANUAL

DANE COUNTY DEPARTMENT OF PUBLIC WORKS,
HIGHWAY AND TRANSPORTATION

PUBLIC WORKS ENGINEERING DIVISION
1919 ALLIANT ENERGY CENTER WAY
MADISON, WISCONSIN 53713

REQUEST FOR BIDS NO. 320038
DANE COUNTY SHERIFF'S SE PRECINCT
REMODEL AND ADDITION
125 VETERANS ROAD
STOUGHTON, WISCONSIN

VOLUME 2 of 2

Due Date / Time: **TUESDAY, MARCH 16, 2021 / 2:00 P.M.**

Location: **PUBLIC WORKS OFFICE**

Performance / Payment Bond: **100% OF CONTRACT AMOUNT**

Bid Deposit: **5% OF BID AMOUNT**

FOR INFORMATION ON THIS REQUEST FOR BIDS, PLEASE CONTACT:

STEVE RICHARDS, PROJECT MANAGER
TELEPHONE NO.: 608/516-8367
FAX NO.: 608/267-1533
E-MAIL: RICHARDS.STEVE@COUNTYOFDANE.COM

SECTION 00 01 07

SEALS PAGE

ARCHITECT

I hereby certify that this drawing, specification or report was prepared by me or under my direct supervision and that I am a duly Registered Architect under the laws of the State of Wisconsin.



Architect's Seal
Wesley T. Reynolds
OPN Architects, Inc.
301 North Broom Street, Suite 100
Madison, WI 53703
Telephone: (608) 819-0260

CIVIL ENGINEER

I hereby certify that this drawing, specification or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Wisconsin.



Civil Engineer's Seal
Matt Haase
JSD Professional Services, Inc.
161 Horizon Drive, Suite 101
Verona, WI 53593
Telephone: (608) 848-5060

MECHANICAL AND ELECTRICAL ENGINEER

I hereby certify that this drawing, specification or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Wisconsin.



Mechanical and Electrical Engineer's Seal
Kelly Harrer
Design Engineers
437 South Yellowstone Drive, Suite 110
Madison, WI 53719
Telephone: (608) 424-8814

STRUCTURAL ENGINEER

I hereby certify that this drawing, specification or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Wisconsin.



Structural Engineer's Seal
Chad Whittinghill
Strategic Structural Design, LLC
725 Heartland Trail, Suite 203
Madison, WI 53717
Telephone: (608) 770-4265

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SECTION 21 00 10
FIRE SUPPRESSION GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL

- A. Refer to Division 00 – Procurement, Contracting and Warranty Requirements and Division 01 - General Requirements, which all apply to work under this section.

1.2 DESCRIPTION OF WORK

- A. This section applies to all work under the fire suppression contract. This shall include, but not necessarily be limited to, the following:
1. Water Based Fire Suppression Systems
- B. The work shall include all materials, equipment and labor required for complete and properly functioning fire suppression systems.
- C. Drawings for fire suppression work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, piping and approximate sizes and locations of equipment and materials.
- D. Where job conditions require reasonable changes in indicated locations and arrangements, make such changes without additional cost to Owner.
- E. Because of the scale of the drawings, certain piping or items such as unions or fittings may not be shown, but where such items are required by other sections of the specifications, or where they are required by the nature of the work, they shall be furnished and installed.
- F. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- G. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
1. International Fire Suppression Code
 2. Wisconsin State Plumbing Code
 3. International Building Code
 4. National Electric Code (NEC)
 5. National Fire Protection Association Standards (NFPA)
 6. Local Utility Company Requirements
 7. Local Codes, all trades
 8. Standards of ASME, ASHRAE, NEMA, IEEE, AGA, SMACNA
 9. Occupational Safety and Health Administration (OSHA)
 10. Underwriters Laboratories, Inc. (U.L.)
 11. Wisconsin Administrative Codes
 12. Americans With Disabilities Act (ADA)
- B. Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

- C. Where drawings or specifications call for workmanship or materials in excess of code requirements, a lower grade of construction will not be permitted.

1.4 REQUIREMENTS & FEES OF REGULATORY AGENCIES

- A. Contractor shall comply with the rules and regulations of the authorities having jurisdiction and local utility companies. Contractor shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Secure all required permits and pay for all inspections, licenses and fees required in connection with the fire suppression work. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.

1.5 FIRE SUPPRESSION DRAWINGS

- A. The fire suppression drawings indicate in general the building arrangement only, Contractor shall examine all construction drawings to familiarize himself with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.
- B. Drawings for piping are intended to convey the scope of the work and to indicate the general arrangement and locations of piping and equipment.
- C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of piping so as to best fit the layout of the work.
- D. Contractor shall take his own field measurements for verifying locations and dimensions: scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as pipe fittings and valves may not be shown, but where such items are required by code or by other sections of the specifications, such items shall be furnished and installed.

1.6 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact location of all existing services prior to beginning work in that area.
- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.
- C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.7 SITE INSPECTION

- A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the work required because of the contractor's failure to make this inspection.

1.8 COORDINATION AND COOPERATION

- A. It shall be Contractor's responsibility to schedule and coordinate his work with the schedule of General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.

- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications, or between the requirements set forth for the various contractors, shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and his decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting and plaster until the project is substantially completed. Damage from rust, paint and scratches shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the painting contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires Contractor to work in finished areas of the building, Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall arrange with General Contractor for patching and refinishing of such areas which may be damaged in this respect.

1.9 OPENINGS, CUTTING AND PATCHING

- A. Piping and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe or sleeve shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where piping and sleeves pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.
- B. New structure:
 - 1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the fire suppression work with the General Contractor.
 - 2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.
- C. Existing Structure:
 - 1. Contractor shall provide cutting, lintels and patching, and patch painting in the existing structure, as required for the installation of his work, and shall furnish lintels and supports as required for openings.
 - 2. Cutting of structural support members will not be permitted without prior approval of the Design Professional. Extent of cutting shall be minimized; use core drills, power saws or other machines which will provide neat, minimum openings.
 - 3. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.

1.10 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item. Where two or more units are required of the same item, they shall be furnished by the same manufacturer except where specified otherwise.

- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items, when required, shall be furnished as part of the equipment, whether or not specifically called for.

1.11 SUBMITTALS

- A. Contractor shall furnish to Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- D. After award of contract, Contractor shall provide a completed submittal schedule including dates that the submittals will be to Design Professional for review.
- E. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
21 10 00	Water Based Fire Suppression System	X	X			X	X	1, 2

Notes:

- 1. Hydraulic calculations.
- 2. All certifications and test results required by NFPA.

- F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.
- G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

1.12 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted to Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.

- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three-ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
FIRE SUPPRESSION SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
1. Equipment and system warranties and guarantees.
 2. Installation instructions.
 3. Operating instructions.
 4. Maintenance instructions.
 5. Spare parts identification and ordering list.
 6. Local service organization, address, contract and phone number.
 7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
 8. Reports of all tests and demonstrations including certificate of owner instruction, testing and balancing report, etc.

1.13 TRAINING AND DEMONSTRATIONS

- A. Prior to acceptance of the fire suppression installation, Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.
1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
 2. Prepare the instruction format for a minimum of four Owner Representatives.
- B. Equipment training:
1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
 2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
 3. Training shall be performed by qualified factory trained technicians.
 4. Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
 5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

C. The following are minimum requirements for Owner instruction:

Section	Description	Hours (Note 1)	Presented By	Others Present	Remarks
21 10 00	Water Based Fire Suppression System	4	Contractor		
1. Any unused hours shall be used at Owner's discretion during the first year of occupancy.					

D. Contractor shall submit to Design Professional a certificate, signed by Owner stating the date, time and persons instructed and that the instruction has been completed to the Owner's satisfaction. An example of a certificate form is as follows:

CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that the contractor has demonstrated the hereafter listed systems to Owner's representatives in accordance with the Contract documents and that the instruction has been completed to the Owner's satisfaction.

A. Project:

B. System(s):

C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

D. Owner's representatives receiving instruction:

Owner: _____

E. Acknowledgement of demonstration:

NAMES	DATE	HOURS

Contractor's Representative:

_____ signature

_____ date

Owner's Representative:

_____ signature

_____ date

1.14 SUBSTITUTIONS

- A. Refer to Divisions 00 and 01.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.15 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the contractor and/or the manufacturer.
- C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions (including accessibility for maintenance), operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.16 WARRANTY

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
 - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
 - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
 - b. The entire Fire Suppression system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 21 sections for systems, equipment, or material requiring extended warranties beyond one year.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

1.17 COMPLETION

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.
- B. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

1.18 CLEANING

- A. At the conclusion of the construction, the entire system of piping and equipment shall be cleaned internally.
- B. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.

PART 2 -PART 2 - PRODUCTS (Not Applicable)

PART 3 -PART 3 - EXECUTION (Not Applicable)

END OF SECTION 21 00 10

SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 GENERAL

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 21 00 10 - Fire Suppression General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. This section includes the following:
 - 1. Sleeves
 - 2. Escutcheons
 - 3. Fire Stopping

PART 2 - PRODUCTS

2.1 DEMOLITION MATERIALS

- A. All materials removed shall be the property of the removing contractor and shall be removed from the site by him, unless otherwise specified.

2.2 SLEEVES

- A. Sleeves passing through non-load bearing walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:
 - 1. For pipes 2-1/2" and smaller - 24 gauge
 - 2. For pipes 3" to 6" - 22 gauge
- B. Sleeves passing through load bearing walls, concrete beams, fireproof walls, foundations, footings and waterproof floors shall be Schedule 40 steel pipe or cast iron pipe.
- C. Sleeves are not required in masonry walls which are core drilled or walls of drywall construction, except where partition is a firestop, smokestop, or side of air plenum.
- D. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.
- E. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water and fill space between sleeves and pipe with graphite packing and caulking compound.
- F. Sleeves passing through membrane waterproofing or lead safe shall be provided with flashing, furnished and installed by General Contractor, extending 12" beyond sleeve in all directions; flashing shall be secured and sealed to membrane or lead safe and shall be sealed to sleeve and caulked watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 6" above roof.

2.3 ESCUTCHEONS

- A. Provide chrome plated escutcheons at each sleeved opening into finished spaces. Escutcheons shall fit around pipe; outside diameter shall cover sleeve. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension. Secure escutcheons or plates to sleeve with set screws or other approved devices.

2.4 FIRESTOPPING

- A. Piping and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor, pipe, and sleeve, shall be sealed with UL Listed intumescent fire barrier material equivalent to rating of wall/floor.

PART 3 - EXECUTION

3.1 SLEEVES

- A. Install sleeves for all piping passing through floors, roof, walls, concrete beams and foundations as required by this section.

3.2 ESCUTCHEONS

- A. Install escutcheons for all pipes entering finished spaces.

END OF SECTION 21 05 00

SECTION 21 05 13
COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 21 00 10 - Fire Suppression General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 SUBMITTALS

- A. Submit for all motors provided.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Comply with NEMA MG1 unless noted otherwise.
- B. Motor type: Minimum 1.15 service factor; rated at 90 deg. C. ambient temperature (Class B insulation) with 40 deg. C. temperature rise.
- C. Multiple speed motors: Multiple windings.
- D. Motor Efficiency: Premium efficiency as defined in NEMA MG1.
- E. Peak instantaneous current: Maximum 130% of full-load.
- F. All motors shall be provided as required for motor orientation within equipment.
- G. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulations.
- H. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torques.
- I. Motor Enclosures:
 - 1. Shall be the NEMA types shown on the drawings for the motors.

2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types which are most suitable for the environmental conditions where the motors are being installed. Motors located outdoors to be totally enclosed weatherproof epoxy-sealed type.
 3. Thoroughly clean and paint the enclosures at the factory with manufacturer's prime coat and standard finish.
- J. Additional requirements for specific motors, as indicated in other sections, shall also apply.

2.2 SINGLE PHASE POWER

- A. Capacitor start motors starting torque shall be three times full load torque and starting current shall be less than five times full load current.
- B. Pull-up Torque: Up to 350 percent of full load torque.
- C. Breakdown Torque: Approximately 250 percent of full load torque.
- D. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- E. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- F. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

PART 3 - EXECUTION (Not Used)

END OF SECTION 21 05 13

SECTION 21 10 00
WATER-BASED FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 21 00 10 - Fire Suppression General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of fire suppression work is indicated on drawings and schedules, and by requirements of this section.
- B. Applications of fire suppression systems include the following:
 - 1. Sprinkler systems.

1.3 QUALITY ASSURANCE

- A. NFPA Code: Comply with ANSI/NFPA 13, "Installation of Sprinkler Systems", and ANSI/NFPA 24, "Private Fire Service Mains and Their Appurtenances", where applicable.
- B. UL Labeling: Provide fire sprinkler piping products which have been approved and labeled by Underwriters Laboratories.
- C. Local Fire Marshal Regulations: Comply with governing regulations pertaining to fire sprinkler piping.
- D. All fire suppression work shall be performed by a qualified sprinkler contractor with at least three years experience that has obtained current certification in the State of Wisconsin under the Fire Extinguishing System Contractor Certification program. During the installation, a minimum of one person with at least three years sprinkler experience shall be present.
- E. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- F. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data for fire suppression systems, materials and products.
- B. Piping Shop Drawing and Hydraulic Calculations: The Contractor shall prepare a complete set of detailed working drawings and hydraulic calculations showing all equipment, fire service lines, risers, piping and heads. These drawings and calculations shall be approved in writing or stamped approved by the authorities having jurisdiction. Contractor is responsible for any fees associated with the review and approval of the fire suppression layout drawings, product data and hydraulic calculations by the State Fire Marshal's office. Contractor is also responsible for completion of the required fire extinguishing system submittal form to the SFM.
- C. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed
- D. Grooved joint couplings and fittings shall be referred to on drawings and product submittals and be identified by the manufacturer's listed model or series designation.

- E. Certificate of Installation: Submit certification upon completion of fire suppression piping work which indicates that work has been tested in accordance with ANSI/NFPA 13 (Factory Mutual) and also that system is operational, complete and has no defects.

PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Automatic Sprinklers

- 1. Reliable Sprinkler Corporation.
- 2. Tyco.
- 3. Viking Corp.
- 4. Globe Fire Sprinkler Corporation
- 5. Victaulic

B. Backflow Preventers

- 1. Watts
- 2. Apollo Valves
- 3. Febco
- 4. Zurn Wilkins

C. Gate Valves

- 1. NIBCO
- 2. Powell
- 3. Milwaukee
- 4. Watts
- 5. Victaulic

D. Bronze Body Butterfly Valves

- 1. NIBCO
- 2. Milwaukee

E. Butterfly and Swing Check Valves

- 1. Victaulic
- 2. Gruvlok by Anvil International
- 3. Kennedy
- 4. Milwaukee
- 5. NIBCO

F. Ball Valves

- 1. Watts B-6000 Series
- 2. Milwaukee BA-100/BA-150
- 3. NIBCO T-580 Series
- 4. Apollo 77C Series
- 5. Victaulic

G. Dry Type System (including valve, air pressure maintenance and low pressure horn device)

- 1. Viking Corp.
- 2. Reliable
- 3. Tyco
- 4. Victaulic

- H. Grooved Piping Systems
 - 1. Gruvlok by Anvil International
 - 2. Victaulic
- I. Fire Department Connections
 - 1. Larsen's Manufacturing Company
 - 2. Guardian Fire Protection Equipment
 - 3. Potter-Roemer
 - 4. Croker
- J. Water Flow Indicators and Supervisory Switches
 - 1. Potter-Roemer / Potter Electric
 - 2. System Sensor

2.2 FIRE SUPPRESSION SPECIALTIES

- A. General: Provide fire suppression specialties, UL listed, in accordance with the following listing. Provide sizes and types which mate and match piping and equipment connections.
 - 1. Water Flow Indicators: Provide vane type water flow detectors.
 - 2. Supervisory Switches: Provide products recommended by manufacturer for use in service indicated.
 - 3. Low Air Pressure Horn: Provide low air pressure horn as indicated.
 - 4. Air Pressure Maintenance Device, Dry-Pipe System: Provide air pressure maintenance device for dry-pipe standpipe piping as recommended by the manufacturer.
 - 5. Automatic Sprinklers:
 - a. Provide automatic sprinklers of type indicated on drawings, and in accordance with the following listing. Provide liquid bulb, ordinary temperature, except where intermediate or high temperature rated sprinklers are required per NFPA 13 or as indicated on the plans.
 - 1) Upright
 - 2) Concealed Pendent with Flat Cover Plate
 - 3) Pendant
 - 4) Standard Dry-Type Pendent
 - 5) Standard Dry-Type Upright
 - 6) Dry-Type Concealed Pendent with Flat Cover Plate
 - b. Finish: Painted white for concealed pendent, cast brass for upright pendent, white for recessed pendent or provide finish as indicated on the plans.
 - 6. Sprinkler Cabinet and Wrench: Furnish steel, baked red enameled, sprinkler box with capacity to store 10 sprinklers and wrench sized to sprinklers.
 - 7. Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.
 - 8. Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss cast in the sprinkler body.
- B. Fire Department Connection: Provide fire department connection with integral clappers, 175 psi rated working pressure, of size and end type indicated.

2.3 BACKFLOW PREVENTERS

- A. Double Check Assembly Backflow Preventer (at main sprinkler system supply): A double check assembly shall be installed at referenced cross connections to prevent the backflow of polluted water into the potable water supply. The cross connections shall be determined by local inspection authority for use where a high hazard situation does not exist; it shall be a complete assembly consisting of two independent tri-link check modules within a single housing, sleeve access port, four test cocks and two drip tight shut-off valves. Checks shall be removable and serviceable, without use of special tools. 304 Schedule 40 stainless steel pipe with groove end connections. Assembly shall be Watts Regulator Co. Series 757 or 757N. The device shall meet the requirements of ANSI/ASSE Standard 1015 and AWWA Standard C510-92 and be approved by the FCCCHR at USC. All components of the backflow preventer assembly shall meet the requirements for ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

2.4 VALVES

- A. Butterfly - 1/4" to 2" Milwaukee Butterball BB2 Series
- B. Ball - 2" to 3" Victaulic Series 727
- C. Butterfly - 4" to 8" Victaulic Series 705 (Normally Open Valves) or Series 707C (Normally Closed Valves)
- D. Gate - 2-1/2" and larger, iron body O.S.&Y., Powell Fig. 1797
- E. Check - 2-1/2" to 3", Central Model 90, 4" to 8" Victaulic Series 717

2.5 DRY PIPE SYSTEM

- A. Furnish and install where shown on plans a dry type system complete with a dry valve and pneumatic supervision of the automatic sprinkler system. Supervisory pressure must be relieved from the sprinkler system before the dry valve will open to fill the system with water.
- B. The dry valve shall be the quick opening, differential type flood valve with a rolling diaphragm or latched clapper design. The valve shall be held closed by system water pressure trapped in the priming chamber so that the outlet chamber and system piping remain dry. When the releasing system operates, pressure is released from the priming chamber and the clapper opens to allow water to flow into the system piping. The valve shall be equal to a Viking Model F-1 and, as a minimum, shall have the following features:
 - 1. Field replaceable diaphragms and rubber seated clapper assembly.
 - 2. Shall be designed to be externally resettable or self resetting without opening the valve.
 - 3. Shall be approved for use with pneumatic and/or electric release systems.
- C. The dry pipe system shall be furnished complete with the following (as a minimum):
 - 1. Dry valve.
 - 2. Dry valve conventional trim.
 - a. Priming valve (normally open).
 - b. Strainer.
 - c. Spring loaded check valve.
 - d. Alarm test valve (normally closed).
 - e. Auxiliary drain valve (normally closed).
 - f. Drip check valve.
 - g. Drain check valve.
 - h. Alarm shut-off valve (normally open).
 - i. Pressure operated relief valve (P.O.R.V).
 - j. Emergency release.
 - k. Priming pressure water gauge and valve.
 - l. Water supply pressure gauge and valve.
 - m. Drain cup.
 - n. Flow test valve (normally closed).
 - 3. Water flow alarm equipment.
 - a. Alarm pressure switch with two sets of independently adjustable contacts.
 - b. Water motor alarm (strainer required).
 - c. Strainer.
 - d. Electric alarm bell.
 - 4. Riser.
 - a. Water supply control valve.
 - b. Check valve.
 - 5. Supervisory air supply.
 - a. System pressure gauge and valve.
 - b. Check valve.
 - c. Air pressure supervisory switch with two sets of independently adjustable contacts.

6. Air supply.
 - a. Air compressor (refer to schedule on plans).
 - b. Refrigerated Air Dryer.
7. Accelerators.
 - a. Provide accelerators as dictated by system volume and NFPA 13.

2.6 PIPE MATERIALS

	<u>Material</u>	<u>Service</u>
A.	Black steel pipe, Schedule 40, ASTM A795	Wet systems.
B.	Black steel pipe, Schedule 10, ASTM A795	Wet systems.
C.	Galvanized Steel Pipe Schedule 40, ASTM A795.	Dry systems.
D.	Flexible sprinkler head connectors are <u>not</u> allowed.	

2.7 PIPE FITTINGS

A. Steel Pipe:

1. Threaded pipe (2" dia and smaller): Malleable or Ductile iron fittings, 150 pound standard flat band water pattern.
2. Welded pipe (2 1/2" dia and larger): Standard radius weld fittings and weld neck or slip-on flanges, same material and strength as pipe.
3. Mechanical grooved and roll-groove steel piping system and fittings: may be used as approved by code for black steel, stainless steel and galvanized steel. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.
 - a. In lieu of groove type couplings and fittings, Victaulic Installation-Ready™ fittings matching the pipe schedule with grooved end steel piping in fire protection applications sizes NPS 1-¼" thru 2½", consisting of a ductile iron housing conforming to ASTM A-536, Grade 65-45-12, with Installation-Ready™ ends, prelubricated Grade "E" EPDM Type 'A' gasket, and ASTM A449 electroplated steel bolts and nuts. UL listed for a working pressure of 300 psi (2065 kPa) and FM approved for working pressure 365 psi (2517kPa).
 - b. Grooved joint fittings shall be ductile iron conforming to ASTM A-536 Grade 65-45-12, short-pattern with flow equal to standard pattern fittings. Basis of Design: Victaulic FireLock.

2.8 JOINTS

A. Steel Pipe:

1. Threaded pipe (2" dia and smaller): Make joints using Teflon tape applied to male threads only. Cut pipe square, cut threads clean, remove burrs and ream ends to full size of bore.
2. Welded pipe (2 1/2" dia and larger): Welding shall conform to welding section of ANSI-B31.3 "Code for Power Piping."
3. Mechanical grooved and roll-groove pipe couplings: Grooved couplings may be used as approved by code for black steel and galvanized steel piping. Gasket type to be used shall be appropriate for intended service. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.
 - a. In lieu of groove type couplings and fittings, Victaulic Installation-Ready™ fittings matching the pipe schedule with grooved end steel piping in fire protection applications sizes NPS 1-¼" thru 2½", consisting of a ductile iron housing conforming to ASTM A-536, Grade 65-45-12, with Installation-Ready™ ends, prelubricated Grade "E" EPDM Type 'A' gasket, and ASTM A449 electroplated steel bolts and nuts. UL listed for a working pressure of 300 psi (2065 kPa) and FM approved for working pressure 365 psi (2517kPa).
 - b. Grooved joint fittings shall be ductile iron conforming to ASTM A-536 Grade 65-45-12, short-pattern with flow equal to standard pattern fittings. Basis of Design: Victaulic FireLock.

2.9 NIPPLES AND UNIONS

- A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2", use extra strong nipple; do not use close nipples.
- B. For pipe 2" and smaller, use screwed unions, for pipe 2-1/2" and over use flanged unions. For steel pipe use black or galvanized malleable iron unions, to conform to pipe with ground joint. Cast iron flanged unions gasket type. For threaded brass pipe, use bronze ground joint unions with octagon ends.
- C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:
 - 1. Long runs, at intervals of 80 feet.
 - 2. In by-pass around equipment, valves, and controls.
 - 3. In connections to equipment.
 - 4. Where indicated on drawings.

PART 2 - EXECUTION

3.1 GENERAL

- A. Contractor shall familiarize himself with the general construction, plumbing, heating, ventilating, and electrical work and to use the information to avoid conflicts in space allocation with the other trades. Do not place pipes over electrical equipment.
- B. In the case of an interference occurring during construction, Contractor shall rework and reinstall piping and equipment in order to make space available for another contractor's equipment without additional cost to the Owner.
- C. Contractor shall work closely with the ceiling system installers and install sprinkler head drops before ceiling tiles are installed, and return to job after or during ceiling tile installation for installation of sprinkler heads.
- D. Heads shall be located in center of ceiling tiles or as directed by Design Professional.

3.2 FIRE SUPPRESSION SPECIALTIES

- A. General: Install fire suppression specialties as indicated, and in accordance with ANSI/NFPA 13.
- B. Provide wire guards for all exposed sprinkler heads installed below ductwork in mechanical rooms, in electrical rooms, in telecommunication rooms, and locations where heads are susceptible to mechanical damage (e.g. within seven feet of floor level).

3.3 BACKFLOW PREVENTERS

- A. Install backflow preventers where required per local code and in accordance with manufacturer's recommendations. Backflow preventers to be installed accessible for testing, installing contractor shall provide testing by a certified backflow assembly tester at time of installation as required by Code.

3.4 VALVES

- A. Install valves as indicated on the drawings and as specified herein. Install sectional valves in inlet piping at bottom of each riser and in loops as indicated. Locate valves for easy access and operation. Do not locate valves with stems below horizontal. Mount supervisory switches on each sectional valve.
- B. Install valves in equipment rooms to provide easy access to valve.
- C. Check valves shall not be installed in vertical runs of piping unless they are specifically designed for vertical operation.

- D. Normally Open (N.O.) or Normally Closed (N.C.) valves shall be provided as required for intended system operation. For all supervised valves, the off-normal signal shall be initiated during the first two revolutions of the hand wheel or during one-fifth of the travel distance of the valve control apparatus from its normal position.

3.5 PIPING

- A. General: Comply with requirements of ANSI/NFPA 13 for installation of fire sprinkler piping products where indicated, in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that fire sprinkler piping complies with requirements and serves intended purposes.
- B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other mechanical items. Locate groups of pipes parallel to each other; space at a distance to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
- C. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage. Install drain piping at low points of fire sprinkler piping.
- D. Install valved hose connections of sizes indicated, or 3/4" size if not otherwise indicated, on sprinkler at ends of branch lines and cross mains at locations where indicated.
- E. Install air vents at high points of sprinkler piping.
- F. Hangers and supports: Comply with NFPA for hanger materials
 - 1. Install sprinkler system piping according to NFPA 13.
- G. Grooved joints shall be installed in accordance with the manufacturer's latest published instructions. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

3.6 ADJUST AND CLEAN

- A. Sprinkler Piping Flushing: Prior to connecting sprinkler risers for flushing, flush water feed mains, lead-in connections and control portions of sprinkler piping. After fire sprinkler piping installation has been completed and before piping is placed in service, flush entire sprinkler system, as required to remove foreign substances, under pressure as specified in ANSI/NFPA 13. Continue flushing until water is clear, and check to ensure that debris has not clogged sprinklers.

3.7 FIELD QUALITY CONTROL

- A. Hydrostatic Testing: After flushing system, test fire sprinkler piping hydrostatically, for period of 2 hours, at not less than 200 psi or at 50 psi in excess of maximum static pressure when maximum static pressure is in excess of 150 psi. Check system for leakage of joints. Measure hydrostatic pressure at low point of each system or zone being tested.
- B. Dry-Pipe Testing: Test dry-pipe hydrostatically except, in freezing conditions, test with air at pressures not less than 50 psi, for period of 2 hours. Check system for leakage. Leave differential dry-valve clappers open during test, to prevent damage.
- C. Repair or replace piping system as required to eliminate leakage in accordance with ANSI/NFPA standards for "little or no leakage", and retest as specified to demonstrate compliance.

3.8 EXTRA STOCK

- A. General: For each style and temperature range required, furnish additional sprinkler heads, amounting to 1 unit for every 100 installed units, but not less than 5 units of each.

END OF SECTION 21 10 00

SECTION 22 00 10
PLUMBING GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL

- A. Refer to Division 00 – Procurement, Contracting and Warranty Requirements and Division 01 - General Requirements, which all apply to work under this section.

1.2 DESCRIPTION OF WORK

- A. This section applies to all work under the plumbing contract. This shall include, but not necessarily be limited to, the following:
1. Waste and Vent Systems
 2. Hot and Cold Water Distribution System
 3. Plumbing Fixtures
 4. Water Heating Systems
 5. Sanitary Sewer
 6. Piping Insulation
 7. Natural Gas System
- B. The work shall include all materials, equipment and labor required for complete and properly functioning plumbing systems.
- C. Drawings for plumbing work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, piping and approximate sizes and locations of equipment and materials.
- D. Where job conditions require reasonable changes in indicated locations and arrangements, make such changes without additional cost to Owner.
- E. Because of the scale of the drawings, certain piping or items such as unions or fittings may not be shown, but where such items are required by other sections of the specifications, or where they are required by the nature of the work, they shall be furnished and installed.
- F. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- G. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
1. International Mechanical Code
 2. Wisconsin State Plumbing Code
 3. International Building Code
 4. International Fire Code
 5. National Electric Code (NEC)
 6. National Fire Protection Association Standards (NFPA)
 7. Local Utility Company Requirements
 8. Local Codes, all trades
 9. Standards of ASME, ASHRAE, NEMA, IEEE, AGA, SMACNA
 10. Occupational Safety and Health Administration (OSHA)
 11. Underwriters Laboratories, Inc. (U.L.)
 12. Wisconsin Administrative Codes
 13. Americans With Disabilities Act (ADA)
 14. ANSI/NSF 372

- B. Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.
- C. Where drawings or specifications call for workmanship or materials in excess of code requirements, a lower grade of construction will not be permitted.

1.4 REQUIREMENTS & FEES OF REGULATORY AGENCIES

- A. Contractor shall comply with the rules and regulations of the authorities having jurisdiction and local utility companies. Contractor shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Meters for incoming services shall be selected based on the project requirements. Any questions concerning this shall be referred to Design Professional prior to bidding. Contractor shall provide the appropriate meter and associated materials if not furnished by the utility company.
- C. Secure all required permits and pay for all inspections, licenses and fees required in connection with the plumbing work. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.
- D. Contractor shall make all arrangements with each utility company and pay all service charges associated with new service.

1.5 PLUMBING DRAWINGS

- A. The plumbing drawings indicate in general the building arrangement only, Contractor shall examine construction drawings to familiarize himself with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.
- B. Drawings are intended to convey the scope of the work and to indicate the general arrangement and locations of piping and equipment.
- C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of piping so as to best fit the layout of the work.
- D. Contractor shall take his own field measurements for verifying locations and dimensions: scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as pipe fittings and valves may not be shown, but where such items are required by code or by other sections of the specifications, such items shall be furnished and installed.

1.6 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact location of all existing services prior to beginning work in that area.
- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.
- C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.7 SITE INSPECTION

- A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.8 COORDINATION AND COOPERATION

- A. It shall be Contractor's responsibility to schedule and coordinate his work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by Design Professional and his decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting and plaster until the project is substantially completed. Damage from rust, paint and scratches shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires Contractor to work in finished areas of the building, Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.

1.9 OPENINGS, CUTTING AND PATCHING

- A. Piping and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe and/or sleeve shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where piping and sleeves pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.
- B. New structure:
 - 1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the plumbing work with the General Contractor.
 - 2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.

C. Existing Structure:

1. Contractor shall provide cutting, lintels and patching, and patch painting in the existing structure, as required for the installation of his work, and shall furnish lintels and supports as required for openings.
2. Cutting of structural support members will not be permitted without prior approval of the Design Professional. Extent of cutting shall be minimized; use core drills, power saws or other machines which will provide neat, minimum openings.
3. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.

1.10 EXCAVATING AND BACKFILLING

- A. Contractor shall do all excavating necessary for sanitary sewers, storm sewers, water piping, gas piping, etc., and shall backfill trenches and excavations after work has been inspected. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way, except where lines must cross under a wall footing. Where a line must pass under a footing, the crossing shall be made by the smallest possible trench to accommodate the pipe. Excavation shall be kept free from water by pumping if necessary.
- B. Backfill about the structure shall be placed, when practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit. Backfill shall be in accordance with Division 31 Specifications.

1.11 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item. Where two or more units are required of the same item, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items, when required, shall be furnished as part of the equipment, whether or not specifically called for.

1.12 SUBMITTALS

- A. Contractor shall furnish, to Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- D. After award of contract, Contractor shall provide a completed submittal schedule including dates that the submittals will be to Design Professional for review.

E. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
22 05 19	Meters and Gages for Plumbing Piping		X					
22 05 23	General Duty Valves for Plumbing Piping		X					
22 05 53	Plumbing Identification		X					
22 07 00	Plumbing Insulation		X					
22 11 16	Domestic Water Piping		X					
22 11 23	Domestic Water Pumps		X			X	X	
22 13 16	Sanitary Waste and Vent Piping		X					
22 13 19	Grease Interceptors		X			X		
22 15 16	Facility Natural Gas Piping		X					
22 31 00	Domestic Water Softeners		X			X	X	
22 34 00	Fuel-Fired Domestic Water Heaters		X			X	X	
22 40 00	Plumbing Fixtures		X			X		
22 47 00	Drinking Fountains and Water Coolers		X			X		

F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.

G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

1.13 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be submitted to Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.

B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
PLUMBING SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
1. Equipment and system warranties and guarantees.
 2. Installation instructions.
 3. Operating instructions.
 4. Maintenance instructions.
 5. Spare parts identification and ordering list.
 6. Local service organization, address, contract and phone number.
 7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
 8. Reports of all tests and demonstrations including certificate of owner instruction, testing and balancing report, etc.

1.14 TESTS AND DEMONSTRATIONS

- A. Tests Required: Piping shall be tested and proved tight under the following static pressures. Pressure shall be maintained for four (4) hours.

<u>System</u>	<u>Pressure</u>
Domestic Water Piping Systems	Refer to Section 22 1116 – Domestic Water Piping
Soil and Waste Piping Below Grade	10 feet waterhead or fill to top of vent outlet above roof.
Soil and Waste Piping Above Grade	Fill piping with water to top of vent outlet above roof, or 10 feet waterhead.
Gas Piping	10 psi air pressure, liquid soap test around all joints.

TESTING NOTE: All rubber gasket joints for cast iron soil pipe and fittings should be properly restrained if test pressures exceed 10 feet of head.

- B. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner. Contractor shall submit a report to Design Professional citing dates, times, pressures, and results of all tests performed.

1.15 TRAINING AND DEMONSTRATIONS

- A. Prior to acceptance of the plumbing installation, Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.
1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
 2. Prepare the instruction format for a minimum of four Owner Representatives.
- B. Equipment training:
1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
 2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
 3. Training shall be performed by qualified factory trained technicians.
 4. Plumbing Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
 5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

C. System training:

1. These sessions shall include hands-on demonstrations of system wide start-up, operation in all possible modes, shut-down and emergency procedures.

D. The following are minimum requirements for Owner instruction:

Section	Description	Hours (Note 1)	Presented By	Others Present	Remarks
22 00 10	Plumbing System (Excluding Equipment)	4	Contractor		Note 2
22 31 00	Water Softeners	2	Manufacturer's Representative	Contractor	
22 34 00	Water Heaters	2	Manufacturer's Representative	Contractor	
<ol style="list-style-type: none"> 1. Any unused hours shall be used at Owner's discretion during the first year of occupancy. 2. System training shall include, but not be limited to, valve locations, system routing, and air/water flow patterns, system start-up/shut-down/emergency procedures. 					

- E. Contractor shall submit to Design Professional a certificate, signed by Owner stating the date, time and persons instructed and that the instruction has been completed to Owner's satisfaction. An example of a certificate form is as follows:

CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that Contractor has demonstrated the hereafter listed systems to Owner's representatives in accordance with the Contract documents and that the instruction has been completed to Owner's satisfaction.

A. Project:

B. System(s):

C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

D. Owner's representatives receiving instruction:

Owner: _____

NAMES	DATE	HOURS

E. Acknowledgement of demonstration:

Contractor's Representative:

_____ signature

_____ date

Owner's Representative:

_____ signature

_____ date

1.16 SUBSTITUTIONS

- A. Refer to Divisions 00 and 01.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.17 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of Contractor and/or the manufacturer.
- C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions (including accessibility for maintenance), operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.18 WARRANTY

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
 - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
 - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
 - b. The entire Plumbing system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 22 sections for systems, equipment, or material requiring extended warranties beyond one year.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

1.19 COMPLETION

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.
- B. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

1.20 CLEANING

- A. At the conclusion of the construction, the entire system of piping and equipment shall be cleaned internally.
- B. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.
- C. Before being placed in service, all domestic water distribution systems, including those for cold water and hot water shall be chlorinated as required per Section 22 11 16 - Domestic Water Piping.

1.21 ELECTRICAL WORK

- A. Electrical work and equipment provided by Contractor shall include the following:
 - 1. Starters and disconnects for motors of plumbing equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 2. Wiring from motors to disconnect switches or junction boxes for motors of plumbing equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 3. All control wiring in accordance with the requirements of Division 26.
- B. Electrical Contractor shall provide all power wiring for plumbing equipment, including services for motors and equipment furnished by the plumbing contractor. Motor and equipment locations are shown on the electrical drawings.
- C. Electrical Contractor shall make final connections for all motors and equipment furnished by the plumbing contractor.
- D. Electrical Contractor shall furnish safety disconnects and starters for all motors and equipment furnished by the plumbing contractor (unless specifically indicated to be furnished integrally with the equipment), so as to make service complete to each item of equipment.
- E. Contractor shall consult with Electrical Contractor prior to conduit rough-in and shall verify with him the exact locations for rough-ins, and the exact size and characteristics of the services required and shall provide Electrical Contractor a schedule of electrical loads for the equipment furnished by him. These schedules will be used for sizing services, disconnects, fuses, starters and overload protection.

1.22 TEMPORARY UTILITIES

- A. Refer to Division 01 for specific requirements concerning temporary utilities.

END OF SECTION 22 00 10

SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.01 GENERAL

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. This section includes the following:
1. Demolition
 2. Sleeves
 3. Escutcheons
 4. Fire Stopping

PART 2 - PRODUCTS

2.01 DEMOLITION MATERIALS

- A. All materials removed shall be the property of the removing contractor and shall be removed from the site by him, unless otherwise specified.

2.02 SLEEVES

- A. Sleeves passing through non-load bearing walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:
1. For pipes 2-1/2" and smaller - 24 gauge
 2. For pipes 3" to 6" - 22 gauge
- B. Sleeves passing through load bearing walls, concrete beams, fireproof walls, foundations, footings and waterproof floors shall be Schedule 40 steel pipe or cast iron pipe.
- C. Sleeves are not required in masonry walls which are core drilled or walls of drywall construction, except where partition is a firestop, smokestop, or side of air plenum.
- D. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.
- E. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water and fill space between sleeves and pipe with graphite packing and caulking compound.
- F. Sleeves passing through membrane waterproofing or lead safe shall be provided with flashing, furnished and installed by General Contractor, extending 12" beyond sleeve in all directions; flashing shall be secured and sealed to membrane or lead safe and shall be sealed to sleeve and caulked watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 6" above roof.
- G. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and pipe shall be sealed with modular rubber links tightened with bolts (Link-Seal or equal). Waterproofing of pipe penetrations in exterior walls shall be coordinated with waterproofing contractor.

2.03 ESCUTCHEONS

- A. Provide chrome plated escutcheons at each sleeved opening into finished spaces. Escutcheons shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension. Secure escutcheons or plates to sleeve but not to insulation with set screws or other approved devices.

2.04 FIRESTOPPING

- A. Piping, sleeves and ducts passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe, sleeve, and/or duct shall be sealed with UL Listed intumescent fire barrier material equivalent to rating of wall/floor.

PART 3 - EXECUTION

3.01 DEMOLITION

- A. General:
 - 1. Demolition shall be accomplished by the proper tools and equipment for the work to be removed. Personnel shall be experienced and qualified in the type of work to be performed.
 - 2. Contractor shall remove existing equipment and piping not necessary for additions or existing portions of building as indicated on drawings and/or specified herein. To include all abandoned equipment and piping back to point of origin. Demolition of equipment shall include removal of associated concrete equipment pad and/or support steel.
 - 3. Contractor shall be responsible for the cutting and capping of all existing services before any work is commenced by the General Contractor.
- B. Work by Others: Unless specifically noted under other contracts, Contractor shall assume all required work shall be performed by him. In general, the following will be performed by others:
 - 1. General Contractor will remove any floors, walls and ceilings, neatly patch, match, complete and finish all affected surfaces.
 - 2. Electrical Contractor will disconnect all electrical services and remove abandoned conduit back to point of origin.
- C. Existing Conditions:
 - 1. If any piping serving existing fixtures or equipment which are to remain are disturbed by operations under this Contract, Contractor shall provide pipe and insulation required to reestablish continuity of such piping systems.
 - 2. Contractor shall arrange for General Contractor to repair, patch and paint all construction, with material necessary to match surrounding material, which is necessary due to removal of equipment and piping.
 - 3. Contractor shall furnish all required labor and material where required to extend new work to connect to similar work where new addition adjoins existing building and for extension of existing system. Connection shall be made in a suitable manner.
- D. Owner's Right of Salvage: The Owner may designate and have salvage rights to any material herein demolished by the Contractor.

3.02 SLEEVES

- A. Install sleeves for all piping passing through floors, roof, walls, concrete beams and foundations as required by this section.

3.03 ESCUTCHEONS

- A. Install escutcheons for all pipes entering finished spaces.

END OF SECTION 22 05 00

SECTION 22 05 13
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 SUBMITTALS

- A. Submit for all motors provided.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Comply with NEMA MG1 unless noted otherwise.
- B. Constant Speed Motors: Minimum 1.15 service factor; rated at 40 deg. C. ambient temperature with 90 deg. C. temperature rise (Class B insulation).
- C. Motors Used with Variable Frequency Controllers: Inverter duty rated, Class F insulation (minimum). Windings shall be copper magnet with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
- D. Multiple speed motors: Multiple windings.
- E. Motor Efficiency: Premium efficiency as defined in NEMA MG1.
- F. All motors shall be provided as required for motor orientation within equipment.
- G. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulations.
- H. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torques.
- I. Motor Enclosures:
 - 1. Shall be the NEMA types shown on the drawings for the motors.

2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types which are most suitable for the environmental conditions where the motors are being installed. Motors located outdoors to be totally enclosed weatherproof epoxy-sealed type.
 3. Thoroughly clean and paint the enclosures at the factory with manufacturer's prime coat and standard finish.
- J. Additional requirements for specific motors, as indicated in other sections, shall also apply.

2.2 SINGLE PHASE POWER

- A. Capacitor start motors starting torque shall be three times full load torque and starting current shall be less than five times full load current.
- B. Pull-up Torque: Up to 350 percent of full load torque.
- C. Breakdown Torque: Approximately 250 percent of full load torque.
- D. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- E. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- F. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

PART 3 - EXECUTION (Not Used)

END OF SECTION 22 05 13

SECTION 22 05 19
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install meters and gauges as required by the drawings and this section.

1.03 SUBMITTALS

- A. Submit manufacturer's catalog cuts showing complete descriptive data.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Thermometers
 1. Weiss 9VU35 with lead free thermowell (Base Specification)
 2. Taylor
 3. Weksler
 4. U.S. Gauge
 5. Trerice

2.02 THERMOMETERS

- A. 9" "Adjust-Angle" industrial thermometer, complete with double thick glass front, red reading, separable socket and arranged so the unit can be set at any required angle front to back or left to right during or after installation. Range 30-180 deg. F for domestic hot water.

PART 3 - EXECUTION

- 3.01** Install thermometers in discharge and return piping at water heaters and at other points as indicated on the drawings.

END OF SECTION 22 05 19

SECTION 22 05 23
GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install valves as required by the drawings and this section.

1.3 SUBMITTALS

- A. Submittal data shall include physical dimensions, construction materials, and pressure and temperature ratings.

1.4 QUALITY ASSURANCE

- A. ANSI/NSF 372 Certification: All potable water supply piping valves (excluding main gate valves greater than 2”) shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Check Valves

- 1. NIBCO
- 2. Powell
- 3. Milwaukee
- 4. Watts
- 5. Clow

B. Ball Valves

- 1. Watts LFB-6080/6081
- 2. Milwaukee UPBA-400S/450S
- 3. NIBCO T/S-585-66 LF
- 4. Apollo 77CLF-140/240

C. Domestic Hot Water Recirculation Balancing Valves

- 1. Taco
- 2. Bell & Gossett
- 3. Wheatley
- 4. Armstrong
- 5. Flow Design Inc. (Flow Set)
- 6. Griswold
- 7. NIBCO

- D. All valves of same type shall be of the same manufacturer unless otherwise specified in this section or on the drawings.

- E. Model numbers in valve schedule based on NIBCO, unless noted otherwise.

2.2 VALVE CONSTRUCTION

- A. Gate valves shall have solid tapered wedge, except where otherwise specified.
- B. Check Valves: 2" and smaller, horizontal swing type with Teflon seat, bronze lead free body. 200 psi, CWP and 300 deg. F maximum temperature.
- C. Ball Valves 4" and smaller: Bronze two-piece with stainless steel ball, teflon seats and stuffing box ring, vinyl insulated lever handle.
 - 1. Full port for valves 2-1/2" and smaller.
 - 2. Standard port for valves 3" and larger.
- D. Domestic hot water recirculation balancing valves: Bell & Gossett Model CB "Circuit Setter" or equal.
 - 1. Ball type valve with brass body and stainless-steel ball construction, glass and carbon fitted TFE seat rings, extended readout ports with integral check valves and gasketed caps, drain port, calibrated nameplate and position indicator, memory stops, and NPT connectors, rated for 300 psig at 250°F.
 - 2. Valves to seal leak-tight at maximum rated working pressure.
 - 3. Valves to be selected for 5 ft. pressure drop at full open setting and design water flow.

2.3 VALVE SCHEDULE

- A. Furnish valves as per the following schedule:

<u>Service</u>	<u>Valve type</u>
Domestic hot and cold-water pressures up to 200 psi	Ball - 2-1/2" and smaller, Apollo 77C-LF Ball - 3" and 4", Apollo 70-LF Check - 2" and smaller, T/S413Y-LF
Domestic hot water recirculation valves	All sizes – Bell & Gossett Model CB circuit setter.

- B. Valves installed on all systems with insulated piping shall be provided with valve handle extensions and/or extended neck design to facilitate installation of insulation and make handles operable without damage to the insulation.

PART 3 - EXECUTION

- 3.01** Install valves in accessible location in general locations indicated on the drawings and as called for in other sections.
- 3.02** Install valves in equipment rooms to provide easy access to valve.
- 3.03** Check valves shall not be installed in vertical runs of piping unless they are specifically designed for vertical operation.

END OF SECTION 22 05 23

SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

- A. Provide materials, equipment, labor and supervision necessary to install hangers, supports, anchors, guides and seals as required by the drawings and this section.
- B. Types of supports, anchors and seals specified in this section include the following:
 - 1. Horizontal-Piping Hangers and Supports.
 - 2. Vertical-Piping Clamps.
 - 3. Hanger-Rod Attachments.
 - 4. Building Attachments.
 - 5. Saddles and Shields.
 - 6. Miscellaneous Materials.

1.03 QUALITY ASSURANCE

- A. Code Compliance: Comply with applicable plumbing and mechanical codes pertaining to product materials and installation of supports, anchors and seals.
- B. UL and FM Compliance: Provide products which are Underwriters Laboratories listed and Factory Mutual approved.
- C. ANSI Compliance: All supports and parts shall conform to the latest requirements of the ANSI Code for Pressure Piping B31.1.0 except as supplemented or modified by the requirements of this specification.

PART 2 - PRODUCTS

2.1 HANGERS, SUPPORTS AND ACCESSORIES (*Reference Catalog Figure numbers from Anvil*)

- A. Pipe support systems shall secure pipes in place, prevent pipe vibration, provide vertical adjustment for maintaining required grades, and provide for expansion and contraction.
- B. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.
- C. Wherever possible, pipe attachments for horizontal piping shall be pipe clamps.
- D. Wherever possible, structural attachments shall be beam clamps.
- E. All rigid hangers shall provide a means of vertical adjustment after erection.
- F. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.
- G. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.

- H. Where supports are attached to concrete or other structural members, care shall be taken to prevent damage or weakening of the structural members.
- I. Hangers and supports that are in direct contact with copper piping shall be copper plated or have nonmetallic coating for electrolytic protection.

PART 3 - EXECUTION

3.01 INSTALLATION - HORIZONTAL PIPE SUPPORT

- A. Steel pipe shall be supported at a maximum span of 10 feet for all pipe sizes, with hanger rods sized accordingly for total supported weight.
- B. Copper pipe shall be supported at a maximum length of 6 feet for pipe sizes up through 1-1/2" and at a maximum length of 10 feet for pipe sizes 2" and larger with hanger rods sized accordingly for the total supported weight.
- C. PVC and CPVC pipe shall be supported at a maximum span of 3 feet for pipe sizes up through 1" and at a maximum span of 4 feet for pipe sizes 1-1/4" and larger with hanger rods sized accordingly for total supported weight.
- D. PEX tubing shall be supported at a maximum span of 32" with hanger rods sized accordingly for the total supported weight.
- E. Cast Iron soil pipe shall be supported with one hanger for each section of pipe (maximum 10' span) with hanger rods sized accordingly for the total supported weight. Locate hangers within 18" of hub or joint.
- F. In addition to the above specified spacings, install additional hangers at change in pipe direction and at concentrated loads, large valves, strainers, etc.
- G. When two or more pipes are to be run parallel together, they may be supported on trapeze type hangers. Trapeze bar angles or channels and hanger rods shall be of sufficient size with required spacing to support the particular group of pipes.
- H. For suspending hanger rods from brackets attached to walls; use welded steel brackets, Fig 194 for loads up to 750 lbs; Fig. 195 for loads up to 1,500 lbs; Fig. 199 for loads up to 3000 lbs.
- I. Where pipes are to be racked along walls, use malleable iron one-hole clamp, Fig. 126 for pipes up to 3". For pipes larger than 3", use steel channel strut pipe rack.
- J. Where pipes are to be supported from floor, use unistrut pipe stand with post base. Unformed concrete will not be permitted.
- K. Hangers and supports for insulated cold piping shall not injure or pierce insulation. Provide insulation protection shields or saddles for piping, (Fig. 167) in conjunction with hanger or roll device.

3.02 INSTALLATION - VERTICAL PIPE SUPPORTS

- A. Support vertical steel and copper pipe at every other floor line.
- B. Support vertical cast iron soil pipe at every floor line.
- C. In addition to the above, support vertical pipes at base of riser with base fitting set on concrete or block pier, or by hanger located on horizontal connection close to riser.
- D. Where pipe sleeves extend above floor, place pipe clamps at ceiling below and support clamp extensions from inserts or other approved attachment.

3.03 PIPE ATTACHMENTS

- A. For horizontal steel pipe, use adjustable carbon steel clevis, Fig. 260, for pipes up to 30".
- B. For horizontal copper pipe and tube, use copper plated adjustable carbon steel clevis, Fig. CT-65.

3.04 INTERMEDIATE ATTACHMENTS

- A. Hanger rods: use carbon steel single or double end threaded, Figs. 140 and 253 as required. Continuous threaded rod, Fig. 146, may be used wherever possible. Contractor may at his option cut and thread rod on the job site.
- B. Chain, wire or perforated strap hangers will not be permitted. One pipe shall not be suspended from another pipe.
- C. Hangers shall be supported from appropriate structural members. In no case shall hangers be supported from ductwork, cable trays, piping, or other equipment. Existing hangers and supports shall not be used as supports for new hangers unless specifically designed as such, or additional loadings have been confirmed to be acceptable for existing supports.

3.05 STRUCTURAL ATTACHMENTS

- A. For attaching steel hanger rods to structural steel beams, use malleable iron C-clamps, Fig. 87, with retaining clip for loads up to 500 lbs.; Fig. 229 with extension piece for loads up to 1,365 lbs. For copper plated hanger rods, use copper plated malleable iron C-clamps, Fig. CT-88, with hardened cup point set screw, for loads up to 400 lbs.
- B. For attaching steel hanger rods to wood structural members, use malleable iron ceiling flange pipe threaded, Fig. 128 for loads up to 480 lbs., Fig. 153 for loads up to 1270 lbs. For copper plated hanger rods, use copper plated malleable iron ceiling flange, Fig. CT-128R for loads up to 180 lbs.
- C. Under no circumstances shall hangers be attached to metal roof deck.

3.06 PIPE COVERING PROTECTION

- A. Hangers and supports for insulated cold piping and ductwork shall not injure or pierce insulation. Provide insulation protection shields or saddles for piping, Fig. 160, 161, 162, 163, 164, 165, 165A, 166A, or 167 in conjunction with hanger or roll device.

END OF SECTION 22 05 29

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of plumbing identification work required by this section is indicated on drawings and/or specified in other Division-22 sections.
- B. Type of identification devices specified in this section include the following:
1. Painted identification materials
 2. Plastic pipe markers
 3. Plastic tape
 4. Valve tags
- C. Identification furnished as part of factory fabricated equipment, is specified as part of the equipment assembly in other Division-22 sections.

1.3 QUALITY ASSURANCE

- A. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

1.4 SUBMITTALS

- A. Schedules: Submit valve schedule for each piping system, formatted in an Excel spreadsheet with a digital copy provided to the Owner along with a printed copy on 8-1/2" x 11" paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition, furnish extra copies for Maintenance Manuals.
- B. Labeling Nomenclature: Submit list indicating system types with appropriate nomenclature to be provided on the pipe labels. Where possible, match to system labels on drawings.

PART 2 - PRODUCTS

2.01 IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-22 sections. Where more than one single type is specified for an application, selection is Installer's option, but provide single selection for each product category.
- B. Painted Identification Materials:
1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 3/4" high letters for access door signs and similar operational instructions.
 2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
 3. Identification Paint: Standard identification enamel of colors indicated, or, if not otherwise indicated for piping systems, comply with color chart below for colors.

C. Plastic Pipe Markers:

1. General: Provide manufacturer's standard pre-printed flexible or semi-rigid, permanent, color-coded, plastic-sheet pipe markers..
2. Color: Color of pipe markers shall comply with ANSI A13.1.
3. Small Pipes: For external diameters not greater than 6" (including insulation if any), provide full-band pipe markers extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - b. Adhesive lap joint in pipe marker overlap.
 - c. Laminated or bonded application of pipe marker to pipe (or insulation).
 - d. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide full circle at both ends of pipe marker, tape lapped 1-1/2".
4. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Design Professional in cases of variance with names as shown or specified.
5. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

D. Plastic Tape:

1. General: Manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
 - a. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6".
 - b. Color: Comply with color selection indicated for Plastic Pipe Markers.

E. Valve Tags:

1. Brass Valve Tags: Provide polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 7/16" high, and with 3/16" hole for fastener. Tag thickness 0.040 inches.
 - a. Provide 2" diameter tags, except as otherwise indicated.
 - b. Fill tag engraving with black enamel.
2. Plastic Valve Tags: Provide red heavy plastic tag with 7/16" white embossed sequenced numbers.
3. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks or heat sealed braided copper wire of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

F. Name Plates:

1. General: Provide manufacturer's standard preprinted plastic, brass, or aluminum with stamped, engraved or embossed letters.
2. Lettering: 3/4" lettering as appropriate.
3. Attachments: Mounting holes and screws, pressure sensitive adhesive backing, or solid brass chain.

2.02 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. General Installation Requirements:

1. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags, install identification after completion of covering and painting if any. Install identification prior to installation of acoustical ceilings and similar concealment.

B. Piping System Identification:

1. General: Install pipe markers of one of the following types on each piping system, and include arrows to show normal direction of flow:
 - a. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
 - b. Plastic pipe markers, with application system as indicated under "Materials" in this section.
 - c. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.
2. Locate pipe markers and color bands as follows wherever piping is exposed to view in unoccupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations. Install all markers such that lettering is visible from the floor.
 - a. Near each valve and control device.
 - b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - c. Near locations where pipes pass through walls or floors/ceilings or enter non-accessible enclosures.
 - d. At access doors, manholes and similar access points which permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced intermediately at maximum spacing of 20' along each piping run with a minimum of one marker in each room.
 - g. On piping above removable acoustical ceilings.

C. Valve Identification:

1. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

D. Equipment Identification:

1. General: Provide equipment identification for all equipment including water heaters, heat exchangers, water softeners, and pumps.
2. Labeling: All equipment shall be labeled as per construction document plan marks or as designated by Owner.
3. Provide identification by means of nameplates or stenciled painting as appropriate.
 - a. For equipment with factory furnished casing, identification shall be by adhesive fixed name plates.
 - b. Field insulated items, such as heat exchangers may be identified by plastic pipe markers or stenciled lettering.

END OF SECTION 22 05 53

SECTION 22 07 00
PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this Section.

1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install insulation to all hot and cold surfaces of piping, tanks, fittings and other surfaces as required by the drawings and this section.
- B. Insulation shall include insulating materials, jackets, adhesive, mastic coatings, tie wire and other materials as required to complete the insulating work.

1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Insulating materials, jackets, mastics, etc., shall meet flame spread and smoke developed ratings in accordance with NFPA-90A. Flame spread rating of not more than 25, smoke developed rating of not more than 50 as tested by ANSI/ASTM E84 (UL 723) (NFPA 255) method. All accessory items such as PVC jacketing and fittings, adhesive, mastic, cement tape and cloth shall have the same component ratings as specified above.
- B. Installation of insulation materials shall be in accordance to the latest edition of MICA/NIAC National Commercial & Industrial Standards for the appropriate material application.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications and installation instructions for each type of plumbing insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each plumbing system requiring insulation.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of products.
- B. Protect insulation against dirt, water, and chemical and plumbing damage. Do not install damaged insulation; remove from project site.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Insulating Materials
 - 1. Owens/Corning Fiberglass Corp.
 - 2. Armacell
 - 3. Pittsburgh Corning Corp.
 - 4. CertainTeed Corp.
 - 5. Knauf Fiber Glass
 - 6. John's-Manville Corp.
 - 7. Aeroflex
- B. Mastics and adhesives as recommended by insulation manufacturer.

2.2 PIPE INSULATION

- A. Type 'A': Preformed sectional heavy density fiberglass insulation and factory applied vapor barrier, all service jacket with pressure sensitive self-sealing longitudinal laps and butt strips. Suitable for operating temperatures from 0 to +850 deg. F. Thermal conductivity shall be no more than 0.23 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Water vapor permeance of .02 perms. Equal to Owens Corning 25 ASJ/SSL.
- B. Type 'B': Flexible elastomeric extruded pipe covering, 6 pound density, 0.27 K factor, water vapor permeance of 0.20 perms. Suitable for temperature from -40 deg. F to +220 deg. F. Equal to Armacell, AP Armaflex, joints sealed with adhesive as recommended by insulation manufacturer.

2.3 FITTING INSULATION

- A. Type 'A1': Fittings: Insulate with mitered segments of same insulating material as for adjacent pipe covering, or with pre-molded fiberglass wired in place and covered with all-service jacket or low smoke PVC fitting covers. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as for adjacent pipe covering, wired in place and covered with all-service jacket.
- B. Type 'B1': Fittings: Insulate fittings, valve bodies, strainer bodies, etc., with mitercut pipe insulation or sheet insulation of same material as pipe covering.

PART 3 - EXECUTION

3.01 Use only experienced applicators regularly engaged in the trade. Rough work will be rejected. Application details shall be in accordance with the insulating materials supplier's recommendations except where a higher standard is specified. All surface finishes shall be extended in such a manner as to protect all raw edges, cuts and surfaces of insulation.

3.02 Do not insulate the following:

- A. Valve bonnets
- B. Unions in hot piping

3.03 Inspect all piping and equipment before applying insulation to ensure the installing contractor has completed all leak tests, and that all surfaces are clean, dry and ready for application of insulation.

3.04 Covering for "cold" pipes shall pass unbroken through hanger clevises, sleeves, etc. All details of covering for cold surfaces shall be such that continuous covering with unbroken vapor barrier and uncompressed insulation is provided as required to prevent condensation. The same covering and hanging detail shall be used for pipes connecting to vibrating equipment or carrying pulsating pressures to avoid metal contact between pipes and hangers.

3.05 Insulation at removable heads, strainer plugs, and other access points shall be fabricated in such a manner that it can be readily removed without damage to the insulation. Removable insulation shall have a vapor proof cover fabricated so as to allow it to be resealed to the equipment vapor barrier.

3.06 INSULATION SCHEDULE

Service	Type Insulation and Thickness*
<p style="text-align: center;"><u>Above Ground Piping</u></p> <p>Domestic cold water lines (including all pipe material types)</p>	<p>Type A and A1: All pipe sizes – 1" thick</p> <p>Type B and B1: 1-1/4" and smaller – 1/2" thick 1-1/2" and larger – 1" thick</p>

Service	Type Insulation and Thickness*
Domestic hot water, tempered water, and recirculating lines (including all pipe material types)	Type A and A1: 1 1/4" and smaller – 1" thick 1-1/2" and larger – 1-1/2" thick Type B and B1: 1 1/4" and smaller – 1" thick 1-1/2" and larger – 1-1/2" thick
* Insulation type and thickness indicated in table apply for all pipe materials. **For piping exposed to outdoor ambient temperatures or located in the garage, increase thickness by 1/2"	

END OF SECTION 22 07 00

SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.
 - 1. Extent of domestic water piping work is indicated on drawings and schedules, and by requirements of this section.
 - 2. Insulation of domestic water piping is specified in other Division-22 sections and is included as work of this section.
 - 3. Installation of valves for domestic water piping system is specified in other Division-22 sections and is included as work of this section.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: Fabricate and install domestic water piping in accordance with ASME B31.9 "Building Services Piping".
- B. Wisconsin State Plumbing Compliance: Fabricate and install domestic water piping in accordance with the "Wisconsin State Plumbing Code".
- C. Plumbing and Drainage Institute: Fabricate and install domestic water piping with Standard PDI-WH201.
- D. ANSI/NSF 372 Certification: All potable water supply piping, valves, fittings, and fixtures (excluding toilets, urinals, fill valves, flush valves, shower valves, and main gate valves greater than 2") shall meet the requirements for ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

1.4 SUBMITTALS

- A. Submit manufacturer's material data and installation methods for each type of system to be provided.
- B. Submit manufacturer's catalog cuts for each type of device to be used.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Water Hammer Arrestors
 - 1. Ancon
 - 2. Sioux Chief
 - 3. Wade
 - 4. Watts
 - 5. Zurn
- B. Copper Pressure Seal Fittings
 - 1. Viega Pro Press
 - 2. NIBCO Press System

C. Commercial Expansion Tanks

1. Bell & Gossett
2. Amtrol
3. Spiro Therm
4. Wessels

2.02 BASIC MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with Uniform Plumbing Code and International Plumbing Code where applicable, base pressure rating on domestic water piping system's maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in domestic water piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.
- B. Valves: Refer to Section 22 05 23 - General Duty Valves for Plumbing Piping.
- C. Piping Specialties: Refer to Section - 22 05 00 - Common Work Results for Plumbing.
- D. Meters and Gauges: Refer to Section 22 05 19 - Meters and Gages for Plumbing Piping.
- E. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

2.03 PIPE:

- A. Provide pipe materials meeting the following criteria and referenced standards:
 1. Ductile Iron Pipe (D-Iron): Cement lined ductile iron, ANSI/AWWA C104/A21.4.
 2. Polyvinyl Chloride (PVC): DR18 ANSI/AWWA C900 or C905 with tracer wire.
 3. Chlorinated Polyvinyl Chloride (CPVC): SDR 11 tubing, ASTM D2846 and F442.
 4. Type K Copper (K Cu): Type K copper water tube, hard temper, ASTM B88.
 5. Type L Copper (L Cu): Type L copper water tube, hard temper, ASTM B88.
 6. Brass (Brass): Schedule 40 Chromium plated, ASTM B43.
 7. Cross Linked Polyethylene (PEX): Cross-linked polyethylene PEXa (DIN 4726) , ASTM F876, ASTM F877, ASTM F1960.
 8. Stainless Steel (St St): Type 304 schedule 10
- B. Unless specifically prohibited by local codes, provide piping materials for systems indicated according to the following table:

Service	Material							
	D-Iron	PVC	CPVC	K Cu	L Cu	Brass	PEX	St St
Underground water service main for domestic water, 2" and larger	X							
Above ground domestic water			X		X		X	
Exposed fixture connections						X		

2.04 FITTINGS:

- A. Cast iron water pipe: Class 250 ANSI A21.20, AWWA C110-71, standard mechanical joint fittings.
- B. Copper water tube cast bronze or wrought copper:
 1. Solder joint type. ANSI B16.18 and B16.22-63. Where copper piping is used for combined water/fire protection water service, joints upstream of fire protection backflow preventer shall be brazed.

2. Pressure Seal pipe joining system, copper press fittings, 1/2" to 4" in diameter. ASME B16.18, ASME B16.22. O-rings for copper press fittings shall be EPDM. Installation per manufacturer's recommendations.
- C. Brass pipe: Cast bronze screwed, 125-pound, flat band water pattern, chromium plated, for chromium plated pipe.
- D. Cross-Linked Polyethylene (PEX) (domestic water): ASTM F1960 utilizing expander fittings. ASTM F1960 brass fittings ANSI/NSF 14 and 61 certified.

2.05 JOINTS

- A. Copper water tube:
 1. Use non-corrosive 95-5 tin-antimony solder, cut pipe square, clean, ream and polish tube ends and inner surfaces of fittings, apply flux and solder joint as recommended by manufacturer of solder type fittings. Where copper piping is used for combined water/fire protection water service, joints upstream of fire protection backflow preventer shall be brazed.
 2. Pressure Seal pipe joining system, copper press fittings, 1/2" to 4" in diameter. ASME B16.18, ASME B16.22. O-rings for copper press fittings shall be EPDM.
- B. Cross-Linked Polyethylene (PEX) (domestic water): ASTM F1960 utilizing expander fittings. ASTM F1960 brass fittings ANSI/NSF 14 and 61 certified.

2.06 NIPPLES AND UNIONS

- A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2", use extra strong nipple; do not use close nipples.
- B. For pipe 2" and smaller, use screwed unions, for pipe 2-1/2" and over use flanged unions.
- C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:
 1. Long runs, at intervals of 80 feet.
 2. In by-pass around equipment, valves, and controls.
 3. In connections to equipment.
 4. Where indicated on drawings.
- D. Dielectric unions shall be installed between any connection of copper pipe and ferrous piping or equipment. In grooved piping systems, provide Clearflo by Victaulic.

2.07 AIR VENTS

- A. Manual Air Vents: Bell & Gossett Model No. 17SR.

2.08 WATER HAMMER ARRESTORS

- A. Water hammer arrestors shall be piston type with seamless copper chamber, two O-ring piston and a 60 psi charge. Water hammer arrestors shall be sized, tested and certified in accordance with the Plumbing and Drainage Institute Standard PDI-WH201 and American Society of Sanitary Engineering Standard ASSE-1010.

2.09 EXPANSION TANKS

- A. Furnish and install pre-charged steel expansion tanks as indicated on plans. Tanks shall have integral heavy-duty Butyl rubber diaphragm, system connection(s), and a .302" - 32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank shall be suitable for potable water.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which domestic water piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

- A. General: Install basic materials and products as per manufacturers' recommendations, Wisconsin State Plumbing Code, local code requirements and as required to meet system pressure and performance requirements.
- B. Piping Protection: Protect piping from damage during construction, including, but not limited to covering pipes during application of spray on fire-proofing to prevent fire proofing material from coming in contact with the pipes.
- C. Valves
 - 1. Refer to Section 22 05 23 - General Duty Valves for Plumbing Piping.
 - 2. Locate valves for easy access and operation. Do not locate valves with stems below horizontal.
 - 3. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures and elsewhere as indicated.
 - 4. Shutoff Valves: Install on inlet and outlet of each domestic water equipment item and elsewhere as indicated.
 - 5. Check Valves: Install on discharge side of each pump, and elsewhere as indicated.
- D. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.
- E. Meters and Gauges: Refer to Section 22 05 19 - Meters and Gages for Plumbing Piping.
- F. Supports and Anchors: Refer to Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.

3.3 DOMESTIC WATER PIPING

- A. Install pipe for all domestic water and domestic water systems as indicated on drawings, as called for in other sections, and as specified herein.
- B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other trades. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
- C. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage.
- D. Check all piping for interference with other trades; avoid placing water pipes over electrical equipment.
- E. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.
- F. Extend cold water and hot water piping to each fixture and other equipment requiring water supplies.
- G. Pitch pipes to accessible drainage point where unions, plugged tees or drainage valves shall be provided.
- H. Branch take off pipe connections shall come off the top of mains.

- I. Pipes built into masonry or concrete construction shall be wrapped with tar paper or burlap to prevent bonding to the concrete.
- J. No pipe shall be located in an outside wall or other location where freezing is likely to occur.
- K. No pipe shall be in contact with, or attached to, a structural member in a manner that causes the transmission of noise to the structure. Block ends of runs to prevent movement due to water hammer.

3.4 EQUIPMENT CONNECTIONS

- A. Refer to Section 22 11 23 - Domestic Water Pumps, 22 31 00 - Domestic Water Softeners, and 22 34 00 - Fuel Fired Domestic Water Heaters.
- B. General: Connect domestic water piping system to plumbing equipment as indicated and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union on supply and return, drain valve on drain connection.

3.5 INSTALLATION OF FIXTURES

- A. Refer to Section 22 40 00 - Plumbing Fixtures and 22 47 00 - Drinking Fountains and Water Coolers.
- B. General: Connect water piping system to plumbing fixtures as indicated and comply with manufacturer's instructions where not otherwise indicated.
- C. Refer Water supply to all fixtures and containers shall be so installed as to prevent back siphonage of polluted water into the water supply. All supplies shall be either above the flood rim of the fixture or separated from the drainage end by means of approved vacuum breakers.

3.6 INSTALLATION OF WATER HAMMER ARRESTORS

- A. Install water hammer arrestors as indicated on the drawings and as required per Plumbing and Drainage Institute Standard PDI-WH201. Water hammer arrestors to be installed in accessible locations where possible.

3.7 INSTALLATION OF PLUMBING SPECIALTIES

- A. General: Install plumbing specialties and valves as per manufacturer's installation instructions.
- B. Provide unions, valves to units at each connection as required by inspection.

3.8 HYDROSTATIC TESTING

- A. General: New water mains shall be subject to hydrostatic testing in accordance with AWWA C600 and other applicable AWWA Standards of latest revision and the following supplemental instructions.
- B. Supplemental Instructions:
 - 1. All newly laid pipe or any valved section thereof shall be subject to a hydrostatic pressure of 1.5 X the working pressure at the point of testing or 100 psig, whichever is greater.
 - 2. The test procedures shall:
 - a. Not exceed pipe or thrust restraint design pressures.
 - b. Be of at least 4-hour duration.
 - c. Not exceed the rated pressure of the valves or hydrants.
 - 3. Each valved section of pipe shall be filled with water slowly and the specified test pressure shall be applied by means of a pump connected to the pipe.
 - 4. Before applying the specified test pressure, air shall be expelled completely from the pipe, valves and hydrants.
 - 5. Any damaged or defective pipe, fittings, valves or hydrants that are discovered following the pressure test shall be repaired or replaced with sound material and the test shall be repeated.

6. A leakage test shall be conducted concurrently with the pressure test. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain test pressure.
7. No pipe installation will be accepted where leakage is observed.

3.9 DISINFECTION

- A. General: Upon completion of a newly installed piping or when repairs to an existing pipe are made, the piping shall be disinfected according to instructions listed in AWWA C651, local codes, local utility requirements, and the following supplemental instructions.
- B. Repairs: Repairs to mains and plumbing shall be disinfected by swabbing with hypochlorite and flushing in accordance with AWWA C651.

END OF SECTION 22 11 16

**SECTION 22 11 23
DOMESTIC WATER PUMPS**

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of plumbing pumps work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of pumps specified in this section include the following:
 - 1. In-line Circulators
- C. Refer to Division-26 sections for the following work; not work of this section:
 - 1. Power supply wiring from power source to power connection on pumps. Include starters, disconnects and required electrical devices, except where specified as furnished, or factory installed, by manufacturer.

1.3 QUALITY ASSURANCE

- A. UL Compliance: Design, manufacturer and install pumps in accordance with UL 778 "Motor Operated Water Pumps".
- B. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.
- C. ANSI/NSF 372 Certification: Domestic Water Pumps shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.
- B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to pumps. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Handle pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged pumps or components; replace with new.
- B. Store pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. In-Line Circulators
 - 1. Armstrong Pumps, Inc.
 - 2. Aurora
 - 3. Bell & Gossett ITT; Fluid Handling Div.
 - 4. Grundfos
 - 5. Taco, Inc.
- B. General: Provide factory tested pumps, thoroughly cleaned and painted with one coat of machinery enamel prior to shipment. Type, size and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

2.02 IN-LINE CIRCULATORS

- A. General: Provide in-line circulator pumps where indicated, and of capacities as scheduled. In-line circulators shall be of either all bronze or stainless-steel construction.
- B. Type: Horizontal mount, permanently lubricated, designed for 150 psi working pressure and 225 deg. F continuous water temperature.
- C. Construction: Cast bronze or stainless-steel body with suction and discharge flanges. Steel shaft mounted on permanently lubricated, sealed ball-bearings. Water-tight seal fill mechanical carbon on silicon carbide face seals.
- D. Impeller: Composite construction, enclosed type, hydraulically and dynamically balanced, and keyed to shaft.
- E. Motor: Non-overloading at any point on pump curve, drip-proof, permanently sealed ball bearings, resilient mounted construction, permanent split capacitor with thermal overload protection, single phase motors.
- F. Controls: Provide circulator with integral time clock.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable with Installer.

3.02 INSTALLATION OF PUMPS

- A. General: Install plumbing pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that pumps comply with requirements and serve intended purposes.
- B. Access: Provide access space around pumps for service as indicated, but in no case less than that recommended by manufacturer.
- C. Support: Install in-line circulators supported from piping system.
- D. Controls: Install devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer for power wiring.
 - 1. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

- E. Piping Connections: Refer to Division-22 Plumbing piping sections. Provide piping, valves, accessories, and supports as indicated, including the following:
 - 1. Strainer and shut-off valve in suction line.
 - 2. Check valve valve in discharge line.

3.03 ADJUSTING AND CLEANING

- A. Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
- B. Start-up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 22 11 23

SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.
 - 1. Extent of sanitary waste and vent piping work is indicated on drawings and schedules, and by requirements of this section.

1.3 QUALITY ASSURANCE

- A. Wisconsin State Plumbing Code Compliance: Fabricate and install sanitary waste and vent piping in accordance with "Wisconsin State Plumbing Code".
- B. Plumbing and Drainage Institute: Fabricate and install domestic water piping with Standard PDI-WH201.

1.4 SUBMITTALS

- A. Submit manufacturer's catalog cuts for each type of device to be used.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Floor Drains
 - 1. Jay R. Smith
 - 2. Jonespec
 - 3. Josam
 - 4. Wade
 - 5. Watts
 - 6. Zurn
- B. Trench Drains
 - 1. Jay R. Smith
 - 2. Watts
 - 3. Zurn
 - 4. Aco Drain
 - 5. ABT, Inc. (Polydrain)

2.02 BASIC MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with Wisconsin State Plumbing Code. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in sanitary waste and vent piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.

- B. Piping Specialties: Refer to Section - 22 05 00 - Common Work Results for Plumbing.
- C. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

2.03 PIPE:

- A. Provide pipe materials meeting the following criteria and referenced standards:
 1. Cast Iron Soil Pipe (C-Iron): Service class, bell and spigot, asphalt coated, ASTM A74.
 2. No-Hub Cast Iron Soil Pipe (C-Iron NH): Service class, no hub, asphalt coated, CISPI 301 or ASTM A-888.
 3. Polyvinyl Chloride (PVC): Schedule 40, DWV, ASTM D1785 and ASTM D2665.
 4. Type K Copper (K Cu): Type K copper water tube, hard temper, ASTM B88.
 5. Type M Copper (M Cu): Type M copper water tube, hard temper, ASTM B88.
 6. Brass (Brass): 17 gauge brass tube, chromium plated, ASTM B43.
 7. Acid Resistant Fire-Retardant Polypropylene (FR PP): Schedule 40 drainage pipe.
 8. Acid Resistant Polypropylene (PP): Schedule 40 drainage pipe.
 9. Chlorinated Polyvinyl Chloride (CPVC): Schedule 40, ASTM Cell Classification 23447, manufactured in accordance with ASTM F 2618.
- B. Unless specifically prohibited by local codes, provide piping materials for systems indicated according to the following table:

Service	Material								
	C-Iron	C-Iron NH	PVC	K Cu	M Cu	Brass	FR PP	PP	CPVC
Sanitary waste and vent below slab	X		X						
Sanitary waste and vent above slab, up to and including 2-1/2"		X	X		X				
Sanitary waste and vent above slab, 3" and larger	X	X	X		X				
Exposed fixture connections						X			

2.04 FITTINGS:

- A. PVC DWV pipe fittings: ASTM D2665 DWV Schedule 40 socket type. Provide fittings produced and recommended for the service indicated by manufacturer of tubing. Solvent cements as per ASTM 2564.
- B. Copper drainage tube: Cast bronze fittings, solder joint fittings. ANSI B16.23.
- C. Brass pipe: Cast bronze screwed, 125 pound, flat band water pattern, chromium plated, for chromium plated pipe.

2.05 JOINTS

- A. Cast iron bell and spigot soil pipe: Pack joints with oakum, fill with molten lead at one pouring, caulk solid flush with hub rim. If approved by Code, pre-set plastic or neoprene joint may be used, ASTM C 564.
- B. Cast iron no-hub pipe: Coupling assembly tightened by torque wrench, CISPI 310, ASTM C 564.
- C. PVC DWV pipe: Solvent cement in accordance with ASTM D2564.
- D. Copper drainage tube: Use non-corrosive 50-50 solder, cut pipe square, clean, ream and polish tube ends and inner surface of fittings, apply flux and solder joint as recommended by manufacturer of solder type fittings. Use same method for copper refrigerant pipe, except use silver solder with 5% silver content, or equal strength brazing alloy.

2.06 VENTS

- A. Vents through the roof shall be cast iron long increasers beginning at 12" under the roof and extending at least above the highest possible water level on the roof but in no case less than 8". Size increases as follows:

<u>Vent Size</u>	<u>Increase To</u>
1-1/4" and 1-1/2"	3" minimum
2" and 2-1/2"	4" minimum
3"	4"
4"	6"

- B. Provide and install flashing for each vent through the roof. The flashing shall extend up around the pipe and be sealed to the pipe and shall extend over the roof deck at least one foot in each direction from the base.

2.07 FLOOR DRAINS

- A. Shall be of the style as called for in fixture schedule.
- B. Drains without integral traps shall have service class p-traps.

2.08 CLEANOUTS

- A. In floors of finished areas: cast iron caulking ferrule for soil pipe hub with brass countersunk plug and cast brass round flush access cover with polished top.
- B. In floors of unfinished areas: cast iron with tapered body for caulking into soil pipe hub, with brass countersunk plug.
- C. In walls of finished areas: cast brass raised head plug and round stainless steel cover plate with polished top and countersunk cover screw. Provide with caulking ferrule where installed in cast iron soil pipe.
- D. In walls of unfinished areas: cast brass raised head, iron pipe size male threads. Provide with caulking ferrule where installed in iron soil pipe.
- E. In floors of areas subject to vehicular travel: cast iron with tapered body for caulking into soil pipe hub, with brass countersunk plug. Weight rated for fork truck and heavy traffic duty.

PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which sanitary waste and vent piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

- A. General: Install basic materials and products as required per manufacturer=s recommendations, Wisconsin State Plumbing Code, local code requirements and as required to meet the intent of the documents.
- B. No soil or waste pipe shall be covered by earth or construction without first being proved free of leaks by a hydrostatic test of at least 10 feet head.
- C. Install vents in practical alignment and supported with constant pitch back to the drainage system, concealed from finished spaces, unless shown or directed otherwise.
- D. Soil, waste and vent connections to fixtures shall be accurately located and concealed from finished spaces, unless indicated otherwise.

- E. Connections to horizontal branches shall be at 45 deg. angle using Wye or Tee-Wye. Connection to vertical stacks shall be with Sanitary Tee or Tee-Wye at 45 deg.

3.03 SANITARY WASTE AND VENT PIPING

- A. Install pipe for all sanitary waste and vent systems as indicated on drawings, as called for in other sections, and as specified herein.
- B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other trades. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
- C. Provide proper support to maintain uniform fall of 1/4" per foot for lines 3" and smaller and 1/8" per foot for lines 4" and larger. Protect all openings against the entrance of dirt. Where piping must cross footings, the piping shall cross under footings unless noted otherwise on the drawings.
- D. Check all piping for interference with other trades, avoid placing water pipes over electrical equipment.
- E. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.
- F. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.
- G. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.
- H. Equipment Connections
 - 1. General: Connect sanitary waste and vent piping system to plumbing equipment as indicated and comply with equipment manufacturer's instructions where not otherwise indicated.
- I. Field Quality Control
 - 1. Piping Tests: Test sanitary waste and vent piping in accordance with testing requirements of Division-22 Basic Materials and Methods, Section 22 00 10 - Plumbing General Provisions.

3.04 INSTALLATION OF CLEANOUTS

- A. Provide a cleanout at the base of each stack where the sewer leaves the building and at other points where required by code and good practice. Cleanout spacing shall not exceed 50'-0" on long runs. Cleanouts shall be the same size as pipe up to and including 6" and 6" for 6" or larger pipes. Cleanouts for concealed pipes shall be set flush with floor and wall surfaces.

3.05 INSTALLATION OF FLOOR DRAINS

- A. Obtain exact finish floor levels from the General Contractor and set floor drain top rims accurately to proper level. Allow for proper slope towards drains.

3.06 INSTALLATION OF FIXTURES

- A. Refer to Section 22 40 00 - Plumbing Fixtures and 22 47 00 - Drinking Fountains and Water Coolers.

END OF SECTION 22 13 16

**SECTION 22 13 19
GREASE INTERCEPTORS**

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 - Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary for the plumbing fixture installation as required by the drawings and this section.
- B. Fixtures, trim and accessories shall be of type and model numbers as scheduled on the drawings.

1.3 SUBMITTALS

- A. Submit catalog cuts giving manufacturer's model numbers, fixture and rough-in dimensions, and construction material for each type of fixture, trim and accessory scheduled.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Grease Interceptors
 - 1. Josam
 - 2. Mifab
 - 3. Wade
 - 4. Watts

PART 3 - EXECUTION

- 3.1** Install grease interceptor and make waste and vent connections as indicated on the drawings.
- 3.2** Grease interceptor shall be covered after they are set to prevent damage during the balance of construction. At the conclusion of work, the covering shall be removed and the lid properly cleaned at construction completion.

END OF SECTION 22 13 19

SECTION 22 15 16
FACILITY NATURAL GAS AND COMPRESSED AIR PIPING

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.
 - 1. Extent of natural gas piping work is indicated on drawings and schedules, and by requirements of this section.
 - 2. Installation of valves for natural gas piping system is specified in other Division-22 sections and is included as work of this section.
- B. Trenching and Backfill: Trenching and backfill required in conjunction with gas service piping is specified in applicable Division-22 sections and is included as work of this section.

1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and install natural gas systems in accordance with NFPA 54 "National Fuel Gas Code".
- B. Utility Compliance: Fabricate and install natural gas systems in accordance with local gas utility company requirements.
- C. UPC Compliance: Fabricate and install natural gas systems in accordance with IAPMO "Uniform Plumbing Code".

1.4 SUBMITTALS

- A. Submit manufacturer's material data and installation methods for each type of system to be provided.
- B. Submit manufacturer's catalog cuts for each type of device to be used.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Pressure Regulator:
 - 1. Cashco
 - 2. Fisher
- B. Plug Valves
 - 1. Homestead
 - 2. Nordstrum
- C. Ball Valves
 - 1. Watts
 - 2. Nibco
 - 3. Apollo
 - 4. Milwaukee

2.2 BASIC MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with NFPA 54 where applicable; base pressure rating on natural gas piping system's maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in natural gas piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.
- B. Piping Specialties: Refer to Section - 22 05 00 - Common Work Results for Plumbing.
- C. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

2.3 PIPE:

<u>Material</u>	<u>Service</u>
A. Black steel pipe Schedule 40, ASTM A53	Interior natural gas piping.
B. Painted Black steel pipe Schedule 40, ASTM A53	Exterior natural gas piping.
C. High Density Polyethylene (PE), PE3408 ASTM D2837, ASTM D3035	Exterior below grade gas piping.

2.4 FITTINGS:

- A. Steel Pipe:
 - 1. Threaded pipe (2" dia and smaller): Malleable iron fittings, 125 pound standard flat band water pattern.
 - 2. Welded pipe (2 1/2" dia and larger): Standard radius weld fittings and weld neck or slip-on flanges, same material and strength as pipe.
- B. Polyethylene pipe fittings (gas service): Heat fusion fittings, provide fittings produced and recommended for the service indicated by manufacturer of piping.

2.5 JOINTS

- A. Steel Pipe:
 - 1. Threaded pipe (2" dia and smaller): Make joints using Teflon tape applied to male threads only. Cut pipe square, cut threads clean, remove burrs and ream ends to full size of bore. For fuel piping and lubricating oil piping, joint sealing material shall be resistant to petroleum products.
 - 2. Welded pipe (2 1/2" dia and larger): Welding shall conform to welding section of ANSI-B31.3 "Code for Power Piping."
- B. Polyethylene pipe fittings (gas service): Heat fusion joints made in accordance with practices for the pipe service as recommended by manufacturer of piping.

2.6 NIPPLES AND UNIONS

- A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2", use extra strong nipple; do not use close nipples.
- B. For pipe 2" and smaller, use screwed unions, for pipe 2-1/2" and over use flanged unions. For steel pipe use black or galvanized malleable iron unions, to conform to pipe with ground joint. Cast iron flanged unions gasket type. For threaded brass pipe, use bronze ground joint unions with octagon ends.

- C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:
 - 1. In by-pass around equipment, valves, and controls.
 - 2. In connections to equipment.
 - 3. Where indicated on drawings.

2.7 VALVES

- A. Natural Gas: 2" and smaller: Two-piece full-port bronze ball valve, suitable for natural gas service, threaded ends.
- B. Natural Gas: 2 1/2" to 6": Carbon steel or cast iron plug valve MSS SP-78, WOG (suitable for natural gas service) with flanged ends.
- C. Natural Gas Meter Valve: Provide with tamper-proof operator.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which natural gas piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

- A. General: Install basic materials and products as per manufacturer's recommendations, Uniform Plumbing Code, local code requirements, Utility Company requirements and as required to meet the intent of the document.
- B. Natural Gas Piping
 - 1. Install pipe for all natural gas systems as indicated on drawings, as called for in other sections, and as specified herein.
 - 2. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other natural gas items. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
 - 3. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage.
 - 4. Check all piping for interference with other trades; avoid placing pipes over electrical equipment.
 - 5. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.
 - 6. Piping up to 2" diameter shall be screwed, piping 2-1/2" diameter and over shall be welded. Concealed gas piping shall be welded or otherwise installed as required per NFPA 54 and local code.
 - 7. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping, or equipment connections are completed.
 - 8. Install "Tee" fitting with bottom outlet plugged or capped, at bottom of pipe risers.
 - 9. Install piping with 1/64" per foot (1/8%) downward slope in direction of flow.
 - 10. Exposed outside pipe: Prime coat with appropriate lead oxide paint and apply finish enamel coat to match color of adjacent building material.
- C. Valves
 - 1. Locate valves for easy access and operation. Do not locate valves with stems below horizontal.
 - 2. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more natural gas terminals or equipment connections, and elsewhere as indicated.

3. Shutoff Valves: Install on inlet and outlet of each natural gas equipment item, and on inlet of each natural gas terminal, and elsewhere as indicated.
 4. Drain Valves: Install on each natural gas equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain natural gas piping system.
- D. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.
- E. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.
- F. Install specialties and accessories as indicated on drawings and in accordance with manufacturer's recommendations and applicable codes and standards.

3.3 INSTALLATION OF GAS SERVICE

- A. General: Arrange with utility company to provide gas service to indicated location with shutoff at terminus. Consult with utility as to extent of its work, costs, fees, and permits involved. Pay such costs and fees; obtain permits.
- B. Extend service pipe from utility's terminus to inside building wall, under utility's direction.

3.4 INSTALLATION OF EQUIPMENT CONNECTIONS

- A. General: Connect gas piping to each gas-fired equipment item, with drip leg and shutoff gas cock. Comply with equipment manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

- A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility company requirements.

3.6 ADJUSTING AND CLEANING

- A. Cleaning and Inspecting: Clean and inspect natural gas systems in accordance with requirements of Division-22 Basic Mechanical Materials and Methods, Section 22 00 10 – Plumbing General Provisions.

3.7 SPARE PARTS

- A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring same.

END OF SECTION 22 15 16

SECTION 22 31 00
DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of plumbing equipment work is indicated on drawings and provisions of this section, including schedules and equipment lists associated with either drawings or this section.
- B. Types of plumbing equipment required for project include the following:
 - 1. Water Softeners

1.03 QUALITY ASSURANCE

- A. UL and NEMA Compliance: Provide electric motors and electrical components required as part of plumbing equipment, which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.
- B. NEC Compliance: Comply with National Electrical Code (ANSI/NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of plumbing equipment.
- C. ANSI/NSF 372 Certification: Domestic Water Softeners shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's plumbing equipment specifications, installation and start-up instructions, and capacity and ratings, with selection points clearly marked.
- B. Shop Drawings: Submit assembly type shop drawings indicating dimensions, weights, required clearances, and methods of assembly of all components.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Water Softeners
 - 1. Culligan
 - 2. Hellenbrand

2.2 WATER SOFTENERS

- A. General: Furnish, install, and place in operation an Automatic Water Softener System of capacities and performance as scheduled.
- B. Tanks: Softener tank(s) shall be of woven fiberglass media.
- C. Brine System: A combination salt storage and brine measuring tank constructed of fiberglass reinforced plastic.

- D. Automatic Controls: The automatic control will be of top mount design, The control shall be fully automatic multi-port control valve operated by a rotary pilot that hydraulically or pneumatically activates cartridge style diaphragm valves for regeneration. The multi-port valve will incorporate self-adjusting flow regulators to control the rate of flow during backwash and brine-rinse and fast rinse positioners, regardless of pressure fluctuations. The control will open and close slowly to prevent noise and hydraulic shock.
- E. The electrical control mechanism shall be provided in a gasketed, moisture-resistant case, NEMA 3R enclosure. The unit will have provisions for individual adjustment of backwash and rinse cycle, and provisions for manually regenerating the water filter by means of inlet hydraulic pressure. Regeneration will be demand based controlled by an aqua-sensor that operates regeneration cycles.
- F. Controller: The controller shall be top mounted and allow for automatic control of the system, including adjustments of water softening level and scheduling for backwash cycles. Provide with 10 ft power cord.
- G. Flow Control: An automatic backwash control shall be provided to maintain a proper backwash and fast flush flows over wide variations of operating pressure. Controller to contain no moving parts, and require no field adjustment. The flow controls shall be manufactured by the same manufacturer as the entire softening system.
- H. Piping: Manufacturer to furnish softener tank, with assembled valve manifold piping. Contractor shall furnish and install interconnecting piping. Drain shall have an air gap conforming to local codes to permit observation of discharge backwash water and manufacturer shall provide a valved drain at the lowest point of the softener system.
- I. Provide the following accessories:
 - 1. Inlet and outlet gauges with isolation valves.
 - 2. Valved drain at lowest point of softener system.

PART 3 - EXECUTION

3.01 INSTALLATION OF WATER SOFTENER

- A. General: Install water softener as indicated, in accordance with manufacturer's installation instructions, and in compliance with applicable codes.
 - 1. Set water softener in indicated location; connect to inlet, outlet and drain piping.
 - 2. Start-up: Start-up, test, and adjust water softener in accordance with manufacturer's start-up instructions. Check and adjust controls for proper operation.

END OF SECTION 22 31 00

SECTION 22 34 00
FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of plumbing equipment work is indicated on drawings and provisions of this section, including schedules and equipment lists associated with either drawings or this section.
- B. Types of plumbing equipment required for project include the following:
 - 1. Water Heaters

1.3 QUALITY ASSURANCE

- A. UL and NEMA Compliance: Provide electric motors and electrical components required as part of plumbing equipment, which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.
- B. NEC Compliance: Comply with National Electrical Code (ANSI/NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of plumbing equipment.
- C. ANSI Compliance: Comply with ANSI Z223.1 (NFPA 54) "National Fuel Gas Code", as applicable to installation of gas-fired water heaters.
- D. AGA Labels: Provide water heaters which have been listed and labeled by American Gas Association.
- E. ANSI/NSF 372 Certification: Fuel-Fired Domestic Water Heaters shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's plumbing equipment specifications, installation and start-up instructions, and capacity and ratings, with selection points clearly marked.
- B. Shop Drawings: Submit assembly type shop drawings indicating dimensions, weights, required clearances, and methods of assembly of all components.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Residential Gas-fired Water Heaters
 - 1. A.O. Smith, Consumer Products Div.
 - 2. Rheem-Ruud
 - 3. State Industries

2.2 WATER HEATERS

- A. Residential Gas-fired Water Heaters
 - 1. General: Provide gas-fired water heaters of size and capacity as indicated on schedule. Comply with ANSI/ASHRAE/IES 90A for energy efficiency.

2. Heater: Working pressure of 150 psi; 3/4" tapping for relief valve; magnesium anode rod; glass lining on internal surfaces exposed to water.
3. Safety Controls: Equip with automatic gas shutoff device to shut off entire gas supply in event of excessive temperature in tank; and pilot safety shutoff.
4. Combustion System: Equip with power venting system certified for power direct venting up to 40 equivalent feet on the intake vent arrangement and up to 40 equivalent feet on the exhaust vent arrangement, using standard PVC, class 160, schedule 40 or CPVC vent piping. Gravity direct vented or heaters that use room air for combustion are not acceptable equals. The water heater shall include a 6' plug-in power cord and provision for direct connection to a standard electrical outlet. Blower shall include pressure switches which will shut down power to the burner in case of vent system failure due to down drafts or vent blockage.
5. Jacket: Provide outer steel jacket with tank insulation and baked enamel finish.
6. Warranty: Furnish 1 year limited warranty for tank leakage.
7. Accessories: Provide brass drain valve; 3/4" relief valve; cold water dip tube.
8. Controls: Provide gas pressure regulator; pilot gas regulator adjustable thermostat.

PART 3 - EXECUTION

3.1 INSTALLATION OF WATER HEATERS

A. Gas-fired Water Heaters

1. General: Install gas-fired water heaters as indicated, in accordance with manufacturer's installation instructions, and in compliance with applicable codes.
2. Support: Set units and orient so controls and devices needing service and maintenance have adequate access. Level and plumb unit.
3. Gas Supply: Connect to gas line with drip leg, tee, gas cock and union; full size of unit inlet connection. Locate piping so as not to interfere with service of unit.
4. Piping: Connect hot and cold water piping to units with shutoff valves and unions.
5. Flue/Intake: Install according to manufacturer's recommendations to be consistent with sealed system or draft hood.
6. Start-Up: Start-up, test and adjust gas-fired water heaters in accordance with manufacturer's start-up instructions, and Utility Company's requirements. Check and calibrate controls, adjust burner for maximum efficiency.
7. Pressure and Temperature Relief: Route pipe to nearest indirect sanitary drain. Pipe size to match relief connection size.

END OF SECTION 22 34 00

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary for the plumbing fixture installation as required by the drawings and this section.
- B. Fixtures, trim and accessories shall be of type and model numbers as scheduled on the drawings.

1.3 SUBMITTALS

- A. Submit catalog cuts giving manufacturer's model numbers, fixture and rough-in dimensions, and construction material for each type of fixture, trim and accessory scheduled.
- B. Furnish rough-in information that impacts other trades to General Contractor for distribution to other sub-contractors. This includes, but is not limited to, sink cut out templates, shower/tub framing dimension drawings, electrical power rough-in dimension drawings, etc.

1.4 QUALITY ASSURANCE

- A. ANSI/NSF 372 Certification: All potable water supply piping and valves shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Vitreous China Fixtures
 - 1. American Standard
 - 2. Crane
 - 3. Eljer
 - 4. Kohler
 - 5. Zurn
 - 6. Sloan
- B. Stainless Steel Sinks
 - 1. Elkay
 - 2. Just
 - 3. Kohler
- C. Lavatory Trim
 - 1. Sloan
- D. Trim (all except lavatories)
 - 1. American Standard
 - 2. Chicago Faucet

3. Delta
 4. Eljer
 5. Elkay
 6. Kohler
 7. T & S Brass Works
 8. Sloan
- E. Flush Valves
1. Sloan
- F. Carriers
1. Jay R. Smith
 2. Josam
 3. Wade
 4. Watts
 5. Zurn
- G. Valve Boxes
1. Guy Gray
- H. Closet Seats
1. Beneke
 2. Church
 3. Olsonite
 4. Sperzel
 5. Comfort Seats
 6. Bemis Commercial
 7. ProFlo
- I. Shower Valves
1. Leonard
 2. Symmons
 3. Delta
 4. Kohler
 5. Bradley
- J. Mop Sinks and Service Sinks
1. Fiat
 2. Mustee
 3. Pro Flo
- K. Garbage Disposals
1. In-Sink-Erator
- L. Wall Hydrants
1. Woodford
 2. Prier
 3. JR Smith

M. Hose Thread Vacuum Breakers

1. Watts
2. Zurn Wilkins
3. Apollo

2.02 VITREOUS CHINA FIXTURES

- A. Vitreous ware shall be non-absorbant, even color, unwarped, two-fired vitreous china, grade "A" as rated by the Bureau of Standards.
- B. Vitreous China fixtures shall be white, except where other colors are called for in the schedule.

2.03 STAINLESS STEEL SINKS

- A. Stainless steel sinks shall be fabricated from 18 gauge nickel-bearing type 302 stainless steel, with satin finish, sound deadening treatment and 3/16" drop down ledge. Provide with channel and pull down clips to ensure tight seal between sink and countertop.

2.04 TRIM

- A. Trim to include supply pipes, stop valves, faucets, tail pieces, strainers, waste and traps. Floor and wall plates shall be brass. Exposed trim shall be chrome plated.
- B. Potable water supply piping and fixtures (excluding toilets, urinals, fill valves, flush valves, and shower valves) shall meet the certification requirements of ANSI/NSF 372 – Drinking Water System Components, Lead Content.
- C. Stop valves shall be compression type with loose key control.
- D. P-trap shall be adjustable 18 gauge tubular brass. Where offset P-traps are required for handicapped accessible lavatories, offset and P-trap shall be insulated with Handi Lav-Guard by Truebro, or equal. When supply risers are exposed, they shall be insulated with Handi Lav-Guard by Truebro, or equal.
- E. Trim shall be considered "exposed" even when concealed behind base cabinets having doors.
- F. Piping under the counter shall be covered with Lav-Shield by Truebro or equal in areas where a cabinet does not cover them.

2.05 VALVE BOXES

- A. Box material shall be PVC High temperature Resin with Intumescent pad for to achieve fire rating required to match rating of wall where box is shown on plans. Snap on frame shall accommodate up to two layers of 5/8" drywall.
- B. Valves shall be included as indicated in Plumbing Fixture Schedule on the plans. All valves for domestic hot or cold water shall be lead free and comply with NSF/ANSI 372 (annex G) and the US Safe Drinking Water Act.
- C. Accessories: Provide other accessories as indicated in the Plumbing Fixture Schedule on the plans.

2.06 HOSE THREAD VACUUM BREAKERS

- A. Anti-siphon vacuum breaker certified under ASSE 1011 and that is designed to be non-removable.
- B. Finish shall be either brass (Watts 8A) or chrome (Watts 8AC) to match the finish of the hose thread to which it is connecting.

PART 3 - EXECUTION

- 3.01** Install fixtures and make water supply, waste and vent connections as indicated on the drawings.
- 3.02** Set fixtures in center of stalls, between partitions where required. Dimensions for spacing shall be verified with General Contractor. Fixtures in ADA accessible stalls shall be installed with the flush valve handle to the open side of the stall, where applicable.
- 3.03** Setting shall be absolutely tight and rigid on proper ground. Use Miracle Adhesive Corporation Tub-Caulk or approved equal pointing material under all setting surfaces.
- 3.04** Wall hung fixtures shall be securely hung. All wall hung fixtures shall have carriers unless other mounting means are approved by Design Professional. Mounting heights shall be as indicated on Architectural elevations, and in accordance with the requirements of the ADA.
- 3.05** Carriers for urinals shall have thrust bolts at bottom. Carriers for lavatories and electric water coolers shall have mounting plate type hanger or concealed arms as required by the fixture schedule. Carriers shall be coordinated with plumbing fixtures.
- 3.06** Fixtures shall be covered after they are set to prevent damage during the balance of construction. At the conclusion of work, the covering shall be removed and the fixtures properly cleaned.
- 3.07** Contractor shall be responsible for the protection of the fixtures until acceptance by Owner. Damaged fixtures shall be replaced at no additional cost to Owner.
- 3.08** Joints of lavatories with counter and/or wall, sinks with wall, urinals with wall and water closets with wall and/or floor shall be caulked with transparent silicone caulk by Contractor.
- 3.09** Provide a hose thread vacuum breaker at all locations indicated on the plans and at all threaded hose connections.

END OF SECTION 22 40 00

SECTION 22 47 00
DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary for the plumbing fixture installation as required by the drawings and this section.
- B. Fixtures, trim and accessories shall be of type and model numbers as scheduled on the drawings.

1.3 QUALITY ASSURANCE

- A. ANSI/NSF 372 Certification: Drinking Fountains and Water Coolers shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

1.4 SUBMITTALS

- A. Submit catalog cuts giving manufacturer's model numbers, fixture and rough-in dimensions, and construction material for each type of fixture, trim and accessory scheduled.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Electric Water Coolers
 - 1. Elkay
 - 2. Halsey Taylor
 - 3. Haws
 - 4. Oasis
 - 5. Sunroc/Western

2.02 ELECTRIC WATER COOLERS

- A. Refer to Plumbing Fixture Schedule for models and accessories.
- B. Provide with factory wired 3-prong power cord(s) for unit power.

PART 3 - EXECUTION

- 3.1** Install fixtures and make water supply, waste and vent connections as indicated on the drawings.
- 3.2** Fixtures shall be covered after they are set to prevent damage during the balance of construction. At the conclusion of work, the covering shall be removed and the fixtures properly cleaned.
- 3.3** Contractor shall be responsible for the protection of the fixtures until acceptance by Owner. Damaged fixtures shall be replaced at no additional cost to Owner.

END OF SECTION 22 47 00

SECTION 23 00 10
HVAC GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL

- A. Refer to Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements, which all apply to work under this section.

1.2 DESCRIPTION OF WORK

- A. This section applies to all work under the HVAC contract. This shall include, but not necessarily be limited to, the following:
1. Piping Insulation
 2. Ductwork for Air Distribution
 3. Grilles, Registers, Diffusers and Dampers
 4. Exhaust Fans and Ducts
 5. Thermostats and Control Wiring
 6. Insulation of Ducts and Plenums
 7. Variable Refrigerant Flow Systems
 8. Energy Recovery Units
- B. The work shall include all materials, equipment and labor required for complete and properly functioning HVAC systems.
- C. Drawings for HVAC work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, piping and approximate sizes and locations of equipment and materials.
- D. Where job conditions require reasonable changes in indicated locations and arrangements, make such changes without additional cost to Owner.
- E. Because of the scale of the drawings, certain piping or items such as unions or fittings may not be shown, but where such items are required by other sections of the specifications, or where they are required by the nature of the work, they shall be furnished and installed.
- F. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- G. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
1. International Mechanical Code
 2. Wisconsin State Plumbing Code
 3. International Building Code
 4. National Electric Code (NEC)
 5. National Fire Protection Association Standards (NFPA)
 6. Local Utility Company Requirements
 7. Local Codes, all trades
 8. Standards of ASME, ASHRAE, NEMA, IEEE, AGA, SMACNA
 9. Occupational Safety and Health Administration (OSHA)
 10. Underwriters Laboratories, Inc. (U.L.)
 11. Wisconsin Administrative Codes
 12. Americans With Disabilities Act (ADA)

- B. Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.
- C. Where drawings or specifications call for workmanship or materials in excess of code requirements, a lower grade of construction will not be permitted.

1.4 REQUIREMENTS & FEES OF REGULATORY AGENCIES

- A. Secure all required permits and pay for all inspections, licenses and fees required in connection with the HVAC work. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.

1.5 HVAC DRAWINGS

- A. The HVAC drawings indicate in general the building arrangement only, Contractor shall examine construction drawings to familiarize himself with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.
- B. Drawings are intended to convey the scope of the work and to indicate the general arrangement and locations of ducts, piping and equipment.
- C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of piping and ducts so as to best fit the layout of the work.
- D. Contractor shall take his own field measurements for verifying locations and dimensions: scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as pipe fittings and valves may not be shown, but where such items are required by code or by other sections of the specifications, such items shall be furnished and installed.

1.6 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact location of all existing services prior to beginning work in that area.
- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.
- C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.7 SITE INSPECTION

- A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.8 COORDINATION AND COOPERATION

- A. It shall be Contractor's responsibility to schedule and coordinate his work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by Design Professional and his decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting and plaster until the project is substantially completed. Damage from rust, paint and scratches shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires Contractor to work in finished areas of the building, Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.

1.9 OPENINGS, CUTTING AND PATCHING

- A. Piping, sleeves and ducts passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe, sleeve, and/or duct shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where piping, sleeves and ducts pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.
- B. New structure:
 - 1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the HVAC work with the General Contractor.
 - 2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.
- C. Existing Structure:
 - 1. Contractor shall provide cutting, lintels and patching, and patch painting in the existing structure, as required for the installation of his work, and shall furnish lintels and supports as required for openings.
 - 2. Cutting of structural support members will not be permitted without prior approval of the Design Professional. Extent of cutting shall be minimized; use core drills, power saws or other machines which will provide neat, minimum openings.
 - 3. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.

1.10 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item. Where two or more units are required of the same item, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items, when required, shall be furnished as part of the equipment, whether or not specifically called for.

1.11 SUBMITTALS

- A. Contractor shall furnish, to Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- D. After award of contract, Contractor shall provide a completed submittal schedule including dates that the submittals will be to Design Professional for review.
- E. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
23 05 48	Vibration Controls for HVAC Piping, Ductwork and Equipment		X					
23 05 53	HVAC Identification		X					
23 05 93	Testing, Adjusting and Balancing for HVAC							1
23 07 00	HVAC Insulation		X					
23 09 00	Building Automation System	X	X			X	X	
23 31 13	Metal Ducts	X	X					
23 33 00	Air Duct Accessories		X			X		
23 34 16	HVAC Fans		X			X	X	
23 37 13	Diffusers, Registers and Grilles		X					
23 38 13	Commercial Kitchen Exhaust Equipment		X			X		
23 55 23	Gas Fired Radiant Heaters		X			X		
23 55 33	Fuel Fired Unit Heaters		X			X		
23 72 00	Air-to-Air Energy Recovery Equipment		X			X	X	

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
23 81 27	Variable Refrigerant Flow System		X			X	X	
23 82 16	Air Coils		X			X		
23 82 39	Unit Heaters		X			X		

NOTES:

1. Submit test reports as described in specification section.

- F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.
- G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

1.12 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted to Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.
- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
HVAC SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
 1. Equipment and system warranties and guarantees.
 2. Installation instructions.
 3. Operating instructions.
 4. Maintenance instructions.
 5. Spare parts identification and ordering list.
 6. Local service organization, address, contract and phone number.
 7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
 8. Reports of all tests and demonstrations including certificate of owner instruction, testing and balancing report, etc.

1.13 TESTS AND DEMONSTRATIONS

- A. Tests Required: Piping shall be tested and proved tight under the following static pressures. Pressure shall be maintained for four (4) hours.

<u>System</u>	<u>Pressure</u>
Refrigeration Piping: Precharged Lines	Charge and operate unit. Check for leaks with electronic leak detector.

- B. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner. Contractor shall submit a report to Design Professional citing dates, times, pressures, and results of all tests performed.

1.14 TRAINING AND DEMONSTRATIONS

- A. Prior to acceptance of the HVAC installation, Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed and shall instruct Owner in the proper operation and maintenance of such systems.

- 1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
- 2. Prepare the instruction format for a minimum of four Owner Representatives.

- B. Equipment training for Owner:

- 1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
- 2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
- 3. Training shall be performed by qualified factory trained technicians.
- 4. HVAC Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
- 5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

- C. System training for Owner:

- 1. HVAC and Temperature Controls Contractors shall jointly conduct system operating training. These sessions shall include:
 - a. HVAC system overview.
 - b. System wide start-up.
 - c. Operation of control system.
 - d. Function of each component.
 - e. System operating procedures in all possible modes.
 - f. Programming procedures.
 - g. Shut-down and maintenance procedures.
 - h. Emergency procedures.

D. The following are minimum requirements for Owner instruction:

Section	Description	Hours (Note 1)	Presented By	Others Present	Remarks
23 00 10	HVAC System (Excluding Equipment)	8	Mech. Contractor T.C. Contractor		Note 2
23 09 00	Temperature Control System	8	T.C. Contractor		Note 3
23 34 16	Fans	2	Contractor		
23 38 13	Commercial Kitchen Exhaust Equipment	2	Manufacturer's Representative	Contractor	
23 55 23	Gas Fired Radiant Heaters	1	Manufacturer's Representative	Contractor	
23 72 00	Energy Recovery Equipment	2	Manufacturer's Representative	Contractor	
23 81 27	Variable Refrigerant Flow System	8	Manufacturer's Representative	Contractor	Note 3
<ol style="list-style-type: none"> 1. Any unused hours shall be used at Owner's discretion during the first year of occupancy. 2. System training shall include, but not be limited to, valve locations, system routing, and air/refrigerant flow patterns, system start-up/shut-down/emergency procedures. 3. Training shall occur in several sessions over the course of the first year of operation. A minimum of two separate dates are required. 					

E. Contractor shall submit to Design Professional a certificate, signed by Owner stating the date, time and persons instructed and that the instruction has been completed to Owner's satisfaction. An example of a certificate form is as follows:

CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that Contractor has demonstrated the hereafter listed systems to Owner's representatives in accordance with the Contract documents and that the instruction has been completed to Owner's satisfaction.

A. Project:

B. System(s):

C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

D. Owner's representatives receiving instruction:

Owner: _____

NAMES	DATE	HOURS

E. Acknowledgement of demonstration:

Contractor's Representative:

_____ signature

_____ date

Owner's Representative:

_____ signature

_____ date

1.15 SUBSTITUTIONS

- A. Refer to Divisions 00 and 01.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.16 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of Contractor and/or the manufacturer.
- C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions (including accessibility for maintenance), operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.17 WARRANTY

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
 - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
 - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
 - b. The entire HVAC system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 23 sections for systems, equipment, or material requiring extended warranties beyond one year.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

1.18 COMPLETION

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.
- B. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

1.19 CLEANING

- A. Prior to assembly of pipe and piping components, all loose dirt, scale, oil, and other foreign matter on internal and exterior surfaces shall be removed by means consistent with good piping practices. During fabrication and assembly, slug and weld splatter shall be removed from both internal and external pipe joints by preening, chipping, and wire brushing.
- B. At the conclusion of the construction, the entire system of piping and equipment shall be cleaned internally. Prior to flushing erected piping surfaces, Contractor shall disconnect all instrumentation and equipment and open wide all valves.
- C. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.
- D. Heating and air conditioning equipment shall be thoroughly cleaned and clean filters installed.

1.20 ELECTRICAL WORK

- A. Electrical work and equipment provided by HVAC Contractor shall include the following:
 - 1. Starters and disconnects for motors of HVAC equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 2. Wiring from motors to disconnect switches or junction boxes for motors of HVAC equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 3. Electrical heating coils and similar elements in HVAC equipment.
 - 4. All control wiring in accordance with the requirements of Division 26.
- B. Electrical Contractor shall provide all power wiring for HVAC equipment, including services for motors and equipment furnished by the HVAC contractor. Motor and equipment locations are shown on the electrical drawings.
- C. Electrical Contractor shall make final connections for all motors and equipment furnished by the HVAC contractor.
- D. Electrical Contractor shall furnish safety disconnects and starters for all motors and equipment furnished by the HVAC contractor (unless specifically indicated to be furnished integrally with the equipment), so as to make service complete to each item of equipment.
- E. Contractor shall consult with Electrical Contractor prior to conduit rough-in and shall verify with him the exact locations for rough-ins, and the exact size and characteristics of the services required, and shall provide Electrical Contractor a schedule of electrical loads for the equipment furnished by him. These schedules will be used for sizing services, disconnects, fuses, starters and overload protection.
- F. Refer to Division 23 Controls section for control system wiring. Control wiring shall be done in accordance with the requirements of Division 26.

1.21 TEMPORARY UTILITIES

- A. Refer to Division 01 for specific requirements concerning temporary utilities.
- B. Under no circumstances shall the building HVAC equipment be used for temporary heat, cooling or ventilation during construction prior to Owner acceptance of the building at substantial completion.

END OF SECTION 23 00 10

SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 GENERAL

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. This section includes the following:
1. Demolition
 2. Sleeves
 3. Escutcheons
 4. Fire Stopping

PART 2 - PRODUCTS

2.1 DEMOLITION MATERIALS

- A. All materials removed shall be the property of the removing contractor and shall be removed from the site by him, unless otherwise specified.

2.2 SLEEVES

- A. Sleeves passing through non-load bearing walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:
1. For pipes 2-1/2" and smaller - 24 gauge
 2. For pipes 3" to 6" - 22 gauge
- B. Sleeves passing through load bearing walls, concrete beams, fireproof walls, foundations, footings and waterproof floors shall be Schedule 40 steel pipe or cast iron pipe.
- C. Sleeves are not required in masonry walls which are core drilled or walls of drywall construction, except where partition is a firestop, smokestop, or side of air plenum.
- D. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.
- E. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water and fill space between sleeves and pipe with graphite packing and caulking compound.
- F. Sleeves passing through membrane waterproofing or lead safe shall be provided with flashing, furnished and installed by General Contractor, extending 12" beyond sleeve in all directions; flashing shall be secured and sealed to membrane or lead safe and shall be sealed to sleeve and caulked watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 6" above roof.

2.3 ESCUTCHEONS

- A. Provide chrome plated escutcheons at each sleeved opening into finished spaces. Escutcheons shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension. Secure escutcheons or plates to sleeve but not to insulation with set screws or other approved devices.

2.4 FIRESTOPPING

- A. Piping, conduit, sleeves and ducts passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe, conduit, sleeve, and/or duct shall be sealed with UL Listed intumescent fire barrier material equivalent to rating of wall/floor.

PART 3 - EXECUTION

3.1 DEMOLITION

- A. General:
 - 1. Demolition shall be accomplished by the proper tools and equipment for the work to be removed. Personnel shall be experienced and qualified in the type of work to be performed.
 - 2. Contractor shall remove existing equipment and piping not necessary for additions or existing portions of building as indicated on drawings and/or specified herein. To include all abandoned equipment and piping back to point of origin. Demolition of equipment shall include removal associated concrete equipment pad and/or support steel.
 - 3. Contractor shall be responsible for the cutting and capping of all existing services before any work is commenced by the General Contractor.
- B. Work by Others: Unless specifically noted under other contracts, Contractor shall assume all required work shall be performed by him. In general, the following will be performed by others:
 - 1. General Contractor will remove any floors, walls and ceilings, neatly patch, match, complete and finish all affected surfaces.
 - 2. Electrical Contractor will disconnect all electrical services and remove abandoned conduit back to point of origin.
- C. Existing Conditions:
 - 1. If any piping serving existing fixtures or equipment which are to remain are disturbed by operations under this Contract, Contractor shall provide pipe and insulation required to reestablish continuity of such piping systems.
 - 2. Contractor shall arrange for General Contractor to repair, patch and paint all construction, with material necessary to match surrounding material, which is necessary due to removal of equipment, piping, ductwork, or other mechanical items.
 - 3. Contractor shall furnish all required labor and material where required to extend new work to connect to similar work where new addition adjoins existing building and for extension of existing system. Connection shall be made in a suitable manner.
- D. Owner's Right of Salvage: The Owner may designate and have salvage rights to any material herein demolished by the Contractor.

3.2 SLEEVES

- A. Install sleeves for all piping passing through floors, roof, walls, concrete beams and foundations as required by this section.

3.3 ESCUTCHEONS

- A. Install escutcheons for all pipes entering finished spaces.

END OF SECTION 23 05 00

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 SUBMITTALS

- A. Submit for all motors provided.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Comply with NEMA MG1 unless noted otherwise.
- B. Constant Speed Motors:
 - 1. Located in Conditioned or Tempered Spaces: Minimum 1.15 service factor; rated at 40 deg. C. ambient temperature with 90 deg. C. temperature rise (Class B insulation).
 - 2. Located in Garage, Garage Attic, or Untempered Spaces: Minimum 1.15 service factor; rated at 40 deg. C. ambient temperature with 115 deg. C. temperature rise (Class F insulation).
- C. Motors Used with Variable Frequency Controllers: Inverter duty rated, Class F insulation (minimum). Windings shall be copper magnet with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters. Shall include Aegis motor shaft grounding rings.
- D. Multiple speed motors: Multiple windings.
- E. Motor Efficiency: Premium efficiency as defined in NEMA MG1.
- F. All motors shall be provided as required for motor orientation within equipment.
- G. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulations.
- H. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torques.

- I. Motor Enclosures:
 - 1. Shall be the NEMA types shown on the drawings for the motors.
 - 2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types which are most suitable for the environmental conditions where the motors are being installed. Motors located outdoors to be totally enclosed weatherproof epoxy-sealed type.
 - 3. Thoroughly clean and paint the enclosures at the factory with manufacturer's prime coat and standard finish.
- J. Additional requirements for specific motors, as indicated in other sections, shall also apply.

2.02 SINGLE PHASE POWER

- A. Capacitor start motors starting torque shall be three times full load torque and starting current shall be less than five times full load current.
- B. Pull-up Torque: Up to 350 percent of full load torque.
- C. Breakdown Torque: Approximately 250 percent of full load torque.
- D. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- E. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- F. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.03 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing and Performance: Conform to NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum or cast iron with end brackets of cast iron or aluminum with steel inserts.
- H. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

2.04 ELECTRONICALLY COMMUTATED MOTORS

- A. Where indicated, provide electronically commutated motors with the following features:
 - 1. Brushless, permanent magnet DC motor.
 - 2. Built in inverter.
 - 3. Microprocessor based controller for speed control.

4. 0-10VDC or 0-20mA input signal.
5. Minimum 70% efficiency through all speeds.
6. Bearings rated for L10 40,000 hours of continuous operation.

PART 3 - EXECUTION (Not Used)

END OF SECTION 23 05 13

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.2 DESCRIPTION OF WORK

- A. Provide materials, equipment, labor and supervision necessary to install hangers, supports, anchors, guides and seals as required by the drawings and this section.
- B. Types of supports, anchors and seals specified in this section include the following:
 - 1. Horizontal-Piping Hangers and Supports.
 - 2. Vertical-Piping Clamps.
 - 3. Hanger-Rod Attachments.
 - 4. Building Attachments.
 - 5. Saddles and Shields.
 - 6. Miscellaneous Materials.

1.3 QUALITY ASSURANCE

- A. Code Compliance: Comply with applicable plumbing and mechanical codes pertaining to product materials and installation of supports, anchors and seals.
- B. UL and FM Compliance: Provide products which are Underwriters Laboratories listed and Factory Mutual approved.
- C. ANSI Compliance: All supports and parts shall conform to the latest requirements of the ANSI Code for Pressure Piping B31.1.0 except as supplemented or modified by the requirements of this specification.

PART 2 - PRODUCTS

2.1 HANGERS, SUPPORTS AND ACCESSORIES (*Reference Catalog Figure numbers from Anvil*)

- A. Pipe support systems shall secure pipes in place, prevent pipe vibration, provide vertical adjustment for maintaining required grades, and provide for expansion and contraction.
- B. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.
- C. Wherever possible, pipe attachments for horizontal piping shall be pipe clamps.
- D. Wherever possible, structural attachments shall be beam clamps.
- E. All rigid hangers shall provide a means of vertical adjustment after erection.
- F. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.
- G. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.

- H. Where supports are attached to concrete or other structural members, care shall be taken to prevent damage or weakening of the structural members.
- I. Hangers and supports for insulated cold piping shall not injure or pierce insulation. Provide insulation protection shields or saddles for piping, (Fig. 167) in conjunction with hanger or roll device.
- J. Hangers and supports that are in direct contact with copper piping shall be copper plated or have nonmetallic coating for electrolytic protection.

PART 3 - EXECUTION

3.01 INSTALLATION - HORIZONTAL PIPE SUPPORT

- A. Copper pipe shall be supported at a maximum span of 10 feet for all pipe sizes, with hanger rods sized accordingly for total supported weight. For 1/2 in. copper tube, maximum spacing shall be 8 feet.
- B. Plastic pipe (PVC, etc.) shall be supported at a maximum span of 4 feet for all pipe sizes, with hanger rods sized accordingly for total supported weight.
- C. In addition to the above specified spacings, install additional hangers at change in pipe direction and at concentrated loads, large valves, strainers, etc.
- D. When two or more pipes are to be run parallel together, they may be supported on trapeze type hangers. Trapeze bar angles or channels and hanger rods shall be of sufficient size with required spacing to support the particular group of pipes.
- E. For suspending hanger rods from brackets attached to walls; use welded steel brackets, Fig 194 for loads up to 750 lbs; Fig. 195 for loads up to 1,500 lbs; Fig. 199 for loads up to 3000 lbs.
- F. Where pipes are to be racked along walls, use malleable iron one-hole clamp, Fig. 126 for pipes up to 3". For pipes larger than 3", use steel channel strut pipe rack.

3.02 INSTALLATION - VERTICAL PIPE SUPPORTS

- A. Support vertical copper and PVC pipe at every floor line.
- B. Where pipe sleeves extend above floor, place pipe clamps at ceiling below and support clamp extensions from inserts or other approved attachment.

3.03 PIPE ATTACHMENTS

- A. For horizontal steel pipe, use adjustable carbon steel clevis, Fig. 260, for pipes up to 30".
- B. For horizontal copper pipe and tube, use copper plated adjustable carbon steel clevis, Fig. CT-65.

3.04 INTERMEDIATE ATTACHMENTS

- A. Hanger rods: use carbon steel single or double end threaded, Figs. 140 and 253 as required. Continuous threaded rod, Fig. 146, may be used wherever possible. Contractor may at his option cut and thread rod on the job site.
- B. Chain, wire or perforated strap hangers will not be permitted. One pipe shall not be suspended from another pipe.
- C. Hangers shall be supported from appropriate structural members. In no case shall hangers be supported from ductwork, cable trays, piping, or other equipment. Existing hangers and supports shall not be used as supports for new hangers unless specifically designed as such, or additional loadings have been confirmed to be acceptable for existing supports.

3.05 STRUCTURAL ATTACHMENTS

- A. For attaching steel or copper plated hanger rods to reinforced concrete; use black carbon steel concrete inserts, Fig. 285 for loads up to 400 lbs., Fig. 281 for loads up to 1200 lbs. or suitable drilled inserts equal to Ramset/Red Head - Trubolt wedge anchor, Ramset/Red Head Epcon system or Hilti Kwik Bolt II anchor.
- B. For attaching steel hanger rods to structural steel beams, use malleable iron C-clamps, Fig. 87, with retaining clip for loads up to 500 lbs.; Fig. 229 with extension piece for loads up to 1,365 lbs. For copper plated hanger rods, use copper plated malleable iron C-clamps, Fig. CT-88, with hardened cup point set screw, for loads up to 400 lbs.
- C. For attaching steel hanger rods to wood structural members, use malleable iron ceiling flange pipe threaded, Fig. 128 for loads up to 480 lbs., Fig. 153 for loads up to 1270 lbs. For copper plated hanger rods, use copper plated malleable iron ceiling flange, Fig. CT-128R for loads up to 180 lbs.
- D. Under no circumstances shall hangers be attached to metal roof deck.

3.06 PIPE AND DUCT COVERING PROTECTION

- A. Hangers and supports for insulated cold piping and ductwork shall not injure or pierce insulation. Provide insulation protection shields or saddles for piping, Fig. 160, 161, 162, 163, 164, 165, 165A, 166A, or 167 in conjunction with hanger or roll device.

END OF SECTION 23 05 29

SECTION 23 05 48

VIBRATION CONTROLS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Conditions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of vibration isolation work required by this section is indicated on drawings and schedules, and/or specified in other Division-23 sections.
- B. All HVAC equipment over one horsepower, unless otherwise noted shall be isolated from the structure by means of vibration and noise isolators.
- C. Where isolator type and deflection are not shown, the related equipment shall be isolated in accordance with the 2019 ASHRAE Handbook - HVAC Applications, Chapter 48.
- D. Types of vibration isolation products specified in this section include the following:
 - 1. Precompressed Molded Fiberglass Isolators.
 - 2. Elastomeric Isolators.
 - 3. Isolation Hangers.
 - 4. Flexible Duct Connectors.
- E. Vibration isolation products furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division-23 sections.
- F. Refer to other sections of these specifications for equipment foundations, hangers, sealants, gaskets and other work related to vibration isolation work.

1.3 QUALITY ASSURANCE

- A. Product Qualification: Provide each type of vibration isolation unit produced by specialized manufacturer, with not less than 5 years' successful experience in production of units similar to those required for project.
 - 1. The materials and systems specified in this Section shall all be provided by the Contractor, from a single vibration isolation materials manufacturer to assure single responsibility for the performance of all isolation materials.

1.4 SUBMITTALS

- A. The isolator manufacturer's submittal shall include the complete design for required isolation and bases, and a tabulation of the design data including O.D., free and operating heights of the isolators.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Vibration Isolation Products
 - 1. Kinetics Noise Control, Inc.
 - 2. Vibration Eliminator Co., Inc.
 - 3. VMC Group
 - 4. Mason Industries

- B. The following item specifications apply to the corresponding Type numbers used in the Vibration Isolation Schedule. Model types are based on the 2019 ASHRAE Handbook - HVAC Applications, Chapter 48.

2.02 ISOLATION MATERIALS AND SUPPORT UNITS

- A. Springs: All springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. All springs except internal nested springs shall have an outside diameter not less than 0.8 of the compressed height of the spring. Ends of springs shall be square and ground for stability. Laterally stable springs shall have k_x/k_y ratios of at least 0.9. All springs shall be fully color-coded to indicate capacity – color striping is not considered adequate.
- B. Corrosion Protection: All springs shall be powder-coated enamel. Housings shall be galvanized, powder-coated enamel, or painted with rust-resistant paint. Hot-dipped galvanized housings shall be provided as indicated on the Schedule.
- C. Base Types
1. Type A Bases - no base required. Isolators may be attached directly to the supported equipment.
- D. Isolator Types
1. Type 1 Isolator - Rubber Pads and Glass Fiber Pads:
 - a. Isolation pads shall be single ribbed or crossed, double ribbed elastomer-in-shear pads, in combination with steel shims when required, having minimum static deflections as tabulated. All pads shall be true elastomer-in-shear using alternately higher and lower ribs to provide effective vibration isolation, and shall be molded using 2500 PSI (176 kg/cm²) tensile strength, oil resistant compounds with no color additives. Pads shall be 45 to 65 durometer and designed to permit 60 or 120 PSI (4.2 or 8.4 kg/cm²) loading at maximum rated deflections. When two isolation pads are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule or as indicated on the project bid documents, not exceeding published load capabilities.
 - b. Fiberglass continuous support material shall be high-density matrix of compressed molded fiberglass; individually coated with a flexible, moisture-impervious elastomeric membrane, designed to allow controlled air movement in the fiber media. It shall be manufactured in such a way that the pumping action of air between fibers provides viscous damping, reducing motion caused by transient shock and vibration. The material shall be non-corrosive, non-combustible, non-absorbent, and resists rust, ozone, mildew and fungus, vermin proof and it shall not shrink, swell, or decompose. Isolation characteristics of the media shall be constant over a temperature range of -40°F to 250°F (40°C to 121°C).
 2. Type 2 Isolators - Rubber Mounts and Hangers:
 - a. Vibration isolators shall be neoprene, molded from oil-resistant compounds, with cast-in-top steel load transfer plate for bolting to supported equipment, and a bolt-down plate with holes provided for anchoring to supporting structure. Top and bottom surfaces shall have non-skid ribs. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule or as indicated on the project documents but not exceeding published load capabilities. Vibration isolators with maximum static deflection requirements under the operating load conditions not exceeding .40" shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap. The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range. The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30-degree arc without metal-to-metal contact or other short circuit.

3. Type 3 Isolators - Spring Isolators and Hangers:
 - a. Vibration isolators shall be free standing, un-housed, laterally stable springs wound from high strength spring steel. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Springs shall be selected to provide operating static deflections as required. Springs shall be color coded or otherwise identified to indicate load capacity. In capacities up to 5,000 lbs., springs shall be replaceable. In capacities over 5,000 lbs., springs shall be welded to the top and bottom load plate assemblies. Springs shall be assembled between a top and bottom steel load plate. The upper load plate shall be provided with a steel leveling bolt lock nut and washer for attachment to the supported equipment. The lower load plate shall have a non-skid noise isolation pad bonded to the bottom and have provisions for bolting the isolator to the supporting structure.
 - b. Vibration isolators for suspended equipment, with minimum static deflection requirement exceeding .4", shall be hangers consisting of a free-standing, laterally stable steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket. The spring element shall meet all the specified characteristics described in above. The stamped or welded hanger bracket shall meet all the specified characteristics described above. Shall also be fitted with a self-centering load cap for the hanger rod.

- E. Flexible Ductwork Connectors:
 1. Flexible neoprene or heavy glass fabric duct connector with minimum material thickness of 0.024" and weight of 30 oz/sq. yard.
 2. Minimum temperature range shall be 30 to 200 deg F.
 3. The materials shall have a flame spread rating below 25 and smoke development rating below 50.
 4. The minimum static pressure rating shall be 10".

PART 3 - EXECUTION

3.01 PERFORMANCE OF ISOLATORS

- A. General: Comply with minimum static deflections recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, including definitions of critical and noncritical locations, for selection and application of vibration isolation materials and units as indicated.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.02 APPLICATIONS

- A. General: Apply types of vibration isolation materials and units indicated at locations shown or scheduled. Selection is Installer's option where more than one type is indicated.

3.03 INSTALLATION

- A. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.
- B. Anchor and attach units to substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.
- C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.
- D. Locate isolation hangers as near overhead support structure as possible.

- E. Bond flanges of flexible duct connectors to ducts and housings to provide airtight connections. Seal seams and penetrations to prevent air leakage.

3.04 EXAMINATION OF RELATED WORK

- A. Installer of vibration isolation work shall observe installation of other work related to vibration isolation work, including work connected to vibration isolation work; and, after completion of other related work (but before equipment startup), shall furnish written report to Contractor listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to the following:
 - 1. Equipment installations (performed as work of other sections) on vibration isolators.
 - 2. Ductwork Connections including provisions for flexible connections.
 - 3. Passage of piping and ductwork which is to be isolated through walls and floors.
- B. Do not start up equipment until inadequacies have been corrected in manner acceptable to vibration isolation Installer.

END OF SECTION 23 05 48

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of identification work required by this section is indicated on drawings and/or specified in other Division-23 sections.
- B. Type of identification devices specified in this section include the following:
 - 1. Painted identification materials
 - 2. Plastic pipe and duct markers
 - 3. Plastic tape
- C. Identification furnished as part of factory fabricated equipment, is specified as part of the equipment assembly in other Division-23 sections.

1.3 QUALITY ASSURANCE

- A. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-23 sections. Where more than one single type is specified for an application, selection is installer's option, but provide single selection for each product category.
- B. Painted Identification Materials:
 - 1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 3/4" high letters for access door signs and similar operational instructions.
 - 2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
 - 3. Identification Paint: Standard identification enamel of colors indicated, or, if not otherwise indicated for piping systems, comply with color chart below for colors.
- C. Plastic Pipe and Duct Markers:
 - 1. General: Provide manufacturer's standard pre-printed flexible or semi-rigid, permanent, color-coded, plastic-sheet pipe and duct markers.
 - 2. Color: Color of pipe and duct markers shall comply with ANSI A13.1.
 - 3. Small Pipes: For external diameters not greater than 6" (including insulation if any), provide full-band pipe markers extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - b. Adhesive lap joint in pipe marker overlap.
 - c. Laminated or bonded application of pipe marker to pipe (or insulation).
 - d. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide full circle at both ends of pipe marker, tape lapped 1-1/2".

4. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Design Professional in cases of variance with names as shown or specified.
5. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

D. Plastic Tape:

1. General: Manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
 - a. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2 1/2" wide tape for larger pipes or ducts.
 - b. Color: Same as indicated for Plastic Pipe or Duct Markers.

E. Name Plates:

1. General: Provide manufacturer's standard preprinted plastic, brass, or aluminum with stamped, engraved or embossed letters.
2. Lettering:
 - a. Large Equipment: 1 1/2" lettering as appropriate.
 - b. Small Equipment: 3/4" lettering as appropriate.
3. Attachments: Mounting holes and screws, pressure sensitive adhesive backing, or solid brass chain.

2.2 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in HVAC identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of HVAC systems and equipment.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. General Installation Requirements:

1. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags, install identification after completion of covering and painting if any. Install identification prior to installation of acoustical ceilings and similar concealment.

B. Ductwork Identification:

1. Access Doors: Provide stenciled or plastic-laminate type signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.

C. Piping System Identification:

1. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - a. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
 - b. Plastic pipe markers, with application system as indicated under "Materials" in this section.
 - c. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.
2. Locate pipe markers and color bands as follows wherever piping is exposed to view in unoccupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations. Install markers such that lettering is visible from floor.
 - a. Near each valve and control device.

- b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
- c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
- d. At access doors, manholes and similar access points which permit view of concealed piping.
- e. Near major equipment items and other points of origination and termination.
- f. Spaced intermediately at maximum spacing of 20' along each piping run with a minimum of one marker in each room.
- g. On piping above removable acoustical ceilings.

D. Equipment Identification:

- 1. General: Provide equipment identification for all equipment including energy recovery units, terminal units, fans, heaters, control panels, condensing units, heat recovery boxes, etc.
- 2. Labeling: All equipment shall be labeled as per construction document plan marks or as designated by Owner.
- 3. Provide identification by means of nameplates or stenciled painting as appropriate.
 - a. For equipment with factory furnished casing, identification shall be by adhesive fixed name plates.
 - b. Field insulated items, such as heat exchangers may be identified by plastic pipe markers or stenciled lettering.

END OF SECTION 23 05 53

SECTION 23 05 93
TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of testing, adjusting and balancing work is indicated by requirements of this section, and also by drawings and schedules, and is defined to include, but is not necessarily limited to, air distribution systems, domestic water circulation and associated equipment and apparatus of mechanical work. The work consists of setting speed and volume (including pulley changes as required), adjustments of system components, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required by contract documents. Entering, navigating the Building Automation System in order to adjusting 'K factors' and related items is also required.
- B. Component types of testing, adjusting and balancing specified in this section includes the following as applied to HVAC equipment:
1. Air Systems:
 - a. VRF Terminal Units
 - b. Energy Recovery Units
 - c. Exhaust Fans
 - d. Ductwork Systems
 - e. Diffusers and Grilles
 2. Water Systems:
 - a. Domestic Hot Water Recirculating System
- C. The Heating and Air Conditioning Contractor shall provide a complete and operating HVAC system and shall cooperate with the balancing agency by:
1. Installing balancing dampers as required by the Drawings and Specifications and requested by the Testing and Balancing Contractor.
 2. Putting complete system into operation during duration of balancing period.
 3. Providing up-to-date set of Drawings and advising immediately of any changes made to the system during construction.
 4. Providing labor and equipment and cost of performing corrections, such as dampers, belts, etc., as required without undue delay.
 5. Providing complete submittal information for all HVAC equipment, complete with pertinent engineering information.

1.3 REFERENCES

- A. Associated Air Balance Council (AABC) - National Standards for Field Measurement and Instrumentation, Total System Balance.
- B. ASHRAE - HVAC Applications Handbook: Chapter 34, Testing, Adjusting and Balancing. (Most recent edition).
- C. National Environmental Balancing Bureau (NEBB) - Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.4 QUALITY ASSURANCE

- A. Tester: A firm with at least 3 years of successful testing, adjusting and balancing experience on projects with testing and balancing requirements similar to those required for this project, who is not Installer of system to be tested and is otherwise independent of project.
- B. TAB Agency Qualification: Current membership in AABC or certification by NEBB.
- C. Test Equipment Criteria: The basic instrumentation requirements and accuracy/calibration required by AABC, National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
- D. All testing and balancing contractors are to be approved by the Design Professional before bidding. The contractors approved to date are:
 - 1. Environmental Systems Analysis, Inc.
Madison, Wisconsin
(608)221-8817
 - 2. Badger Balancing, LLC
Omro, Wisconsin
(920) 685-2300

1.5 JOB CONDITIONS

- A. Do not proceed with testing, adjusting and balancing work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed.
- B. Do not proceed until work scheduled for testing, adjusting and balancing is clean and free from debris, dirt and discarded building materials.

1.6 SUBMITTALS

- A. TAB Agency Qualifications: Submit names and qualifications of company officers and job supervisor. Submit list of proposed test equipment and sample report format indicating all measurements to be taken. These shall be submitted to and reviewed by Design Professional prior to commencing work.
- B. The test-and-balance report shall be complete with logs, data, and records as required herein. All logs, data, and records shall be typed on white bond paper and bound. The report shall be certified accurate and complete by the balancing agency's certified test-and-balance engineer.
- C. Submit electronic pdf file of the test-and-balance report to Design Professional.
- D. The report shall contain the required data in a format selected by Balancing Contractor.
- E. Report shall include the following information: (For all references to "design", specific information from shop drawings shall be incorporated.)
 - 1. Air Moving Equipment:
 - a. Location
 - b. Manufacturer and Model
 - c. Supply, return and exhaust, air flow, design and actual
 - d. Outside air flow, design and actual (where applicable)
 - e. Inlet, discharge, and total static pressure, design and actual
 - f. Full static pressure profile with measurements between all components through unit.
 - g. Fan RPM, design and actual
 - 2. Duct Traverse:
 - a. System zone/branch

- b. Duct size and area
- c. Velocity and airflow, design and actual
- d. Duct static pressure
- e. Air temperature and correction factor (if applicable)
- 3. Room Air Distribution Test Sheet:
 - a. Air terminal number
 - b. Room number/location
 - c. Terminal type and size
 - d. Area factor
 - e. Velocity, design and actual
 - f. Air flow, design and actual
 - g. Percent of design air flow
 - h. Air outlet differential pressure (for underfloor plenums)
- 4. Pump Data:
 - a. Identification/number
 - b. Manufacturer and model
 - c. Service
 - d. Flow rate, pressure drop, design and actual
 - e. Shut off, discharge, suction and total pressures
- 5. Electric Motors:
 - a. Manufacturer (1/4 hp and larger only)
 - b. HP/BHP, design and actual
 - c. Phase, voltage, amperage; design and actual
 - d. Service factor
 - e. Starter size, rating, heater elements (as applicable)

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

- A. Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jibs, and similar purposes.
 - 1. At Tester's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

PART 3 - EXECUTION

3.1 TESTING

- A. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable. Do not proceed with TAB work until unsatisfactory conditions have been corrected in manner acceptable to Tester. Before initiating balancing work, Contractor shall verify that systems are complete and operable. Ensure the following:
 - 1. Equipment is operable and in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Correct fan rotation.
 - 7. Volume dampers are in place and open.
 - 8. Coil fins have been cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage has been minimized.
 - 12. Correct pump rotation.

- B. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards.
- C. Coordinate TAB procedures with any phased construction completion requirements for the project. Systems serving completed phases of the project will require TAB for such phases prior to partial final inspections.
- D. Allow sufficient time in construction schedule for TAB and submission of reports prior to partial final inspections.
- E. Prepare report of test results, including instrumentation calibration reports, in format recommended by applicable standards. Draft report shall be sent to Design Professional for review prior to issuance to Owner.
- F. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.
- G. Mark equipment settings, including damper control positions, fan speed control levers, and similar controls and devices, to show final settings at completion of TAB work. Provide markings with paint or other suitable permanent identification materials.
- H. Prepare a report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced; including, where necessary, modifications which exceed requirements of contract documents for HVAC work.
- I. The test and balance agency shall perform the following tests and balance the air system in accordance with the following requirements (provide written substantiating data):
 - 1. Test, adjust and record all blower RPM at design requirements.
 - 2. Make pitot tube transverse of main supply ducts and obtain design CFM at all fans and blowers.
 - 3. Test and record all system static pressures, suction and discharge.
 - 4. Test and adjust all systems for design CFM of recirculated air.
 - 5. Test and adjust all systems for design CFM of outside air.
 - 6. Test and record entering and leaving air temperatures (DB and WB); all air units.
 - 7. Adjust all zones to proper design CFM, supply and return.
 - 8. Test and adjust each diffuser, grille and register within 10% design requirements.
 - 9. In reading and tests of diffusers, grilles and registers, include design velocity and final velocity, when required, and design CFM and final CFM after adjustments.
 - 10. In cooperation with the control manufacturer's representative, set adjustments of all controllers to operate as specified, indicated and/or noted.
 - 11. Flow Rate Tolerances:
 - a. Applications which do not require differential pressure control: -10% to +10%.
 - b. Minimum outside air: 0 to +10%
 - 12. Coordinate locations of volume dampers with the mechanical contractor as required to balance the entire system.
- J. The test and balance agency shall perform the following tests and balance the water system in accordance with the following requirements (provide written substantiating data):
 - 1. Before setting pump capacities, check the following items:
 - a. Cleanliness of system water
 - b. Check air vents at coils and high points of system
 - 2. Measure circulating pump capacities by differential pressure measurements, amperage and brake horsepower method using the pump manufacturer's capacity curve.
 - 3. Mark settings of all balancing cocks at required positions. Do not use service or shut-off valves for balancing unless indexed for balance point. For automatic flow control valves: Record differential pressure and verify within operating range of valve.
 - 4. Unless noted otherwise balance all domestic hot water circulation valves to 0.5 gpm.
- K. Where balancer has a question regarding appropriate system configuration for balancing, balancer should contact Design Professional for clarification.

END OF SECTION 23 05 93

SECTION 23 07 00
HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install insulation to all hot and cold surfaces of piping, ductwork, tanks, fittings and other surfaces as required by the drawings and this section.
- B. Insulation shall include insulating materials, jackets, adhesive, mastic coatings, tie wire and other materials as required to complete the insulating work.

1.3 DEFINITIONS

- A. Conditioned Space: an area inside the building which is heated and/or cooled.
- B. Tempered Space: an area inside the building which is not directly heated or cooled, but is adjacent to a heated or cooled space with no insulation separating the two spaces (e.g., ceiling plenums).
- C. Untempered Space: an area inside the building which is not conditioned and is not tempered (e.g., garage or garage attic spaces).
- D. Exterior: An area outside the building (e.g., roof mounted items).

1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Insulating materials, jackets, mastics, etc., shall meet flame spread and smoke developed ratings in accordance with NFPA-90A. Flame spread rating of not more than 25, smoke developed rating of not more than 50 as tested by ANSI/ASTM E84 (UL 723) (NFPA 255) method. All accessory items such as PVC jacketing and fittings, adhesive, mastic, cement tape and cloth shall have the same component ratings as specified above.
- B. Installation of insulation materials shall be in accordance to the latest edition of MICA/NIAC National Commercial & Industrial Standards for the appropriate material application.
- C. NFPA Compliance: Fire Barrier Duct Wrap systems shall meet requirements of NFPA 96 for grease duct application.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications and installation instructions for each type of HVAC insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each HVAC system requiring insulation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of products.
- B. Protect insulation against dirt, water, and chemical and HVAC damage. Do not install damaged insulation; remove from project site.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Insulating Materials
 - 1. Owens/Corning Fiberglass Corp.
 - 2. Armacell
 - 3. Pittsburgh Corning Corp.
 - 4. CertainTeed Corp.
 - 5. Knauf Fiber Glass
 - 6. John's-Manville Corp.
 - 7. Aeroflex

- B. Fire-stop Duct Wrap Systems
 - 1. Thermal Ceramics Fire Master
 - 2. Unifrax FyreWrap

- C. Mastics and adhesives as recommended by insulation manufacturer.

2.2 PIPE INSULATION

- A. Type 'A': Preformed sectional heavy density fiberglass insulation and factory applied vapor barrier, all service jacket with pressure sensitive self-sealing longitudinal laps and butt strips. Suitable for operating temperatures from 0 to +850 deg. F. Thermal conductivity shall be no greater than 0.23 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Water vapor permeance of .02 perms. Equal to Owens Corning 25 ASJ/SSL.

- B. Type 'B': Flexible elastomeric extruded pipe covering, 6 pound density, 0.27 K factor, water vapor permeance of 0.20 perms. Suitable for temperature from -40 deg. F to +220 deg. F. Equal to Armacell, AP Armaflex, joints sealed with adhesive as recommended by insulation manufacturer. Exposed outdoor insulation to be finished with two coats of ArmacellArmaflex WB Finish protective coating.

2.3 FITTING INSULATION

- A. Type 'A1': Fittings: Insulate with mitered segments of same insulating material as for adjacent pipe covering, or with pre-molded fiberglass wired in place and covered with all-service jacket or low smoke PVC fitting covers. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as for adjacent pipe covering, wired in place and covered with all-service jacket.

- B. Type 'B1': Fittings: Insulate fittings, valve bodies, strainer bodies, etc., with mitercut pipe insulation or sheet insulation of same material as pipe covering.

2.4 DUCT INSULATION

- A. Duct Covering: Johns Manville Microlite Standard or equivalent fiberglass duct wrap with factory applied Foil Scrim Kraft (FSK) vapor barrier jacket, 1.0 pound per cubic foot density.

- B. Fire-stop Duct Wrap System shall be of materials as follows:
 - 1. Type F2 Duct Covering: FyreWrap Elite 1.5 Duct Insulation, double-layer of 1.5" thick encapsulated wrap with aluminum foil fiberglass reinforced scrim covering. Meeting requirements of ASTM E-2336 for one- and two-hour rated commercial kitchen grease duct enclosure assemblies, ASTM E119, ASTM E814, ASTM E84, ASTM E136, and ASTM C518.

PART 3 - EXECUTION

3.1 GENERAL

- A. Use only experienced applicators regularly engaged in the trade. Rough work will be rejected. Application details shall be in accordance with the insulating materials supplier's recommendations except where a higher standard is specified. All surface finishes shall be extended in such a manner as to protect all raw edges, cuts and surfaces of insulation.
- B. All piping shall be insulated unless specifically noted otherwise. Piping not noted in the table below shall be insulated with thicknesses matching ASHRAE 90.1 based on the fluid temperatures.

3.2 PIPE INSULATION INSTALLATION

- A. Inspect all piping and equipment before applying insulation to insure the installing contractor has completed all leak tests, and that all surfaces are clean, dry and ready for application of insulation.
- B. Covering for pipes shall pass unbroken through hanger clevises, sleeves, etc. All details of covering for cold surfaces shall be such that continuous covering with unbroken vapor barrier and uncompressed insulation is provided as required to prevent condensation. The same covering and hanging detail shall be used for pipes connecting to vibrating equipment or carrying pulsating pressures to avoid metal contact between pipes and hangers.
- C. Use hydraulic insulating cement anywhere insulation fibers are exposed, to fill voids, and to repair damages to the factory applied vapor barrier. Finish with material matching or compatible with adjacent jacket material.

3.3 DUCT INSULATION APPLICATION

- A. Unless specifically indicated to not be insulated, all ductwork and accessories shall be either lined or covered. Duct systems not listed or without a type or thickness indicated on the plans shall be insulated with 1-1/2" wrap.

3.4 DUCT COVERING INSTALLATION

- A. Inspect all ductwork and equipment before applying insulation to ensure the installing contractor has completed all leak tests, and that all surfaces are clean, dry and ready for application of insulation.
- B. Covering shall be cut slightly longer than circumference of duct to insure full thickness at corners. All insulation shall be adhered with edges tightly banded and shall be adhered to duct with fire resistant adhesive. Adhesive shall be applied so that insulation conforms to duct surfaces uniformly and firmly.
- C. In addition to the adhesive, the insulation shall be additionally secured to the bottom of all ducts 18" or wider by means of grip nails and speed clips. The protruding ends of the pins shall be cut off flush after the speed clips have been applied. The vapor barrier facing shall be thoroughly sealed with a vapor barrier mastic and tape where the pins have pierced through.
- D. Insulation for "cold" ducts and accessories shall pass unbroken through hangers, sleeves, fire dampers, flexible connectors, reheat coils, etc. as required to prevent condensation. All details of covering for cold surfaces shall be such that continuous covering with unbroken vapor barrier and uncompressed insulation is provided. The same covering and hanging detail shall be used for ducts connecting to vibrating equipment or carrying pulsating pressures to avoid metal contact between ducts and hangers. Insulation Contractor shall be responsible for coordination with equipment suppliers as required to ensure continuous covering of unlined equipment components, i.e. VAV terminal unit supply collar and exposed reheat coil u-bends, fan coil unit discharge, etc.
- E. Insulation at all access points shall be fabricated in such a manner that it can be readily removed without damage to the insulation. Removable insulation shall have a vapor proof cover fabricated so as to allow it to be resealed to the equipment vapor barrier.

3.5 FIRE-BARRIER DUCT WRAP INSTALLATION

- A. Install duct wrap TYPE F2 fire-stop system as required to comply with ASTM E2336, NFPA 96 requirements for grease duct application, duct wrap system manufacturer’s written installation instructions and published drawings for products and applications indicated.
- B. Type F2: Install duct wrap fire-stop system in direct contact with the duct that it encloses. Protect every portion of duct with no less than 2 layers as required for grease duct applications. Install perimeter and longitudinal joints in accordance with manufacturer's requirements to meet ASTM E2336; systems requiring overlapping joints are not acceptable.
- C. Repair Procedure.
 - 1. Repair damaged duct wrap fire-stop system material in accordance with manufacturer's instructions.
 - 2. Remove damaged section. Apply a new section of the same dimension. Place and fit ensuring same overlap that existed previously. Place banding around new duct wrap fire-stop system material and tension to sufficiently hold in place. If damage has penetrated to interior layer, remove affected sections and reinstall as specified in 3.03 A.

3.7 PIPE INSULATION APPLICATION

<u>Service</u>	<u>Type Insulation and Thickness*</u>
Condensate drain lines**	Type A and A1: 1” thick for all pipe sizes.
Refrigeration piping**	Type B and B1: 3/4” and smaller – 3/4” thick 7/8” to 1-5/8” – 1” thick 2-1/8” and larger – 1-1/2” thick
* Insulation type and thickness indicated in table apply for all pipe materials. **For piping located in the garage or garage attic, increase thickness by 1/2” minimum.	

END OF SECTION 23 07 00

SECTION 23 09 00
BUILDING AUTOMATION SYSTEM (BAS)

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements Division 22 – Plumbing, Division 23 – HVAC, Division 26 – Electrical and Division 27 – Telecommunications.
- B. Coordination:
1. Coordination Required by BAS Contractor: The BAS Contractor shall provide all required information, material, direction and installation instructions to the designated contractor as required to allow this work to be completed in a timely/cost effective manner. This includes, but is not limited to, the following:
 - a. Coordinate with Sheet Metal Contractor prior to the submittal of ductwork shop drawings:
 - 1) Locations of all sensors, dampers, etc., ensuring accurate readings/operation and required access.
 - b. Coordinate with Testing and Balancing Contractor:
 - 1) Provide support and coordination with Testing and Balancing (TAB) Contractor for all interfaces between controls and TAB scope of work. Provide all devices and timely access to the BAS for TAB Contractor use in completing TAB procedures.
 - c. Coordinate with Electrical Contractor:
 - 1) Quantities and locations for line voltage power requirements for powering BAS panels and devices.
 - 2) If additional line voltage power is required for the operation of the BAS beyond the scope shown on the plans, it is the BAS Contractor's responsibility to provide the additional power; however, this work shall be performed by a qualified Electrical Contractor in accordance with the requirements of Division 26 specifications and included in the BAS Contractor's bid.
 - 3) Quantities and locations of additional junction boxes required for controls components installed in electrical wiring systems (e.g. current sensor, relays, etc.).
 - d. Coordinate with Telecom Contractor:
 - 1) Quantities and locations of information outlet(s).
 - 2) If additional information outlets are needed beyond the quantity shown on the plans, it is the BAS Contractor's responsibility to provide these additional outlets. This work shall be performed by a qualified Telecom Contractor in accordance with Division 27 specifications and included in the BAS Contractors bid.
 2. Work by Others: The following incidental work shall be furnished by the designated under the supervision of the BAS Contractor.
 - a. Sheet Metal Contractor shall:
 - 1) Install all automatic dampers furnished by the BAS Contractor. Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper actuators.
 - 2) Provide necessary blank-off plates or ductwork transitions required to install dampers that are smaller than the duct size.
 - 3) Provide access door or other approved means of access through ducts for service to control equipment.

1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish and install a complete fully functioning BAS including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification and on the plans. The BAS Contractor shall include all items not specifically itemized in these specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these specifications. The BAS shall be a complete system designed for use on Intranets and the Internet. Contractor shall be responsible for coordination with the Owner without disruption to any of the other activities taking place on that LAN.

- B. The BAS shall possess a fully modular architecture, permitting expansion in the future through additional controllers, sensors, actuators, etc.
- C. Manage and coordinate the BAS system work in a timely manner in consideration of the project schedule. Coordinate cooperatively with the associated work of other trades so as to assist the progress and not impede or delay the work of associated trades.

1.3 QUALIFICATIONS

- A. The control system shall be installed by competent control mechanics and electricians employed by the BAS Contractor. BAS Contractor is responsible for all work performed by their subcontractors.
- B. The BAS system shall be provided by a single source manufacturer offering a full line of controllers. This system shall be furnished, engineered, and installed by the manufacturer's local branch office or the manufacturer's locally authorized representative. BAS Contractor shall have factory trained technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.
- C. Control system components shall be the manufacturer's latest standard of design at the time of bid and in conformance with the following applicable standards for products specified.

1.4 QUALITY ASSURANCE

- A. The building automation system and components shall meet the following regulatory requirements:
 - 1. American Society for Testing and Materials, ASTM.
 - 2. Institute of Electrical and Electronic Engineers, IEEE.
 - 3. National Electrical Manufacturers Association, NEMA.
 - 4. Electronics Industries Alliance, EIA.
 - 5. National Fire Protection Association, NFPA.
 - 6. National Electrical Code, NEC.
 - 7. American Society of Heating, Refrigeration, and Air-Conditioning Engineers, ASHRAE, (ASHRAE Standard 135 The BACnet Standard).
 - 8. American National Standards Institute, ANSI (ANSI 568 Commercial Building Telecommunications Cabling Standard).
 - 9. Underwriters Laboratory, UL (UL 916 Energy Management Systems).
 - 10. FCC Regulation, Part 15.
 - 11. Local building codes.

1.5 SUBMITTALS

- A. The following shall be submitted for approval prior to commencing construction of the BAS:
 - 1. Contractor Qualifications: Document compliance with qualification requirements listed above. Include names, email addresses, and phone numbers of the project manager, primary programmer, electrical sub-contractor, and other team members.
 - 2. BAS Design Submittal, including:
 - a. A bookmarked PDF with bookmarks for each plan sheet with title and number, each schedule, and each product cut sheet with appropriate description.
 - b. A table of contents listing sheet titles and sheet numbers.
 - c. A floor plan showing the proposed locations of all network controllers.
 - d. BAS network architecture diagrams including all controllers, repeaters, gateways, interconnections, etc.
 - e. Schematics with accurate arrangement of devices as they relate to the equipment.
 - f. Sequences and points lists as intended to be installed and programmed. A direct copy of the sequences and points lists from the plans will not be acceptable.
 - g. Points schedule for each physical point shown on the schematics, including: tag, point type, system name and display units.

- h. Point-to-point wiring diagrams including start-stop arrangement for each piece of equipment, equipment interlocks, controller wiring terminal numbers and any special connection information required for properly controlling the HVAC equipment.
 - i. Controller schedule, including quantity, part number, description, and optional features.
 - j. Control damper schedule including a separate line for each damper and a column for each of the damper attributes, including: associated system, associated equipment, part number, fail position, damper type, damper operator, blade type, bearing type, seals, duct size, damper size, damper material, mounting, and actuator type.
 - k. Product cut sheets including manufacturer's catalog data describing each item of control equipment or component provided and installed for the project. Cut sheets shall include performance data as applicable (e.g. valve Cv, damper pressure drops, operating range, sensor accuracy, sensor units, sensor, sensor hysteresis, sensor stability, etc.).
- B. The following shall be submitted for approval a minimum of two months prior to substantial completion:
- 1. Floor plan graphics.
 - 2. One sample graphic of each different equipment arrangement included on the project. Graphics that are not identical (except for equipment labels) need to be submitted as separate graphics.

1.6 SOFTWARE LICENSES

- A. Provide required copies of all licenses for software, including software licenses on local workstations and software loaded or embedded into controllers or other network devices. BAS licensing shall allow for unlimited access to the system; no restrictions shall be placed on the licensing. All software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.

1.7 CLOSEOUT REQUIREMENTS

- A. Within one month prior to project substantial completion, calibrate all specialty gas sensors and generate calibration reports. Turn over all calibration kits to the Owner.
- B. Provide instructions on how to calibrate all sensors on the project. If a sensor cannot be field recalibrated but has the ability for replacement calibrated parts, include a source for obtaining the replacement parts.
- C. Refer to 23 0010 for Operation and Maintenance (O&M) and Owner training requirements. All products and devices installed shall be included in the O&M manual. Include the following:
 - 1. Manufacturer's catalog data and specifications on sensors, transmitters, controllers, damper actuators, gauges, indicators, terminals, and any miscellaneous components used in the system.
 - 2. A copy of all device calibration reports and certifications (e.g. NIST).
 - 3. An operator's manual which will include detailed instructions for all operations of the system.
 - 4. Operating and maintenance cautions and instructions.
 - 5. An operator's reference table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.
 - 6. Flow charts of the overall system configuration.
 - 7. Complete program listing file and parameter listing file for all programs.
 - 8. A copy of all software licenses.
 - 9. A copy of the warranty.
 - 10. Recommended spare parts list.
- D. Provide as-built documentation in the same format as the BAS Design Submittal, updated with all revisions and as-built conditions. Place a digital copy with a link from the BAS to the final as-built documentation. Also include a PDF copy on the operator workstation, if provided. As-builts shall be submitted after the system demonstration has been performed. Include a copy of the as-built point-to-point wiring diagrams and final programmed sequence inside each control panel enclosure. Also indicate exact installed locations on the floor plans for the following:
 - 1. All network controllers
 - 2. Outdoor air temperature sensor

- E. Provide a warranty on the entire system, including software, hardware, and labor. Refer to 23 0010 for warranty requirements.
 - 1. In the last month of the warranty period, all BAS software and controller firmware, software, drivers, etc., shall be upgraded and validated to the latest release (version) in effect at the end of the warranty period.
 - 2. At the end of the warranty period, the final version of all BAS software and programming shall be fully backed up on external storage device(s) (e.g. CD, USB drive, etc.). Include all software licenses. Turn the external storage device over to the Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, acceptable vendors are as follows:
 - 1. CBRE|ESI
 - 2. Mechanical Technologies, Inc. (MTI)
 - 3. J.F. Ahern

2.2 SYSTEM ARCHITECTURE

- A. The building shall integrate into the Owner's existing central Niagara N4 system.
- B. The complete electronic BAS system may be comprised of the following levels of control devices.
 - 1. Virtual Central File Server (existing) shall store all data required by the system and be permanently connected to the network.
 - 2. Network Controller(s) are used for high level global programming functions and system networking.
 - 3. Local Controllers are for control of large primary HVAC systems such as air handling systems, heating hot water systems and chilled water systems.
 - 4. Application Specific Controllers are dedicated for specific equipment such as VAV boxes, fan coils, and heat pumps.
 - 5. Repeaters are used for communication signal enhancement along the Tier 2 network.
 - 6. Gateways are used to allow communication between two different communication protocols.
 - 7. Network thermostats dedicated to specific equipment such as VAV boxes, fan coils, or heat pumps, etc.
 - 8. Field devices include, but are not limited to, electronic sensors, valves, actuators, switches, relays, and transducers.
 - 9. Tier 1 level network is the main backbone of the system and shall be an Ethernet Local Area Network (LAN). All network controllers, the Operator Workstation, and the Central File Server shall be connected directly to this network without the need for gateway devices.
 - 10. Tier 2 level networks are the communication busses managed by the network controllers. Local Controllers and Application Specific Controllers shall reside on a Tier 2 communication bus without any third-party controllers. All third-party controllers shall reside on a Tier 2 communication bus dedicated to third-party controllers.
- C. Data throughout any level of the network shall be available to and accessible by all other devices, controllers, the Central File Server, and the Operator Workstation.
- D. Interruptions or faults at any point on the network shall not interrupt communications between other nodes on the network.
- E. The BAS network shall support both copper and optical fiber communication media.
- F. All line drivers, repeaters, signal conditioners, etc., shall be provided as necessary for proper data communication.
- G. The system shall use the same application programming language for all levels.

- H. The system shall be configured as a distributed processing network(s) capable and shall be scalable and expandable at all levels of the system using the same software interface and the same types of controllers. Systems that require replacement of either the workstation software or any controllers to expand the system shall not be acceptable.

2.3 OPERATOR INTERFACE

- A. General: The BAS operator interface shall be user friendly, readily understood and shall make maximum use of colors, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the BAS system by authorized users at the Operator Interface. The operator interface shall be an expansion of the Owner's existing interface and consist of all capabilities currently utilized by the Owner.
- B. Alarms: Alarms shall be routed directly from network controllers to the operator workstation and/or servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the operator interface software shall, at the minimum, provide the following functions:
 - 1. The BAS shall annunciate diagnostic alarms, at a minimum, indicating system failure, individual controller failure, individual component failure, and non-normal operating conditions.
 - 2. Any attribute of any object in the system may be designated to report an alarm.
 - 3. Log date and time of alarm occurrence.
 - 4. Generate a "pop-up" window, with audible alarm, informing a user that an alarm has been received.
 - 5. Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
 - 6. Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
 - 7. Provide the ability to direct alarms to an e-mail address or phone number via text message. This must be provided in addition to the pop up window described above. Systems which use e-mail and/or text messaging as the exclusive means of annunciating alarms are not acceptable.
- C. Reports: Reports shall be generated and directed to one or more of the following: operator interface displays or an archive at the user's option. As a minimum, the system shall provide the following reports:
 - 1. All points in the BAS system.
 - 2. All points in each BAS application.
 - 3. All points locked out or overridden in a BAS application.
 - 4. All points currently in alarm in a BAS application.
 - 5. All BAS schedules.
 - 6. All user defined and adjustable variables, schedules, interlocks, etc.
 - 7. BAS diagnostic and system status reports.
- D. Navigation Tree: The system shall have an intuitive and easy to navigate collapsible and expandable navigation tree. Requirements of the navigation tree shall include:
 - 1. A dedicated folder where links to all graphics are located. In systems with many different graphics, locate similar equipment graphics in a sub-folder (e.g. VAVs for Level 1 in a sub-folder).
 - 2. A grouping of all systems/equipment/points by the network controller and communication bus it resides on. All systems and equipment shall match the names indicated on the plans.
 - 3. A minimum of 5 collapsible and expandable levels.
 - 4. Links to long-term trends.
 - 5. Links to all alarms and alarm history logs.
 - 6. Ability for the operator to customize the navigation tree by defining groupings and adding any systems or points to those groups and modifying the order of groups.
 - 7. Ability for groups to be located within other groups.
 - 8. Ability to rename any group, system, or point in the navigation tree.

- E. Dynamic Color Graphics: The system shall allow for the creation of user defined, color graphic displays for the viewing of HVAC, systems, electrical systems, building schematics, etc. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition, users with the appropriate security level shall be able to command equipment or change setpoints from a graphic through the use of the mouse. Requirements of the color graphic subsystem include:
1. An unlimited number of graphic displays shall be able to be generated and executed.
 2. Graphics shall be based on vectorized technology and HTML5 programming language. Rasterized graphics and Java programming language are not acceptable.
 3. Values of real time attributes displayed on the graphics shall be dynamic and updated on the displays.
 4. The graphic displays shall be able to display and provide animation based on real-time BAS data that is acquired, derived, or entered.
 5. Users with the appropriate security level shall be able to change values (setpoints) and states in system controlled equipment directly from the graphic display.
 6. Provide a graphic editing tool that allows users with the appropriate security level to create and edit graphic files. It shall be possible to edit the graphics directly while they are on line, or at an off line location for later downloading to the controller.
 7. BAS system shall be provided with a complete user expandable symbol library containing all of the basic symbols used to represent typical system components. Implementing these symbols in a graphic shall involve dragging and dropping them from the library to the graphic.
 8. The following graphics, at a minimum, shall be provided:
 - a. Floor plan graphics showing all as constructed room numbers, zoning boundaries, zone level space sensors readings (temperature, occupancy, CO₂, CO, etc.) and indicate accurate locations of the sensors. The floor plan graphics shall also show the as constructed location and name of all network controllers.
 - 1) All readings shall be color coded to indicate the deviation from current set point and a legend describing the colors and associated deviation scale.
 - 2) Any readings in an alarm shall flash on the graphic.
 - 3) All zones shall include a link to the zone level equipment graphic page.
 - b. A graphic screen for all equipment connected to the BAS system. At a minimum, all points listed in the minimum points list on the plans shall be visible on the graphic screen.
 - 1) Include a separate graphic screen for every individual piece of equipment. Where two or more pieces of equipment are redundant (e.g. system pumps), they may reside on the same graphic screen.
 - 2) Where a reset or staging schedule is required, include the details of the reset schedule and staging schedule on the graphics. Indicate the current set point or stage as calculated by the reset or staging schedule.
 - 3) Where a software button is required by the sequence, include the software button on the graphic.
 - 4) All software points listed on the plans shall also be included on the graphic.
 - c. Where redundant equipment is set up as lead/lag, the graphic screen shall include the ability for the user to switch the lead/lag positions.
- F. Schedules: It shall be possible to configure and download all schedules within the BAS from the operator interface.
1. The system shall provide multiple schedule input forms for automatic BAS time-of-day scheduling and override scheduling of BAS operations. At a minimum, the following spreadsheet types shall be accommodated:
 - a. Weekly schedules.
 - b. Monthly schedules.
 - c. Special "Only active if today is a holiday" schedules.
 - d. Temporary override schedules.
 2. Schedules shall be provided for each individual piece of equipment. Similar equipment on the same system shall also be able to be scheduled globally. For example, All VAVs on an AHU system shall be able to have the same schedule as the AHU or their own individual schedule for each VAV. Each schedule shall include all output points residing within the system. Each point may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.

3. Monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.
- G. Power failure and automatic restart:
1. Provide for the automatic, orderly and predefined shutdown of parts or all of the BAS following total loss of power to parts or all of the BAS.
 2. Provide for the automatic, orderly and predefined startup and return to normal control of parts or all of the BAS following total loss of power to those parts or all of the BAS. Archive and annunciate time and details of restoration.
 3. Maintain the operation of the BAS real-time clock during periods of power outage for a minimum of 72 hours.
- H. Historical trending and data collection: Trend and store point data as indicated on the plans. Long-term data collection can be stored locally if memory allows or offloaded to a separate system server or hard drive. Data shall be capable of being exported in a .csv, .xls or .xlsx format or other acceptable formats for custom queries and reports using industry standard software analysis tools.
1. Trend shall be capable of recording as raw data or data that is filtered where specified to be filtered before recording by the following typical filter types:
 - a. Average value.
 - b. Maximum value.
 - c. Minimum value.
 - d. Change of value (COV).
 - e. Change of state (COS).
 - f. Range – difference between minimum and maximum values.
 2. The software shall be able to perform the following functions on a set of user selected data:
 - a. Standard deviation.
 - b. Sum of all values.
 - c. Variance.
 3. Trends shall be able to be displayed in a table or graphical format. Trends shall be able to be saved in the navigation tree for future reference. The graphical display shall have the following capabilities:
 - a. Displaying multiple trends of any user selected points on one graph.
 - b. Adjust both the x-axis and y-axis scales.
 - c. Utilize multiple y-axes with unique scales and assign trends to either axis at the user's choosing.
 - d. Change trend colors, line types, and line weights.
 - e. Change display of trends between analog values and binary. Binary displays shall have the option to be displayed as a square wave.
- I. Point naming conventions and abbreviations shall be consistent with the plans and be consistent between all systems and equipment.

2.4 NETWORK CONTROLLERS

- A. General: The network controller shall be a microprocessor based, multi-tasking real time system controller that provides advanced system programming, uplink and downlink communications, polling and other supervisory functions for local and application specific controllers.
- B. Each network controller shall be classified as a BACnet compatible device, supporting the BACnet Building Controller (B-BC) profile. Controllers that support a lesser profile such as B-AAC, B-ASC, or B-SA are not acceptable. Network controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-BC).
- C. Hardware Specifications
1. Operating Environment: The controller shall be capable of operating in an environment of 32 to 122 deg F and 10 to 90% relative humidity non-condensing.

2. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory. If the controller does not have the required built-in memory capacity, a separate data storage device shall be provided.
3. Communication Ports: Each network controller shall provide communication to both the Operator Workstation(s) and the field buses. An on-board Ethernet port shall be provided.
4. Stand-Alone: The controller shall be a true no-host system that does not require a PC or "Host" computer to perform any control functions or communications.
5. Modular Expandability: The system shall employ a modular input/output (I/O) design to allow easy expansion. Input and output capacity is to be provided through plug-in modules. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
6. Real Time Clock (RTC): Each network controller shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day of week, day, month, and year. The system shall automatically correct for daylight savings time and leap years.
7. Power Supply: The power supply for the network controller shall be auto sensing, 120 VAC, 60 Hz power, with a tolerance of +/- 20%. Line voltage below the operating range of the system shall be considered a power outage. The controller shall contain over voltage surge protection and require no external AC power signal conditioning.
 - a. Automatic Restart After Power Failure: Upon restoration of power after an outage, the network controller shall automatically and without human intervention: update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
 - b. Battery backup: The network controller shall include an on-board battery to back up the controller's RAM. The battery shall have a shelf life of over 5 years and provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the network controller shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the network controller shall restart itself from its application program stored in its FLASH memory.
8. Field communication ports shall be individually electrically isolated to protect against transients, spikes, and power surges. The ports shall be optically isolated from each other, the controller circuit board and from power wiring. Optical isolation shall be provided either as an integral component to the controller or provided as a separate interface device between the controller and field wiring.
9. Failure of any network controller shall register as an alarm in the BAS.

D. Network Controller Software

1. General: The network controller shall contain FLASH memory to store both the resident operating system and the application software. There will be no restrictions placed on the type of application programs in the system. Each network controller shall be capable of parallel processing and executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
2. Passwords: User access to the controller shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level (minimum of 4 levels) and partitionable to accommodate the varied access requirements of different user groups. Provide the means to define unique access privileges for each individual authorized user. Also provide the means to establish general password groups to which an individual will then be assigned. Once assigned to the group each individual will assume all the capabilities and restrictions of that group. Provide the means to manage individual user password and access privileges under the control of a master password.
3. Login: A user definable login message shall be displayed every time the workstation is connected to a system controller.
4. User Programming Language: The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings. Controllers that use a "canned" program method will not be accepted.

5. Help Menu: On-line location sensitive help shall be provided for each menu item, describing the consequences of making the highlighted menu selection.
Programming Functions: The software blocks shall provide all the necessary mathematics, logic, utility, and control functions necessary for proper sequence of control. These functions shall be contained in the network controller operating system to be available in any combination for field programming the unit through RAM memory.
 - a. Proportional, Integral plus Derivative Control (PID)
 - b. Self-tuning PID
 - c. Two position control
 - d. Digital filter
 - e. Ratio calculator
 - f. Equipment cycling protection
7. Energy Management Applications: As a minimum, the network controller shall have the ability to, but not be limited to, perform energy management strategies such as:
 - a. Time or event based scheduling
 - b. Calendar/holiday based scheduling
 - c. Temporary schedule overrides
 - d. Adaptive optimum start/stop
 - e. Chiller and boiler reset/optimization
 - f. Demand limiting/load shedding
 - g. Enthalpy switchover (economizer)
 - h. Temperature compensated duty cycling
 - i. CFM tracking
 - j. Temperature or pressure reset
 - k. Run time totalization
 - l. Alarm detection and dial out or email out
 - m. Night setback
 - n. Historical trending
8. Alarms: The network controller shall be capable of comparing analog and digital readings to predetermined high and low limits and annunciate each time a value enters or returns from an alarm condition. Unique high and low limits shall be supplied for each analog point in the network. The network shall be capable of suppressing selected alarm reporting when the primary equipment from which the alarm point is based is in the inactive state. The alarm features of the system controller software shall, as a minimum, provide the following:
 - a. Digital, analog, and hi/low settings and deadband
 - b. Sliding alarm limits
 - c. Conditional alarming
 - d. Alarm inhibiting through feedback loop
 - e. Fluttering alarm suppression
 - f. Separate tailored alarm messages of 70 characters each
 - g. Auto dial of any user selected alarm condition to a minimum of 25 telephone numbers
 - h. Auto email of any user selected alarm condition to a minimum of 25 email addresses
9. Trending: Each network controller shall have the capability to simultaneously trend a minimum of 60 combined points. Adjustable sampling intervals for each trend from 30 seconds to one day or on change of value/state shall be possible. Each trend shall be capable of being automatically started or stopped, based on time of day, externally sensed points, alarms, or a calculated value. Upload of trend data to the operator workstation or other memory storage device shall be automatically performed at any time during the sampling period. The uploaded trend data shall be fully compatible with Microsoft Excel.
10. On-Line Testing: The network shall have the capability to allow the operator to design, test, and implement desired control strategies on-line.
11. Communication Diagnostics: The network controller software shall be capable of self-diagnosing failure automatically without necessary query by the operator. In the event of communications failure or limited power failure, the network shall be capable of both notifying a local operator of the specific occurrence, as well as communicating to a remote operator, either by the internet or auto dialing/emailing the condition. In addition to automatic self-diagnostics, each network controller shall maintain communications statistics on local and application specific controller communications. These statistics shall tabulate total communications attempted versus successful and unsuccessful communications by unit number. An option shall exist to reset communications statistics to zero (0) at any time.

2.5 LOCAL CONTROLLERS

- A. General: Each HVAC local controller shall be a stand-alone BAS controller. The local controllers shall be a local control loop microprocessor-based controller installed at each HVAC system (e.g. energy recovery unit). Each controller shall be fully programmable, contain its own control programs and will continue to operate in the event of a failure or communication loss to its associated network controller.
- B. Each local controller provided must be a BACnet device, supporting the BACnet Advanced Application Controller (B-AAC) profile. Controllers that support a lesser profile such as B-ASC or B-SA are not acceptable. Local controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controller(B-AAC).
- C. Hardware:
1. Operating Environment: The controller shall be capable of operating in an environment of 32 to 122 deg F and 10 to 90% relative humidity non-condensing.
 2. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application plus required history logging. All controllers with volatile memory shall have a battery-backup for a minimum of 72 hours. Each controller shall be addressable by a workstation or laptop.
 3. Isolation: Control, communication, and power circuits for each controller shall be individually electrically isolated to protect against transients, spikes, and power surges.
 4. Input/Output Modules: Provide with at least the minimum quantity of inputs and outputs as required by the sequence of operations and points list.
 - a. Analog inputs shall accept industry standard analog signals (4-20 mA, 0-5 VDC, 0-10 VDC, etc.).
 - b. Binary inputs shall detect contact closures.
 - c. Universal inputs shall have functionality as either an analog or binary input.
 - d. Digital outputs may be latched or momentary contact type.
 - e. Analog outputs shall have a 1% resolution over total output span of 100%.
 - f. Configurable outputs shall have functionality as either an analog or binary output.
 5. Expandability: Provide input and output expansion capability through the use of plug-in modules. At least two I/O expansion modules must be capable of being added to the base local controller.
- D. Software: Provide complete controller software to execute all HVAC system local loop controls functions.
1. Control Parameters: The software blocks in the local controller shall produce all of the necessary reverse acting and/or direct acting PI signals as required by the control sequence. The proportional and integral values which make up the PI output value shall be readable and modifiable, at the system workstation or the portable service tool to facilitate tuning of control loops.
 2. Networking: Each input, output, or calculation result shall be capable of being assigned to the system controller for system networking. The local controller shall also provide the ability to download and upload configuration data, both locally at the controller and via the BAS communications network.
 3. Scan: Controller shall continuously scan and maintain the most recent data in RAM for retrieval by a network controller, operator interface, and by the local controller software programs.
 4. Database: All field control databases shall be entered, changed or downloaded to the local controllers via a laptop or operator workstation.
 5. Auto-Calibration: All inputs shall feature an auto-calibrate function to eliminate sensing errors.
 6. Memory: Provide amount of memory required to store data until it is sent to the network controller.
 7. Programming Functions: Provide the following standard BAS loop programming functions:
 - a. Control block programming
 - b. PI or PID control
 - c. Serial load staging
 - d. Binary load staging
 - e. Analog load staging
 - f. Master-submaster routines
 - g. Anti-windup for integrated loops
 8. Real Time Clock (RTC): All local controllers shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each local controller shall receive a signal, every hour, over the network from the network controller, which synchronizes all local controllers' real time clocks.

E. Failure Operation:

1. Automatic Restart After Power Failure: Upon restoration of power after an outage, the controller shall automatically and without human intervention: update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
2. Stand-Alone Operation During Network Communication Failure: Controllers requiring the application or database to be downloaded from a host or share processing with a network controller shall not be acceptable. During a communication failure the application specific controller must run the control application using the current setpoints and configuration.
3. Failure of any local controller shall register as an alarm in the BAS.

2.6 APPLICATION SPECIFIC CONTROLLERS

A. General: Each HVAC application specific controller shall be a stand-alone BAS controller. The controller shall include all hardware and software required for communications with the network controller. Unless noted otherwise, an individual application specific controller shall be dedicated for each terminal device.

B. Each application specific controller provided must be a BACnet device, supporting the BACnet Application Specific Controller (B-ASC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. Local controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Application Specific Controllers (B-ASC).

C. Hardware:

1. Operating Environment: The controller shall be capable of operating in an environment of 32 to 122 deg F and 10 to 90% relative humidity non-condensing.
2. Input/Output Modules: Provide with at least the minimum quantity of inputs and outputs as required by the sequence of operations and points list.
 - a. Analog inputs shall accept industry standard analog signals (4-20 mA, 0-5 VDC, 0-10 VDC, etc.).
 - b. Binary inputs shall detect contact closures.
 - c. Universal inputs shall have functionality as either an analog or binary input.
 - d. Digital outputs may be latched or momentary contact type.
 - e. Analog outputs shall have a 1% resolution over total output span of 100%.
 - f. Configurable outputs shall have functionality as either an analog or binary output.
3. Expandability: Provide input and output expansion capability through the use of plug-in modules. Where additional inputs or outputs are required for the specified application, provide the expansion module with the application specific controller.

D. Software:

1. Programming: The control program shall reside in the application specific controller. The application program shall be maintained in read only memory (ROM). The default database, i.e. setpoints and configuration information, shall be stored in electrically erasable programmable read-only memory (EEPROM). Controllers requiring local setting of potentiometers or dip switches are not acceptable for programming functions. Dip switches for creating unique addresses for controllers are acceptable.
2. Auto-Calibration: All inputs shall feature an auto-calibrate function to eliminate sensing errors.

E. Failure Operation:

1. Automatic Restart After Power Failure: Upon restoration of power after an outage, the controller shall automatically and without human intervention: update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
2. Stand-Alone Operation During Network Communication Failure: Controllers requiring the application or database to be downloaded from a host or share processing with a network controller shall not be acceptable. During a communication failure the application specific controller must run the control application using the current setpoints and configuration.
3. Failure of any application specific controller shall register as an alarm in the BAS.

2.7 REPEATERS AND SIGNAL CONDITIONERS

- A. Provide a repeaters and signal conditioners at locations in the controls network where required.

2.8 GATEWAYS

- A. Provide a gateway at all points of connections of dissimilar controls networks/protocols. The gateway shall permit the exchange of all specified and required information between the two dissimilar networks/protocols.

2.9 FIELD DEVICES

- A. Multi-Purpose Sensors:

- 1. All multi-purpose or combination sensors shall meet all requirements listed below for the individual sensors that are being combined into one unit.
- 2. Sensors are only allowed to be combined if shown in the exact same location on the controls schematics, HVAC plans, or elevations with no components between them.

- B. Temperature Sensors:

- 1. General:
 - a. All temperature devices shall use precision thermistors or RTD sensors accurate to +/- 1 degree F over a range of -30 to 230 degrees F, unless indicated otherwise.
- 2. Space Sensors and/or Thermostats:
 - b. Sensors shall be available in an off-white ventilated enclosure, unless noted otherwise on the plans. Sensor shall be able to be mounted on a standard electrical box.
 - c. Where indicated on the plans, the sensor housing shall feature both a mechanism for adjusting the space temperature set point and/or a push button for selecting after hours occupied operation.
 - d. Where indicated on the plans, the sensor shall incorporate either an LED or LCD display for viewing the space temperature, set point, and other operator selectable parameters. Using built in buttons, operators shall be able to adjust set points directly from the sensor. Resolution shall be as indicated on the plans.
 - e. Minimum sensing range shall be 32 to 100 deg. If a space is being controlled to a set point outside of this range, then a sensor appropriate for the application shall be provided.
- 3. Duct Sensors: Sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Wiring shall terminate in a galvanized steel box at the end of the probe, except where wiring factory provided wiring can be connected to a controller without additional wiring. Probe style duct sensors are required in air handling applications where the coil or duct area is less than 14 square feet.
 - a. For duct widths 12" or less, use a minimum 4" probe.
 - b. For duct widths between 13" and 24", use a minimum 8" probe.
 - c. For duct widths larger than 24", use a minimum 12" probe.
- 4. Outdoor Air Sensors: Provide with weather shield to protect against solar radiation and precipitation with multiple discs/shields over the probe to allow for good airflow and accurate readings even if mounted in direct sunlight. Minimum sensing range shall be from -40 to 140 deg F.

- C. Specialty Gas Detection:

- 1. All specialty gas detection components shall be manufactured by one of the following:
 - a. Quatrosense Environmental, Ltd. (QEL)
- 2. Carbon Monoxide (CO) Sensors:
 - a. Model: QEL Q5 Series
 - b. Sensing Technology: Electrochemical.
 - c. Range: 0 – 250 ppm.
 - d. Detection Range: 50 ft radius.
 - e. Enclosure: Waterproof with hinged door, LCD display, and audible alarm.
- 3. Nitrogen Dioxide (NO2) Sensors:
 - a. Model: QEL Q5 Series
 - b. Sensing Technology: Electrochemical.

- c. Range: 0 – 10 ppm.
- d. Detection Range: 50 ft radius.
- e. Enclosure: Waterproof with hinged door, LCD display, and audible alarm.

D. Control Dampers:

- 1. Damper frames are to be constructed of minimum 13 gauge metal with linkage concealed in the side channel. Provide with compressible spring stainless steel side seals and self-lubricating bearings.
- 2. Damper blade width shall not exceed 8 inches and the blade length shall not exceed 48 inches. Damper blades shall have an airfoil profile to minimize pressure drop through the damper. Seals shall be butyl-rubber or EPDM and are required at the ends of the blades.
- 3. Provide opposed blade dampers for modulating applications and parallel blade for two-position control.
- 4. Damper shall be constructed of the same material as the duct in which it will be installed, except as noted below:
 - a. Dampers in exhaust or outdoor air ducts shall be aluminum.
- 5. Dampers in exhaust or outdoor air ducts shall have insulated blades and completely thermally broken construction.
- 6. Where damper shafts penetrate the damper housing, it shall be sealed while allowing the free movement of the shaft without breaking the seal.
- 7. Damper shall be ultra-low leakage rated as Class 1A at 1" w.c. and Class 1 at 4" w.c. as defined by AMCA 500.
- 8. Dampers that are indicated to close completely by the sequence of operations shall be provided with flanged connections.

E. Damper Actuators:

- 1. Actuators shall be electronic and shall be direct coupled over the shaft, without the need for connecting linkage.
- 2. Actuators shall have electronic overload circuitry to prevent damage.
- 3. Actuators shall be available with spring return to the normal position when required or as indicated on the plans.
- 4. Actuators shall have a position indicator for external indication of damper position.
- 5. Actuators shall have manual override capability without disconnecting damper linkage.
- 6. Actuators shall be quick opening or slow opening as required by the application.
- 7. Actuators shall be able to completely close the damper against system pressure.
- 8. Actuators shall be two-position or modulating as required by the sequence of operations.
- 9. Provide the appropriate quantity of damper actuators as required by the application.

F. Position Switches: Provide switch that can sense the full closed position and an adjustable open position between 10 and 100%.

G. Current Switches: Current status switches shall be used to monitor motors and other electrical loads as indicated on the plans. Current switches shall be available in solid and split core models and offer either a digital or an analog signal to the automation system. The sensing range of the sensor shall be appropriate for the device being monitored.

H. Audible and Visible Alarms: Horn shall be continuous tone with solid-state electric signal and red LED pilot light. Provide a separate silence button (refer to manual push buttons below) to be mounted at an accessible height. The light shall remain on and the alarm condition active even after the silence button is pressed until the alarm state is resolved.

I. Pilot Lights: Light shall be LED type with push-to-test function and have an oil-tight enclosure. The light shall be green when indicating normal operation and red when indicating an issue or alarm.

J. Manual Push Buttons: Button shall be round, approximately 3/4" in diameter. Provide with the quantity and type of contacts required for the application. Submit color options for selection by the Design Professional during submittal review.

K. Manual Switches: Provide line-voltage toggle switch appropriate for the application. Refer to Division 26.

2.10 CONTROL WIRING

- A. The term "control wiring" is defined to include providing of wire, conduit, junction boxes, and miscellaneous materials as required for mounting and connecting electric or electronic control devices and network communication devices.
- B. All control wiring and wiring connections required for the installation of the BAS system shall be provided by BAS Contractor unless specifically shown on the electrical or telecommunication drawings or called for in Division 26 or Division 27.
- C. All control wiring shall comply with the requirements of local and national electrical codes.
- D. Control wiring in ducts, air plenums, air moving equipment, and other air handling spaces shall be specifically listed for the use, including wiring provided with field devices.

PART 3 - EXECUTION

3.1 GENERAL

- A. Inspect and examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
- B. Install systems and materials in accordance with drawings and details, manufacturer's instructions, reviewed submittals, and contract documents. Install electrical components and use electrical products complying with requirements of applicable Division-26 sections of these specifications.

3.2 INSTALLATION OF CONTROLLERS

- A. Install controllers in accordance with manufacturer's installation instructions and with adequate clearance to allow for maintenance.
- B. Install all controllers in a NEMA 1 control panel enclosure.
- C. Label all control panel enclosures with the system or equipment served. Network controllers shall be labeled to indicate the general areas of the building served. All labels shall match the designations on the as-built drawings, which shall match the equipment tags on the plans.
- D. Include a copy of the as-built point-to-point wiring diagrams and final programmed sequence inside each control panel enclosure.

3.3 INSTALLATION OF FIELD DEVICES

- A. General:
 - 1. Install all field devices where indicated on the plans and in accordance with manufacturer's installation instructions and with adequate clearance to allow for proper operation, maintenance, and removal of the device.
 - 2. Repair duct insulation to maintain the integrity of the insulation vapor barrier. Use foil tape to repair damages to the factory applied vapor barrier.
 - 3. Where a field device penetrates a duct or air moving equipment, seal around the penetration to prevent air leakage.
- B. Room/Wall-mounted Sensors:
 - 1. Install at the elevation indicated on the plans.
 - 2. Install plastic guards over sensors with user adjustment where noted on the plans.
 - 3. Provide insulated back panel where sensors are located on the inside face of an exterior wall or on a column enclosure.

- C. Temperature Sensors:
 - 1. Outdoor Air Temperature Sensors: Install in the location shown on the plans. If not shown on the plans, contact the Design Professional.
- D. Specialty Gas Sensors (e.g. CO, NO₂, etc.)
 - 1. Top entry of conduit into the enclosure is not acceptable.
 - 2. Within one month prior to project substantial completion, calibrate all sensors. Provide calibration reports as part of the closeout documents.
- E. Current Switch: Adjust so that the set point is below the minimum operating current and above motor no load current.
- F. Wall-mounted Audible and Visible Alarms: Install device at 6'-8" above finished floor. Install silence button at 46" AFF and below the audible and visible alarm.
- G. Wall-mounted Push Buttons: Install at the elevation indicated on the plans.

3.4 INSTALLATION OF CONTROL WIRING

- A. The BAS Contractor may use the building telecommunications network for Tier 1 level communication between network controllers. The BAS Contractor shall utilize the data ports indicated specifically for BAS use on the telecommunications plans. If any additional or relocated data ports are required based on the BAS Contractor's system layout, the BAS Contractor shall hire the Telecommunications Contractor to provide the additional data ports at no cost to the Owner.
- B. Control wiring shall be routed in blue conduit in the following locations: concealed in walls, concealed above inaccessible ceilings, finished areas with exposed structure, inside air moving equipment or ductwork, locations subject to moisture, exterior locations, and in all unfinished spaces, such as mechanical rooms, electrical rooms, etc. Where conduit is in an exterior location or subject to moisture, it shall be rigid and sealed to be water tight. Control wiring shall not share conduit with line voltage wiring.
- C. Control wiring routed to devices in accessible locations may be routed in flexible conduit. The minimum size of the flexible conduit shall be 1/2" and the maximum length shall be 36".
- D. Control wiring concealed by accessible construction may be installed without conduit. Accessible locations include areas such as above accessible ceilings and in the attic. Control wiring shall not share cable tray with telecommunications wiring or raceways with any other trade. All wiring shall be neatly routed and tie-wrapped to structural components, supported at least every 4 feet. Excess wire shall be neatly coiled and secured to structure. Under no circumstances shall cable be supported by piping, conduit, ductwork, ceiling tile or ceiling support wires. Cable shall be neatly routed in line with building lines.
- E. Install all control wiring to meet all manufacturer installation requirements, including not exceeding the maximum cable length, tension, or bend radius. At all building expansion joints, provide means for movement of wiring and conduit that exceeds the expected movement of the building.
- F. Label or color code each control wire at each end. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color coded cable with cable diagrams may be used to accomplish cable identification.
- G. Provide interconnecting control wiring for the VRF system as required by the VRF manufacturer.
- H. Splices shall not be made in shielded wiring.

3.5 SYSTEM ACCEPTANCE

- A. System Verification and Testing Procedure: The BAS Contractor shall confirm the system is complete, including all controls installed, graphics complete, and software programs have been completely tested and exercised for proper equipment operation. BAS control panels shall be demonstrated via a functional end to end test such that:
1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their operation verified.
 2. All analog input channels shall be verified for proper operation.
 3. All binary input channels shall be verified by changing the state of the field device and observing the appropriate change of displayed value.
 4. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.
 5. Automatic control operation shall be verified by introducing an error into the system and observing the proper corrective system response.
 6. Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.
- B. Start-up and calibration of the specialty gas sensors shall be by the Supplier.
- C. System Demonstration: After the BAS Contractor has confirmed proper operation, acceptance testing will commence at a mutually agreeable time within ten (10) calendar days of the request. At that time, the BAS Contractor shall demonstrate the operation of the system to the Owner's Representative and Design Professional. Any issues are discovered during this demonstration shall be corrected.
- D. Operation and Maintenance Manuals: Submit copies of operation and maintenance manuals as required by this section and section 23 00 10 – HVAC General Provisions.

END OF SECTION 23 09 00

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.
 - 1. Extent of refrigerant and condensate drain piping work is indicated on drawings and schedules, and by requirements of this section.
 - 2. Insulation of refrigerant piping is specified in other Division-23 sections and is included as work of this section.
 - 3. Installation of valves for refrigerant piping system is specified in other Division-23 sections and is included as work of this section.

1.3 QUALITY ASSURANCE

- A. ANSI Code Compliance: Comply with applicable provisions of ANSI B31.5, "Refrigeration Piping", and extend applicable lower pressure limits to pressures below 15 psig.
- B. Safety Code Compliance: Comply with applicable portions of ANSI ASHRAE 15, "Safety Code for Mechanical Refrigeration".
- C. IMC Compliance: Fabricate and install refrigeration piping in accordance with "International Mechanical Code".

PART 2 - PRODUCTS

2.1 BASIC MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ANSI B31.5 "Code for Refrigeration Piping" where applicable, base pressure rating on refrigeration piping system's maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigeration piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.
- B. Piping Specialties: Refer to Section - 23 05 00 - Common Work Results for HVAC.
- C. Supports, Anchors and Seals: Refer to Section 23 05 29 - Hangers and Supports for HVAC Piping.

2.2 PIPE:

<u>Material</u>	<u>Service</u>
A. Copper refrigeration tube, soft temper. Type L-ACR. ASTM B280.	Refrigerant lines between heat recovery boxes and terminal units.
B. Copper refrigeration tube, hard temper. Type L-ACR. ASTM B280.	Refrigerant lines between condensing units and heat recovery boxes.

- C. Copper water tube, hard temper. Condensate drain lines, above slab.
ASTM B88.
- D. Polyvinyl Chloride (PVC), Schedule 40, DWV. Condensate drain lines, above slab.
ASTM D1785 and ASTM D2665.

2.3 FITTINGS:

- A. Copper refrigerant tubes:
 1. 3/4" and Smaller: Cast copper-alloy for flared copper tubes.
 2. 7/8" through 4 1/8': Wrought-copper, solder joints.
- B. Copper water tube cast bronze or wrought copper:
 1. Solder joint type. ANSI B16.18 and B16.22-63.
- C. PVC DWV pipe fittings: ASTM D2665 DWV Schedule 40 socket type. Provide fittings produced and recommended for the service indicated by manufacturer of tubing. Solvent cements as per ASTM 2564.

2.4 JOINTS

- A. Copper refrigerant tube:
 1. 3/4" and Smaller: Flared.
 2. 7/8" through 4 1/8': Soldered, silver-lead solder, ANSI/ASTM B 32, Grade 96 TS.
- B. Copper water tube:
 1. Use non-corrosive 95-5 tin-antimony solder, cut pipe square, clean, ream and polish tube ends and inner surfaces of fittings, apply flux and solder joint as recommended by manufacturer of solder type fittings.
- C. PVC DWV pipe: Solvent cement in accordance with ASTM D2564.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which refrigerant piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

- A. General: Install basic materials and products as required per manufacturer=s recommendations, ANSI B31.5 ACode for Refrigerant Piping" and as required to meet the intent of the documents.
- B. Refrigerant and Drain Piping
 1. Install pipe for all systems as indicated on drawings, as called for in other sections, and as specified herein.
 2. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other refrigerant items. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
 3. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage. Pitch piping in direction of oil return to compressor.

4. Check all piping for interference with other trades, avoid placing water pipes over electrical equipment.
 5. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.
 6. Drain piping shall be sloped a minimum of 1/8" per foot of horizontal piping.
- C. Piping Specialties: Refer to Section 23 05 00 - Common Work Results for HVAC.
- D. Supports, Anchors and Seals: Refer to Section 23 05 29 - Hangers and Supports for HVAC Piping.
- E. Install specialties and accessories as indicated on drawings and in accordance with manufacturer's recommendations and applicable codes and standards.
- F. Equipment Connections
1. General: Connect refrigerant piping system to refrigerant equipment as indicated and comply with equipment manufacturer's instructions where not otherwise indicated.
- G. Field Quality Control
1. Refrigerant Piping Leak Test: Prior to initial operation, test refrigerant piping with electronic leak detector. System must be entirely leak-free.
 2. Repair or replace refrigerant piping as required to eliminate leaks, and retest as specified to demonstrate compliance.

END OF SECTION 23 23 00

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to fabricate and erect ductwork as required by the drawings and this section.
- B. Low velocity ductwork shall apply to all ductwork.

1.3 DEFINITIONS

- A. Conditioned Space: An area inside the building which is heated and/or cooled.
- B. Tempered Space: an area inside the building which is not directly heated or cooled, but is adjacent to a heated or cooled space with no insulation separating the two spaces (e.g., ceiling plenums).
- C. Untempered Space: an area inside the building which is not conditioned and is not tempered (e.g., garage or garage attic spaces).
- D. Exterior: An area outside the building (e.g., roof mounted items).

1.4 QUALITY ASSURANCE

- A. Duct and plenum construction, metal gauges, reinforcing, methods of supporting and hanging and other sheet metal work as called for shall be in accordance with the following standards:
 - 1. "SMACNA HVAC Duct Construction Standards", most recent Edition, by the Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
- B. Unless noted otherwise, all ductwork shall be provided with pressure class and leakage class as indicated and scheduled on the plans. If pressure or seal class is not indicated, ductwork shall be provided to meet the pressure class based on the scheduled capacity of the equipment it is served by or connected to and with seal class A.
- C. NFPA Compliance: All liner and covering materials shall have maximum UL Flame Spread Index of 25, and maximum Smoke Developed Index of 50, and shall meet all requirements of NFPA-90A.

1.5 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit ¼" per foot scale shop fabrication shop drawings.
 - a. Shop drawings shall include locations of all control devices, including dampers, airflow measuring stations, sensors, etc. Coordinate locations with the BAS Contractor prior to submitting shop drawings. Shop drawings shall include the BAS Contractor's submittal review stamp prior to submitting to the Design Professional for review.
 - 2. Submit shop drawings of elbows and fittings showing static pressure loss charted for air quantities involved in each.

- B. Product Data: Submit manufacturer's specifications and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each mechanical system requiring insulation. Submit product data for each accessory/component for ducts/fittings including, but not limited to turning vanes, tie rods, sealants and balancing dampers.
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data in maintenance manual.
- D. Certifications: Submit certifications or other data as necessary to show compliance with these specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.6 REGULATORY REQUIREMENTS

- A. National Fire Protection Association, NFPA 90A: Air Conditioning and Ventilating Systems.
- B. Underwriter's Laboratories, UL 181: Factory-Made Duct Materials and Air Duct Connections.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect shop-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling.
 - 1. Stored materials subject to rejection due to damage.
- B. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of products.
- C. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged insulation; remove from project site.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. All sheet metal work shall be constructed of prime quality re-squared tight coat galvanized steel, except where other type material is specified. Manufacturer's name and U.S. gauge number shall appear on each sheet.
- B. Duct Lining Materials
 - 1. Certain-Teed
 - 2. Owens Corning Fiberglass
 - 3. Johns-Manville
 - 4. PPG
 - 5. Knauf

2.2 LOW VELOCITY DUCTWORK

- A. General: Provide factory-fabricated or shop fabricated duct and fittings.
- B. Materials:
 - 1. Galvanized sheet steel complying with ANSI/ASTM A527, lockforming quality, with ANSI/ASTM A525, G90 zinc coatings, mill phosphatized.
 - 2. Aluminum sheet complying with ASTM B 209 Alloy 3003, H14 temper with mill finish. Where ductwork is exposed and not designated to be painted, provide one-side bright finish.

- C. Gauge: Comply with code requirements for minimum gauge thickness for various sizes.
- D. Fittings:
 - 1. Construct branches, bends, and elbows with centerline radius of not less than duct 1.0 times the width (diameter), where space conditions will not permit this radius or where indicated on drawings, square elbows with air turns shall be used.
 - 2. Slopes for transitions or other changes in dimension shall be minimum 1:3.
 - 3. Longitudinal seams shall be Pittsburgh Lock or snaplock equal per SMACNA. Lateral seams shall be slip drive or standing. Slip seams and sheet metal screws not permitted.

2.3 PLENUMS

- A. Plenums shall be fabricated of same material as duct connecting to plenum; shall be two metal gauges heavier than gauge of largest duct connecting to plenum.

2.4 KITCHEN EXHAUST DUCTS

- A. General:
 - 1. Fabricate kitchen exhaust ducts and supports, used for smoke and vapor removal from cooking equipment, of 16 gauge minimum stainless steel where concealed, and of 18 gauge minimum stainless steel where exposed.
 - 2. For duct construction, comply with SMACNA "Low Pressure Duct Standards" – most recent Edition, and ANSI/NFPA 96 "vapor Removal from Commercial Cooking Equipment".
- B. All duct seams, joints, penetrations and duct to hood connections shall be made with a liquid tight continuous external weld or as required by NFPA 96.

2.5 LAUNDRY VENT DUCTS

- A. General:
 - 1. Fabricate laundry vent ducts and supports, used for venting of commercial or residential laundry dryers, of 22 gauge minimum aluminum. The male end of the duct at overlapped duct joints shall extend in the direction of airflow. Sheetmetal screws used for connecting sections of laundry vent may not extend more than 1/8" into the duct.
 - 2. Each vertical laundry vent riser shall be provided with a means of cleanout at the base.
 - 3. Duct shall terminate outside the building as shown on drawings. A backdraft damper shall be installed at the termination. No bird or insect screens shall be installed at the termination point.

2.6 DUCT SEALING – LOW VELOCITY

- A. All joints and seams shall be sealed with pressure sensitive fire resisting duct tape complying with UL-181A or UL-181-B (equal to Hardcast Foil Grip A.F.G. – 1402). (SMACNA pressure classes 1/2" - 6" w.g.).
- B. All joints in low velocity duct work shall be sealed with Foster 32-14 or DuctMate ProSeal. Apply and install joint sealer per manufacturer's recommendations. In general, apply to male end of coupling and/or interior of female fitting. After connection, brush sealant over the assembled joint and screws with a 2" to 3" wide band. Sealant shall be allowed to set for 48 hours before any air pressure is put on system. All tie bars, bolts and rivets shall be sealed with the specified sealant. Sealant as manufactured by 3M No. 800 or United Sheet Metal will be considered equal.
- C. Duct Sealing Requirements: SMACNA Seal Class A.

2.7 DUCT LINER

- A. Lining materials shall be Type 'A' Duct Liner, Certain-Teed Toughgard or equivalent, one and one half (1 1/2) pounds per cubic foot density or equal.

- B. Unless specifically indicated to not be insulated, all ductwork and accessories shall be either lined or wrapped. Duct systems not listed or without a type or thickness indicated on the plans shall be insulated with 1-1/2" wrap.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Assemble and install ductwork in accordance with recognized industry practices which will achieve airtight and quiet systems, capable of performing each indicated service.
 - 1. Install each run with minimum joints.
 - 2. Align ductwork accurately at connections and with internal surfaces smooth.
 - 3. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and prevent buckling and vibration.
- B. Ducts shall be installed following essentially lines indicated on drawings, install offsets, angles and transitions as may be required to avoid interferences with other work. Maintain full capacity of ducts at offsets, angles and transitions except where drawings indicate use of reducing or increasing transitions.
 - 1. General: Each duct section shall be rigidly supported from structure. Attach hangers to structure with expansion plugs, concrete inserts, beam clamps or other approved means. Rubber in-shear isolators shall be installed in hangers for all ducts in equipment rooms, to prevent vibration transmission to the structure.
- C. Install hangers and supports in accordance with SMACNA Standards general locations:
 - 1. Install hangers close to transverse joints of main ducts and branches, clinch collar branch connections and the first branch elbows after nested splits.
 - 2. Locate hangers of duct penetrating walls or partitions as though the walls will contribute no support to the duct.
 - 3. Install hangers in pairs on exact opposite sides of duct.
 - 4. Maintain hanger spacing intervals less than, equal to, but not greater than the specified maximums.
 - 5. Install hangers at the midpoint of small and medium size horizontal vaned square elbows. On wide vaned square elbows, install additional hangers at maximum allowable intervals or less measured along the heel lines of the elbows.
 - 6. Provide a set of hangers at the midpoint of small and medium size horizontal radius elbows. Install one or more supplementary hangers, as necessary, along the inside and outside arcs of large radius elbows of any angle whenever the lengths of these arcs exceed the maximum hanger spacing length for that particular size duct.
 - 7. Provide at least one set of hangers for short duct branches 3 feet or less in length.
 - 8. Provide each duct riser with a minimum of two supports completely spanning the shaft opening at each floor. One pair of supports may be used to support more than one duct riser, provided that the strength of the supports is increased appropriately and proper additional supplementary steel is used at the extra risers.
 - 9. Support duct risers, located between floors that are more than 15 feet high, at each floor and halfway points between floors. The distance between intermediate supports on very high floors should not exceed 12 feet. Intermediate hangers may be supported from an adjacent wall or hung by rods from supports on the floor above.
 - 10. Provide one or more sets of hangers for equipment in duct runs such as heating coils, heat pumps, etc., as recommended by their manufacturers.
 - 11. Hangers shall not be attached to metal roof deck.
- D. Locate duct hangers approximately:
 - 1. 2 to 24 inches from flexible connections of fans.
 - 2. 2 to 24 inches from the outlets or flexible connects of VAV control units or mixing boxes.
 - 3. 12 to 36 inches from the main duct to the first hanger of long branch ducts.
 - 4. 2 to 12 inches from the ends of all branch ducts and linear diffuser plenums.
 - 5. 2 to 24 inches from fire damper breakaway joints.

6. 0 inches to half the duct width plus 2 inches from the vertical centerline of the lower elbow of short vertical offsets made with vaned square elbows. The width refers to the dimension of the elbow in the plane of the turn.
 7. 0 inches to half the duct width plus 2 inches from the vertical centerline of the bottom and top elbows of vaned square elbow offsets over 8 feet high.
 8. One-eighth of the arc in from the ends of bottom and top radius elbows of vertical offsets longer than 8 feet. Short vertical offsets require hangers at the bottom elbow. Likewise, sloping offsets need at least one set of hangers at their lower radius elbow.
 9. 6 to 12 inches from transverse joints of ducts whose lengths are the same as specified hanger intervals.
 10. 6 to 12 inches from one side of walls or partitions penetrated by ducts.
- E. Maximum permitted hanger spacing:
1. Ducts with areas up to 4 square feet may have their hangers spaced up to 8 feet apart.
 2. Ducts with areas 4.1 to 10 square feet may have their hangers spaced not more than 6 feet apart.
 3. Ducts with areas over 10 square feet may have their hangers located up to 4 feet apart.
- F. Provide and install locking manual volume dampers in all duct systems as required for controlling air volumes to trunk ducts, branch ducts, outlets and inlets. Provide and install additional volume dampers as required by Testing and Balancing Contractor for balancing of system.
- G. All connections shall be sealed, including but not limited to branch connections, spin-ins, taps, access doors, access panels and connections to equipment. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage.
- H. Duct sizes shown on drawings are net inside dimensions and sheet metal size shall be increased to allow for duct linings.
- I. Install as indicated on the drawings all duct mounted equipment as specified in other sections.
- J. Install eccentric reducers with tops of both duct sizes flush to maintain maximum ceiling space below ducts.
- K. Openings:
1. Provide in ductwork to accommodate access doors, temperature control components and fire dampers.
 2. Install access panels for inspection and servicing of all duct mounted equipment including, but not limited to: reheat coils, sound attenuators, motorized dampers, airflow measuring stations, smoke and fire dampers.
 3. Provide pitot tube openings for testing of systems, complete with metal cap, with spring device or screw to ensure against air leakage.
 4. Where openings are provided in insulated ductwork, install insulation materials inside metal collar.
 5. For kitchen exhaust hood grease ductwork, provide cleanouts as required by code. Provide a cleanout at the inlet and outlet of in-line fans.
- L. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- M. Connections:
1. Connect duct to equipment with flexible fabric, sheet metal clips, screws and washers.
 2. At each point where ducts pass through partitions, provide sleeve with space between duct and sleeve packed with insulation and sealed.
- N. Where ducts pass through fire-rated walls, partitions, floors, and ceilings, seal openings in accordance with Specification Section 23 0 500 - Common Work Results for HVAC.

3.2 DUCT LINER APPLICATION

- A. Apply duct liner with coated or surface designed to be exposed facing the air stream and adhered with 100% coverage of fire retardant adhesive. When width exceeds 12" or height exceeds 24", additionally secure liner with mechanical fasteners spaced 12" maximum centers. Fasteners shall start within 3" of leading edge of traverse joints. Coat all exposed joints and edges of traverse joints with a fire retardant adhesive.
- B. Duct sizes shown on drawings are net inside dimensions and sheet metal size shall be increased to allow for duct lining.

3.3 ADJUSTING AND CLEANING

- A. Cleaning:
 - 1. Clean ductwork internally, as it is installed, of dust and debris.
 - 2. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or where ductwork is to be painted.
- B. Temporary Closure:
 - 1. At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation or that are on-site but not yet installed, provide temporary closure of polyethylene film or other covering until time connections are to be completed.

3.4 DUCT WORK TESTING – KITCHEN EXHAUST DUCTS

- A. Prior to the use or concealment of any portion of a grease duct system, a leakage test shall be performed in the presence of the code official. Ducts shall be considered to be concealed where installed in shafts or covered by coatings or wraps that prevent the ductwork from being visually inspected on all sides. The contractor shall be responsible to provide the necessary equipment and perform the grease duct leakage test. A light test or an approved equivalent test method shall be performed to determine that all welded and brazed joints are liquid tight. A light test shall be performed by passing a lamp having a power rating of not less than 100 watts through the entire section of ductwork to be tested. The lamp shall be open so as to emit light equally in all directions perpendicular to the duct walls.
- B. In The test shall be performed for the entire duct system, including the hood-to-duct connection. The ductwork shall be permitted to be tested in sections, provided that every joint is tested.

3.5 DUCTWORK APPLICATION SCHEDULE – LOW VELOCITY

<u>AIR SYSTEM</u>	<u>MATERIAL</u>
HVAC Supply, Return, Outdoor Air General Exhaust (where indicated on plans) Transfer	Steel, Galvanized
Clothes Dryer Exhaust Exhaust for high moisture areas (where indicated on plans)	Aluminum
Kitchen Grease Hood Exhaust	Stainless Steel, Welded

END OF SECTION 23 31 13

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

- A. Extent of duct accessories is indicated on drawings and by the requirements of this section.
- B. Types of duct accessories required for project include the following:
 - 1. Fire and Smoke Dampers
 - 2. Louvers
 - 3. Volume Dampers/Regulators
 - 4. Flexible Ducts
 - 5. Access Doors
 - 6. Duct-Mounted Filter Housings

1.03 QUALITY ASSURANCE

- A. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) "Fire Damper and Heat Stop Guide".
- B. Industry Standards: Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to construction of duct accessories, except as otherwise indicated.
- C. UL Compliance: Construct, test, and label fire dampers in accordance with Underwriters Laboratories (UL) Standard 555 "Fire Dampers and Ceiling Dampers".
- D. NFPA Compliance: Comply with applicable provisions of ANSI/NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of duct accessories.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical information for each type of duct accessory, including dimensions, capacities, materials of construction, installation instructions, interfacing requirements with ductwork, and method of fastening or support where applicable.
- B. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory; include this data in Maintenance Manual.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products manufactured by one of the following:
 - 1. Flexible Ductwork
 - a. Semco
 - b. Wiremold
 - c. Thermaflex
 - d. Valuflex

2. Louvers
 - a. American Warming & Ventilating
 - b. Pottorff
 - c. Greenheck
 - d. Ruskin
 - e. Louvers & Dampers
 - f. PennBarry
 - g. Air Balance
3. Duct Mounted Filter Housing and Filters
 - a. Flanders
 - b. American Air Filter Co., Inc.
 - c. Farr Co.
 - d. Airguard Industries

2.02 LOUVERS

A. Extruded Aluminum Louvers

1. Furnish and install extruded aluminum louvers as scheduled on the drawings.
2. Frames and blades shall be .081" thick 6063-T5 alloy extruded aluminum. Blades shall be drainable type. Jams shall be constructed with integral downspouts for carrying water from the blades to the louver sill. Screens shall be provided on the interior of the louver and shall consist of 1/2" mesh .063" diameter aluminum wire mounted in an extruded aluminum frame. Screens shall be removable from the louver for cleaning. Louvers shall have a Kynar color finish in standard color as selected by Design Professional.
3. Louvers shall have performance as scheduled and carry less than .01 ounces of water per square foot during a 15 minute period when tested in accordance with AMCA Standard 500. Test criteria shall be based on a 48" square sample. Louvers shall bear the AMCA Certified Ratings Seal for both Air Performance and Water Penetration.

2.03 MISCELLANEOUS

A. Manual Volume Dampers:

1. Rectangular duct width of 48" or smaller and height of 12" or smaller or all round ducts.
 - a. Damper shall be fabricated of same material as the duct, two metal gauges heavier than duct and hammered 1" all around.
 - b. Provide end bearings with gasket. Models listed are Young Regulator Co. Equals by Elgin are acceptable
 - 1) Round ducts 4" to 8" with 3/8" rod: Model 666-RD.
 - 2) Round ducts greater than 8" and all rectangular ducts with 3/8" rod: Model 666-FD.
 - 3) All round and rectangular ducts with 1/2" rod: Model 515A.
 - c. Blades and rods construction:
 - 1) Rectangular duct width of 12" or smaller: Damper blade shall be mounted on two 3/8" pins on the ends of the blade.
 - 2) Rectangular duct width greater than 12": Damper blade shall be mounted on continuous 1/2" rod.
 - 3) Round duct of 12" diameter or smaller: Damper blade shall be mounted on two 3/8" pins on the ends of the blade.
 - 4) Round duct diameters larger than 12": Damper blade shall be mounted on a continuous 1/2" rod.
2. All other rectangular duct that fall outside the criteria above shall be opposed action multi-blade.
 - a. Damper frames are to be constructed of minimum 13-gauge.
 - b. Damper blade width shall not exceed 9 inches and the blade length shall not exceed 48 inches. Damper blades shall be of corrugated type construction.
 - c. Damper shall be constructed of the same material as the duct in which it will be installed.
 - d. Where damper shafts penetrate the damper housing, it shall be sealed while allowing the free movement of the shaft without breaking the seal.
 - e. Provide with shaft extension where duct will have exterior insulation applied.

3. Manual Volume Damper Regulators:
 - a. Accessible areas: Provide locking position regulator with gasket and handle. Below model numbers are based on Young Regulator Co. Equals by Elgin are acceptable.
 - 1) Model 403 for a 3/8" damper shaft on ductwork without external insulation.
 - 2) Model 443B for a 3/8" damper shaft on ductwork with external insulation.
 - 3) Model 404 for a 1/2" damper shaft on ductwork without external insulation.
 - 4) Model 404B for a 1/2" damper shaft on ductwork with external insulation.
 - b. Inaccessible areas: Provide concealed manual volume damper regulators with BCW casing and wire and rack and pinion assembly. Damper shall be able to be operated when the damper and rack and pinion assembly are up to 50 ft apart. Young Regulator Co. Model 270-275 or equal by Elgin.
- B. Air Turns: Elgen "Air-Tite" or equal shop fabricated.
- C. Access Panels: Shall be of same material as ducts in which they are installed, fabricated of two thicknesses of not less than 24 gauge, with 1" thick rigid glass fiber filler. Provide sheet metal frame, air tight gasket and two thumb operated cam lock latches. Latches must be operable without the use of any tools.

2.04 FLEXIBLE DUCT

- A. Flexible duct shall be factory pre-insulated, consisting of vinyl coated spring steel wire helix bonded to vinyl coated fiberglass mesh screen, having one (1) inch nominal fiberglass insulation and vinyl impregnated closely woven fiberglass vapor barrier. Basis of Design: Semco, Type A1.
- B. Composite assembly shall meet Class I requirements of NFPA-90A and shall be UL listed for flame spread rating of not more than 25 and smoke developed rating of not more than 50. Assembly shall meet the requirements of UL-181.
- C. Where flexible duct is allowed, it shall be connected to metal ducts, terminal units and diffusers with Panduit, Tylon or equal tool installed nylon clamps.
- D. Maximum length of flexible duct connections from metal duct to terminal units and grilles, registers and diffusers shall be not greater than 72". All duct turns greater than 45 deg. shall be rigid elbows.

2.05 DUCT-MOUNTED FILTER HOUSINGS

- A. Unit shall be a complete factory-assembled housing with upstream and downstream outwardly-turned flanges for insertion into the ductwork system as indicated on the plans. Filter housing to be double wall with insulation on the entire housing, constructed of all aluminum, and have side access door.
- B. Access doors with continuous gasketing on the perimeter shall be provided on the housing. When an access door is opened, the filter cartridges shall be slid into the housing where they shall be retained on slide channels. These channels shall incorporate a positive-sealing gasket material to seal the top and bottom of the filter cartridge frames to prevent bypass.
- C. Accessories:
 1. Static pressure test posts.
 2. Magnahelic gauges., graduated to read from 0 to 1" w.g.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which duct accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install duct accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install access panels for inspection and servicing of all duct mounted equipment including, but not limited to: motorized dampers. Unless noted otherwise, access doors to be square and dimensions shall be 2" less than the duct dimension where they are installed, with a maximum size requirement of 24" x 24". Locate access doors (i.e. side or bottom of duct) where they provide the best access to duct equipment/accessory relative to surrounding piping, equipment, structure, etc.
- C. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
- D. Coordinate with other work, including ductwork, as necessary to interface installation of duct accessories properly with other work.
- E. Field Quality Control: Operate installed duct accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.
- F. Furnish General Contractor with layout and size of wall openings. Coordinate installation of louver with General Contractor. Make duct connections to louvers as shown on the plans.
- G. Install all manual dampers with damper in full open position to facilitate initial air balancing.

3.03 SPARE PARTS

- A. General: Furnish to Owner, with receipt, the following spare parts for each duct-mounted filter housing:
 - 1. One set of spare filters.

END OF SECTION 23 33 00

SECTION 23 34 16

HVAC FANS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.2 DESCRIPTION OF WORK

- A. Extent of HVAC fan work is indicated on drawings and schedules, and by requirements of this section.
- B. Types of fans required for this project include the following:
 - 1. In-line Centrifugal Fans
 - 2. Axial Fans
- C. Vibration isolation required for air distribution equipment is specified in other Division-23 sections, and is included as work of this section.
- D. Refer to section 23 05 13 Common Motor Requirements for HVAC Equipment for motor requirements furnished with HVAC fans.
- E. Refer to Division-26 sections for power work required in conjunction with air distribution equipment; not work of this section.

1.3 QUALITY ASSURANCE

- A. AMCA Compliance: Provide HVAC fans bearing the Air Movement and Control Association, Inc. (AMCA) Certified Ratings Seal.
- B. UL Compliance: Provide air distribution equipment electrical components which have been listed and labeled by Underwriters Laboratories (UL).
- C. NFPA Compliance: Fan and fan installation shall be compliant with applicable NFPA requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver HVAC fans with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.
- B. Handle HVAC fans carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to fan manufacturer.
- C. Store HVAC fans in clean dry place and protect from weather and construction traffic.

1.5 SUBMITTALS

- A. Submittal data shall include physical dimensions, fabrication details, materials, fan curves, sound ratings, motor size and electrical characteristics and required brake horsepower for specified operating conditions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. In-Line Centrifugal Fans
 - 1. Greenheck
 - 2. Carnes
 - 3. PennBarry
 - 4. Loren Cook Co.
 - 5. Twin City Fan & Blower
 - 6. Acme
 - 7. Thermotek

- B. Vane Axial Fans
 - 1. Greenheck
 - 2. Carnes
 - 3. PennBarry
 - 4. Loren Cook Co.
 - 5. Twin City Fan and Blower
 - 6. Acme
 - 7. Thermotek

2.02 IN-LINE CENTRIFUGAL FANS

- A. General: Provide fans of sizes and arrangement and capacities as indicated on schedule. Fans shall be tested and rated in accordance with ASHRAE Standard 51 (AMCA Standard 210). Fans shall bear the AMCA Certified Rating Seal for both sound and performance.

- B. Housing: Heavy duty galvanized steel with square duct mounting collars and removable access panels for ease of maintenance.

- C. Fan Wheel: Centrifugal backward inclined, aluminum, with wheel and inlet cones. Fan wheels shall be statically and dynamically balanced. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.

- D. Fan Shaft shall be solid AISI-C1040 hot rolled steel, turned and polished. Close tolerances to be maintained where shaft makes contact with bearings.

- E. Bearings: Fans shall have precision, flange-mounted, self-aligning ball bearings at inlet and discharge. Bearings are to be grease lubricated and selected for a minimum average life (AFBMA L-50) in excess of 200,000 hours at maximum cataloged operating conditions. Grease lines extend to exterior of fan housing.

- F. Motors: EC motor.

- G. Finish: All surfaces to have factory primed and painted. Exterior is to have an enamel finish.

- H. Accessories:
 - 1. Insulated Housing
 - 2. Disconnect Switches

2.03 VANE AXIAL FANS

- A. General: Provide fans of sizes and arrangement as indicated, and of capacities and having accessories as scheduled.

- B. Ratings: Test and rate fans in accordance with ASHRAE Standard 51 (AMCA Standard 210). Provide fans bearing AMCA Certified Ratings Seal.
- C. Fan Units: Provide Factory-assembled and tested fan units consisting of housing, wheel, fan shaft, bearings and fan drive. Clean, condition, and prime paint sheet metal parts prior to final assembly. Apply final coat of enamel to exterior surfaces after assembly.
- D. Housing: Fans shall have housings of 14 gauge steel hydraulically expanded to form integral inlet bell and diffuser sections. Hydraulically expanded stiffening rings welded in area of wheel raceway. All sizes have outer frame for mounting and slip-joint duct connections.
- E. Fan Wheel: Fans shall have fan wheel of precision aluminum casting with radially projected blades with airfoil cross sections. All wheels are to be dynamically balanced and keyed to fan shaft. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.
- F. Diffuser: Fans shall have a cast aluminum diffuser with radially projected straightening vanes with airfoil cross section.
- G. Fan Shaft shall be solid AISI-C1040 hot rolled steel, turned and polished. Close tolerances to be maintained where shaft makes contact with bearings.
- H. Bearings: Fans shall have precision, flange-mounted, self-aligning ball bearings at inlet and discharge. Bearings are to be grease lubricated and selected for a minimum average life (AFBMA L-50) in excess of 200,000 hours at maximum cataloged operating conditions. Grease lines extend to exterior of fan housing.
- I. Motors: Provide open drip-proof motors with ball or sleeve bearings. Provide split phase or capacitor start motors for fractional horsepower, with resilient base. Provide induction motors for integral horsepower, with rigid base.
- J. Drives: Direct drive.

PART 3 - EXECUTION

3.1 INSPECTIONS

- A. Examine areas and conditions under which fans are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF HVAC FANS

- A. Install fans where indicated, in accordance with equipment manufacturer's installation instructions, and with recognized industry practices, to ensure that equipment complies with requirements and serves intended purposes.
- B. Coordinate with other work, including ductwork and electrical work as necessary to interface installation of HVAC fans with other work. Furnish layout and size of roof curbs for roof mounted fans and wall openings for wall mounted fans to General Contractor.
- C. Install units with vibration isolators or isolation bases, complying with Division-23, Section 23 0548 - Vibration Controls for HVAC Piping, Ductwork and Equipment.
- D. Alignment: Check alignment of belt driven fans, and, where necessary, realign shafts of motors and fans within recommended tolerances by manufacturer, and in presence of manufacturer's service representative

3.3 ELECTRICAL CONNECTIONS

- A. Ensure HVAC fans are wired properly, with rotation in direction indicated and intended for proper performance.

- B. Provide positive electrical equipment and motor grounding.

3.4 FIELD QUALITY CONTROL

- A. Upon completion of installation of HVAC fans, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

3.5 BALANCING

- A. Refer to Division 23, Section 23 05 93 - Testing, Adjusting and Balancing for HVAC of fan systems; not work of this section.

END OF SECTION 23 34 16

SECTION 23 37 13
DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary for the installation of grilles, registers and diffusers as per the schedules on the drawings.

1.3 SUBMITTALS

- A. Submit manufacturer's catalog cuts for each type of device to be used.
- B. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Acceptable Manufacturers
 - 1. Carnes
 - 2. Titus
 - 3. E.H. Price
 - 4. Metal Aire
 - 5. Krueger
 - 6. Nailor

- 2.2 Diffusers, registers, and grilles shall be of the type and style as scheduled.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install wall mounted grilles and registers plumb and level and flush to surface. Locations may be altered slightly, as acceptable to the Design Professional, so as to fit masonry portions of the structure.
- B. In grid panel type ceilings, lay-in metal pan, acoustical, etc., grilles, registers and diffusers shall be located in the center of the panel.
- C. Coordinate locations of ceiling diffusers and registers with Design Professional's reflected ceiling plan. Where architectural features or other items conflict with installation, notify Design Professional for determination of final location.
- D. Adjust blow pattern as indicated on plans and as scheduled, prior to balancing.

3.2 SPARE PARTS

- A. General: Furnish to Owner, with receipt, the following spare parts for each filter grille:
1. One set of spare filters.

END OF SECTION 23 37 13

SECTION 23 38 13
COMMERCIAL KITCHEN EXHAUST EQUIPMENT

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.2 DESCRIPTION OF WORK

- A. Extent of commercial kitchen exhaust work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of commercial kitchen exhaust equipment specified in this section include the following:
 - 1. Kitchen Exhaust Hood
 - 2. Kitchen Exhaust Fan
- C. Refer to Division-26 sections for the following; not work of the section.
 - 1. Power supply wiring from power source to power connection on exhaust fans. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
- D. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:
 - 1. Control wiring between field-installed controls and indicating devices.

1.3 QUALITY ASSURANCE

- A. Codes and Standards
 - 1. NFPA Compliance:
 - a. Install kitchen exhaust equipment in accordance with NFPA 96 and NFPA 101.
 - 2. Install kitchen exhaust equipment in accordance with all local codes.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories; installation and start-up instructions and electrical characteristics.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data and parts list for each type of equipment, control, and accessory; including "trouble-shooting" maintenance guide. Include this data and product data in maintenance manual.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Handle equipment and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged equipment or components; replace with new.
- B. Store equipment and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

- C. Comply with Manufacturer's rigging and installation instructions for unloading equipment and moving them to final location.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Kitchen Exhaust Hoods and Exhaust Fans
 - 1. Greenheck
 - 2. Captive Aire
 - 3. Kees, Inc.
 - 4. Halton

2.2 KITCHEN EXHAUST HOOD AND FAN SYSTEM

- A. Kitchen exhaust hood and fan system shall be provided by a single manufacturer as a complete system.
- B. Kitchen Exhaust Hood
 - 1. Hood shall be designed to cover 30" domestic gas range installed in commercial environments.
 - 2. Construction
 - a. Hood shall be configured as a wall-style hood.
 - b. Minimum 18 gauge, 300 series stainless steel outer shell and welded without visible outer welds or weld marks. All internal seams shall be sealed with NSF-approved caulk.
 - c. Provide with metal mesh filter.
 - d. Provide with two recessed LED hood lights to provide over 50 foot-candles evenly distributed on range below.
 - 3. Fire suppression system
 - a. Provide factory-installed UL 300A listed fire suppression system, including fully monitored electronic detection and actuation.
 - 4. Provide with 3/4" automatic gas shutoff valve.
 - 5. Provide with locked appliance disconnect with timed-automatic range deactivation.
 - 6. Provide with manual pull station.
 - 7. Provide with horn/strobe.
 - 8. Provide with enclosure panels to conceal space above the hood up to the ceiling.
- C. Kitchen Exhaust Fan
 - 1. Factory supplied Inline fan designed for vertical installation at airflow required by the hood.
 - 2. User interface shall be a color LCD touchscreen.
 - 3. Controls shall be password protected.
- D. Controls
 - 1. User interface shall control fan, range, and lights, including the viewing of statuses and faults/alarms. Controller shall be mounted to the front of the hood.
 - 2. Shall result in an NFPA 101 compliant system when paired with the exhaust hood.
 - 3. Provide two metal-housed temperature sensors that monitor cooking surface.
 - 4. Upon detection of heat on the range surface, the controller shall start the exhaust fan. Alternatively, a manual switch can turn on the exhaust fan.
 - 5. On detection of a second higher temperature, the gas valve shall close.
 - 6. Upon reaching a preset high temperature, the fire suppression chemical will release on the range.
 - 7. Provide with fire system control board, accessible by dropping the hood into a service position without removing the hood.
 - 8. Provide with dry contacts for connection to the building fire alarm system.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF KITCHEN HOOD AND FAN

- A. General: Install kitchen exhaust hood and fan as indicated and in accordance with manufacturers published installation instructions.
- B. Hood to be suspended from the structure on angle iron supports.
- C. Install fire suppression system including all components shipped loose. Installation shall be by fire suppression contractor certified for installation of restaurant fire suppression system.
- D. Install fan in ductwork.
- E. Install all control wiring and control components shipped loose, including gas shutoff valve.

3.3 TESTING OF KITCHEN HOOD

- A. Perform capture and containment test to verify proper hood performance. Test shall be conducted with all appliances under the hood at operating temperature and with all sources of make-up and/or recirculated air serving spaces the hood is located in operating. Capture and containment shall be visually verified by observing smoke or steam produced by actual or simulated cooking such as with smoke candles or smoke puffers etc.

END OF SECTION 23 38 13

SECTION 23 55 23
GAS FIRED RADIANT HEATERS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.2 DESCRIPTION OF WORK

- A. Extent of gas-fired radiant heater work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of gas-fired radiant heaters specified in this section include the following:
 - 1. Gas-Fired, Vented Infrared Radiant Heaters
- C. Refer to appropriate Division-23 sections for fuel piping and breechings in connection with fuel-fired heaters; not work of this section.
- D. Refer to Division-26 sections for the following; not work of the section.
 - 1. Power supply wiring from power source to power connection on gas-fired radiant heaters. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
- E. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:
 - 1. Control wiring between field-installed controls, indicating devices, and heater control panels.

1.3 QUALITY ASSURANCE

- A. Codes and Standards
 - 1. ANSI Compliance: Construct and install gas-fired unit heaters in accordance with ANSI Z83.8 "Gas Unit Heaters".
 - 2. NFPA Compliance: Install fuel gas piping and gas-fired heaters in accordance with NFPA 54 "National Fuel Gas Code".

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories; and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring for gas-fired radiant heaters. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Maintenance Data: Submit maintenance data and parts list for each type of gas-fired radiant heater, control, and accessory; including "trouble-shooting" maintenance guide. Include this data and product data in maintenance manual.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Handle gas-fired radiant heaters and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged gas-fired radiant heaters or components; replace with new.
- B. Store gas-fired radiant heaters and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading gas-fired radiant heaters, and moving them to final location.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Gas-Fired, Vented Infrared Radiant Heaters
 - 1. Co-Ray-Vac division of Roberts-Gordon
 - 2. Detroit Radiant Products

2.2 GAS-FIRED, VENTED INFRARED RADIANT HEATERS

- A. The Gas-Fired, Vented Infrared Radiant Heaters shall be design certified by the American Gas Association and this per American National Standard Z 83.6-1974 and Z 83.6a-1975 "VENTED INFRARED RADIANT HEATER".
- B. Each burner shall have affixed a name plate that bears the seal of the American Gas Association.
- C. Equipment
 - 1. Burner
 - a. Burner shall consist of stainless steel venturi burner.
 - b. A sight glass shall be provided to allow visual inspection of the igniter and burner.
 - 2. Combustion Chamber
 - a. 4" O.D. 16 gauge titanium stabilized aluminum steel, finished with corrosion resistant black coating. Condensation shall not form in the combustion chamber.
 - 3. Emitter Tube
 - a. Radiant pipe shall be of 4" O.D. 16 gauge aluminized steel pipe (i.e. tubing), finished with corrosion resistant black coating.
 - b. Tube shall include turbulator baffle for maximum heat transfer.
 - 4. Reflectors
 - c. Reflectors shall be multi-faceted, 0.025 polished aluminum with end caps. Reflector shall be designed to permit expansion while minimizing noise and/or rattling.
 - 5. Control
 - a. Two-stage burner control.
 - b. Controls shall automatically shutdown system and close the gas valve due to: insufficient combustion, flue blockage, gas supply interruption, electrical power interruption. The system shall be able to automatically restart after an inadvertent shutdown.
 - c. Include three indicator lights: one indicates airflow and two lights indicate low and high firing stages.
 - d. Fan shall provide a 45 second pre-purge before burner operation and 90 second post-purge after burner operation.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which gas-fired radiant heaters are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF GAS-FIRED, VENTED INFRARED RADIANT HEATERS

- A. General: Install gas-fired, vented infrared radiant heaters as indicated and in accordance with manufacturer's published installation instruction.
- B. Hang units from structure using chain, and pipe and reflector hangers provided by the manufacturer. Adjust hangers so radiant tubes are level.
- C. Extend gas piping to burner units, provide drop with manual gas shutoff valve, tee and drip pocket. Locate piping drop so as not to interfere with service of inlet. Extend gas piping runout, full size of unit inlet, from tee to gas connection, provide union with sufficient clearance for burner unit removal and service.
- D. Electrical power wiring is specified in Division 26, not work of this section. Control wiring is work of this section in compliance with the requirements of Division 26.

3.3 START-UP

- A. Start up, test, and adjust gas-fired radiant heaters in accordance with manufacturer's published start-up instructions. Verify proper line and manifold gas pressure. Check and calibrate controls, adjust burner for maximum efficiency.

END OF SECTION 23 55 23

SECTION 23 72 00
AIR TO AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of energy recovery units work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Refer to Division-26 sections for the following work:
 - 1. Power supply wiring from power source to power connection on energy recovery units. Include disconnects and required electrical devices, except where specified as furnished, or factory-installed by manufacturer.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. UL Compliance: Provide energy recovery units which are designed, manufactured and tested in accordance with UL requirements.
 - 2. ARI Compliance: Units shall have certified ratings complying with ARI Standard 1060.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's equipment specifications, equipment capacities, ratings and selection points, fan curves with selection points clearly indicated and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to heat recovery equipment including control and thermostat wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Handle energy recovery units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged energy recovery units or components; replace with new.
- B. Store energy recovery units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.
- C. Comply with manufacturer's rigging and installation instructions for unloading energy recovery units, and moving them to final location.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Energy Recovery Units

1. Venmar
2. Greenheck
3. Semco

2.02 ENERGY RECOVERY UNITS

- A. General: Energy recovery ventilation system consisting of supply and exhaust fans, enthalpy wheel heat exchanger with thermal transfer media, wheel drive system and variable frequency drive, filters, and unit casing and access doors.
- B. Unit Cabinet:
1. Cabinet shall be constructed of 20 gauge G-90 galvanized steel with 12 gauge galvanized frame. Unit to be internally lined with galvanized steel to create a double wall.
 2. Unit shall be provided with inlet and discharge duct collars in the locations shown on the plans.
 3. Hinged access panels shall be provided for fans, motors, wheel, wheel motor, and filters and shall have the same construction as the cabinet.
 4. Insulation: 1/2" fiberglass, neoprene, or injected foam insulation within double wall construction.
- C. Energy Recovery Wheel:
1. Media: Uni-directional, fluted construction for laminar air flow.
 2. Construction: Corrugated aluminum coated with non-migrating permanently bonded desiccant. Media shall be non-asbestos, water resistant, bacteriostatic and fire retardant (meeting NFPA 90A flame spread and smoke generation requirements for installation in air duct). Media shall be strengthened with radial reinforcement.
 3. Wheel Cassette: Heavy gauge steel galvanized frame wheel with self-aligning sealed bearings. Wheel shall be installed in a heavy duty removable "cassette" to facilitate access. Nylon wiping seals at periphery of the rotor and along supply and exhaust divider.
 4. Purge: Purge section between supply and exhaust to limit contamination to the supply air to .04 percent.
 5. Drive: Totally enclosed motor with variable frequency drive to modulate rotational speed.
 6. Access: Enthalpy wheel shall be removable from the unit through side access doors.
- D. Supply and Exhaust: Provide double width double inlet (DWDI) direct drive fans and permanently lubricated motor bearings.
1. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.
- E. Filters: Filter racks designed to hold 2" pleated throw-away filters. Provide with full size access door. Filters to be minimum MERV-8A.
- F. Electrical
1. Separate power connections for supply fan, exhaust fan, and wheel VFD.
 2. Disconnects: Provide disconnects for exhaust and supply fans.
 3. Starters: Provide motor starters (as required) for exhaust and supply fans.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which energy recovery units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF ENERGY RECOVERY UNITS

- A. General: Install energy recovery units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Controls: Install devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor for power wiring.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- C. Ductwork (if applicable): Refer to Division 23, Section 23 31 13 – Metal Ducts. Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.
- D. Start-up of energy recovery units shall be in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.3 TRAINING OF OWNER'S PERSONNEL

- A. Instruct Owner's personnel in operation and maintenance of energy recovery units.

3.4 SPARE PARTS

- A. General: Furnish to Owner, with receipt, the following spare parts for each energy recovery unit:
 - 1. One set of spare exhaust filters.

END OF SECTION 23 72 00

SECTION 23 81 27
VARIABLE REFRIGERANT FLOW SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of variable refrigerant flow system work required by this section is indicated on drawings, schedules and by requirements of this section.
- B. The Variable Refrigerant Flow (VRF) system shall consist of an air cooled condensing unit, heat recovery boxes, indoor terminal units, and DDC (Direct Digital Controls). Each indoor terminal unit or group of indoor terminal units shall be capable of operating in any mode independently of other indoor terminal units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. Each indoor terminal unit or group of indoor terminal units shall be independently controlled and capable of changing mode automatically when zone temperature strays 1.8 degrees F from set point for ten minutes. The sum of connected capacity of all indoor terminal units shall range from 50% to 150% of outdoor rated capacity.
- C. Types of equipment in this section include the following:
1. Air-cooled condensing units.
 2. Heat recovery boxes
 3. Terminal units.
- D. Refer to plans for locations where equipment is shown to be located in the garage. Manufacturer shall certify that equipment shown in the garage can operate in an environment conditioned between 48 deg F and 104 deg F.
- E. Refer to other Division-23 sections for piping, refrigeration specialties, insulation, etc., required; not work of this section.
- F. Refer to Division-26 sections for field-installed power wiring required for condensing units; not work of this section.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. The units shall be listed and labeled by a nationally recognized agency and shall be tested in accordance with UL by Electrical Testing Laboratories (ETL) and bear the ETL label.
 2. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
 3. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the proposed ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the DOE alternative test procedure, which is based on the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standards 340/360, 1230 and ISO Standard 13256-1.
 4. AHRI Compliance: Provide capacity ratings for condensing units in accordance with Air Conditioning, Heating, and Refrigeration Institute (ARI) Standard 240 "Performance Rating for Unitary Air Conditioning and Air Source Heat Pump Equipment".
 5. ASHRAE Compliance: Construct refrigerating system of condensing units in accordance with American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standard ANSI/ASHRAE 15, "Safety Code for Mechanical Refrigeration".
- B. Warranty:
1. Provide ten-year warranty on all parts.

1.4 SUBMITTALS

- A. Provide equipment submittal including the following information:
 - 1. Product Data: Submit manufacturer's equipment specifications, equipment capacities, ratings and selection points and installation and start-up instructions.
 - 2. Shop Drawings: Submit manufacturer's assembly type drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.
 - 3. Refrigerant Piping Diagrams: Submit manufacturer's refrigerant piping requirements, including estimated lengths, sizes, and number of elbows.
 - 4. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Handle condensing units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged condensing units or components; replace with new.
- B. Store condensing units, terminal units, and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Air-cooled Condensing Units, Heat Recovery Boxes, and Terminal Units
 - 1. Daikin
 - 2. Mitsubishi
 - 3. LG
 - 4. York/Johnson Controls

2.2 AIR-COOLED CONDENSING UNIT

- A. General: The air-cooled condensing unit shall be equipped with multiple circuit boards that interface to the controls system and shall perform all functions necessary for operation. Each unit module shall be completely factory assembled, piped and wired and run tested at the factory.
 - 1. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s).
 - 2. The condensing unit shall have an accumulator with refrigerant level sensors and controls.
 - 3. The condensing unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
 - 4. The condensing unit shall be capable of operating in heating mode down to -4°F ambient temperatures or cooling mode down to 23°F ambient temperatures, without additional low ambient controls.
 - 5. The condensing unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
 - 6. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend "no or reduced heating" periods shall not be allowed.
- B. Unit Cabinet:
 - 1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
- C. Fan:
 - 1. Each condensing unit module shall be furnished with direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.

2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
3. All fan motors shall be mounted with integral vibration isolation for quiet operation.
4. All fans shall be provided with a raised guard to prevent contact with moving parts.
5. The condensing unit shall have vertical discharge airflow.
6. The fan speed shall automatically adjust based on the number of operating indoor units and the compressor operating frequency.

D. Coil:

1. The coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
2. The coil fins shall have a factory applied corrosion resistant finish.
3. The coil shall be protected with an integral metal guard.
4. Refrigerant flow from the condensing unit shall be controlled by means of an inverter driven compressor.
5. The coil shall include 4 circuits with two position valves for each circuit, except for the last stage.

E. Compressor:

1. Each condensing unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.
2. The condensing unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of to at least 15% of rated capacity.
3. The compressor will be equipped with an internal thermal overload.
4. The compressor shall be mounted to avoid the transmission of vibration.

F. Controls:

1. The condensing unit shall have the capability of up to 8 levels of demand control for each refrigerant system.

G. Electrical:

1. The condensing unit shall be controlled by integral microprocessors.
2. The control circuit between the terminal units, heat recovery boxes, and the condensing unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor terminal units to one condensing unit with one 2-cable wire, thus simplifying the wiring operation.

2.3 HEAT RECOVERY BOXES (HRBs)

A. General

1. The heat recovery boxes shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices with no subcooling risk bubbles in liquid supplied to LEV and are not allowed.
2. The heat recovery boxes shall be equipped with a circuit board that interfaces to the controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity.

B. Cabinet

1. The casing shall be fabricated of galvanized steel.
2. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
3. The unit shall house two tube-in-tube heat exchangers.

C. Refrigerant valves:

1. The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH.
2. Each branch shall have multiple two-position valves to control refrigerant flow.
3. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
4. Linear electronic expansion valves shall be used to control the variable refrigerant flow.

D. Electrical:

1. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded 2 conductor cable.

2.4 WALL MOUNTED INDOOR TERMINAL UNITS

A. General:

1. The wall-mounted indoor unit section shall have a modulating linear expansion device and a flat front. The wall mounted unit shall support individual control using DDC controllers.

B. Indoor Terminal Unit

1. The indoor terminal unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Terminal Unit Cabinet:

1. All casings, regardless of model size, shall have the same white finish
2. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard.
3. There shall be a separate back plate which secures the unit firmly to the wall.

D. Fan:

1. The fan shall be an assembly with one or two line-flow fan(s) direct driven by a single motor.
2. The fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
4. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.

E. Filter:

1. Return air shall be filtered by means of an easily removable, washable filter.

F. Coil:

1. The coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil. An integral condensate pump shall be provided to pump condensate to a drain.
6. Both refrigerant lines to the indoor units shall be insulated.

7. A drain pan level switch (DPLS1), designed to connect to the control board, shall be provided and installed on the condensate pan to prevent condensate from overflowing.

G. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

H. Controls:

1. This unit shall use controls provided by unit manufacturer to perform functions necessary to operate the system. Please refer to Part 2.06 of this guide specification for details on controllers and other control options.
2. The unit shall have a factory built in receiver for wireless remote control
3. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
4. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
5. Indoor terminal unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
6. Indoor terminal unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.5 HORIZONTAL CONCEALED DUCTED INDOOR TERMINAL UNITS

A. General:

1. There shall be a horizontal concealed ducted fan coil design that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The unit shall support individual control using DDC controllers.

B. Indoor Terminal Unit:

1. The terminal unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Terminal unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Terminal Unit Cabinet:

1. The unit shall be, horizontal concealed, ducted.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.

D. Fan:

1. Concealed unit models shall feature external static pressure settings from 0.14 to 0.60 in. WG.
2. The indoor unit fan shall be an assembly with one or two fan(s) direct driven by a single motor.
3. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
4. The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function
5. The indoor unit shall have a ducted air outlet system and ducted return air system.

E. Filter:

1. Return air shall be filtered by means of a standard factory installed return air filter, where indicated on the plans.

F. Coil:

1. The coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The condensate shall be gravity drained from the fan coil.
7. Both refrigerant lines to the indoor units shall be insulated.
8. A drain pan level switch (DPLS1), designed to connect to the control board, shall be provided and installed on the condensate pan to prevent condensate from overflowing.

G. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

H. Controls:

1. This unit shall use controls provided by unit manufacturer to perform functions necessary to operate the system. Please refer to Part 2.06 of this specification section for details on controllers and other control options.
2. Indoor terminal unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
4. Indoor terminal unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
5. Indoor terminal unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.6 VERTICAL AIR HANDLING UNIT

A. General:

1. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature
2. The indoor units shall be equipped with a condensate pan.
3. The indoor units shall be equipped with a return air thermistor.
4. The indoor units shall be upflow or downflow as indicated on the plans.

B. Terminal Unit Cabinet:

1. The unit shall be ducted.
2. The cabinet shall be constructed of galvanized steel with sound absorbing foamed polystyrene and polyethylene insulation

C. Fan:

1. The fan shall be direct-drive type fan, statically and dynamically balanced impeller with high and low fan speeds available.
2. The airflow rate shall be available in high and low settings.
3. The fan motor shall be thermally protected.
4. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

- D. Filter:
 - 1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.
- E. Coil:
 - 1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
 - 2. A condensate pan shall be located under the coil.
 - 3. A thermistor will be located on the liquid and gas line.
- F. Controls:
 - 1. This unit shall use controls provided by unit manufacturer to perform functions as described later in this section.
 - 2. Provide with a remote in-room, hardwired sensor and control kit to allow for temperature sensing and user adjustment at the wall location indicated on the plans.

2.7 REFRIGERANT

- A. R410A refrigerant shall be utilized in the VRF system.

2.8 SYSTEM CONTROLS

- A. The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and gateway DMS502B71 for communicating with the existing Niagara AX system.
 - 1. Operators shall be able to perform all normal operator functions through the existing Niagara AX system through the VRF BACnet interface.
- B. Wiring:
 - 1. Control wiring shall be installed between the condensing unit and the heat recovery boxes and the indoor terminal units. Control wiring to remote accessories shall be run from the indoor terminal unit terminal block to the accessory associated with that unit.
 - 2. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire.
- C. System controls and control components shall be installed in accordance with the manufacturer's written installation instructions.
- D. Features:
 - 1. Furnish energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.
 - 2. System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs.
 - 3. Provide capability for future system expansion.
 - 4. Advanced Diagnostics – Systems shall include a self-diagnostic, auto-check function to detect a malfunction and display the type and location
 - 5. Configurator Software - Each system shall be available with configurator software package to allow for remote configuration of operational settings and also for assessment of operational data and error codes.
 - 6. Each system shall be capable of integrating with an open protocol BACnet over IP building automation system.
- E. Minimum Niagara AX to VRF Controller Read/Write Points List:
 - 1. Terminal Unit On/Off Status
 - 2. Terminal Unit Heat/Cool/Fan/Dehumidify Status
 - 3. Terminal Unit Temperature Setpoint
 - 4. Terminal Unit Filter Status

5. Terminal Unit Remote Controller Permit/Prohibit
6. Lower Centralized Controller Operation Enable/Disable
7. Terminal Unit Fan Speed
8. Terminal Unit Airflow Direction
9. Terminal Unit Forced System Stop
10. Terminal Unit Forced Thermo-off
11. Terminal Unit Energy Saving Mode
12. System Schedule

F. Minimum Monitoring Points List:

1. Terminal Unit Status
2. Terminal Unit Alarm Status
3. Terminal Unit Malfunction Mode
4. Terminal Unit Room Temperature
5. Terminal Unit Thermo-on Status
6. Condensing Unit Compressor Status
7. Terminal Unit Fan Status
8. Terminal Unit Communication Status
9. System Auto Changeover Operation

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which condensing units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

3.2 INSTALLATION

- A. General: Install in full accordance with manufacturer's requirements, project drawings, and contract documents. Refer to the manufacturer's installation manual for full requirements.
- B. Location: Locate indoor and outdoor units as indicated on drawings. Provide service clearance per manufacturer's installation manual. Adjust and level outdoor units on support structure.
- C. Components / Piping:
1. Refer to 23 2300 - Refrigerant Piping for piping requirements.
 2. Installing contractor shall provide and install all accessories and piping for a fully operational system. Refer to manufacturer's installation manual for full instructions.
 3. Traps, filter driers, and sight glasses are NOT to be installed on the refrigerant piping or condensate lines.
 4. The maximum operation pressure of R410A air conditioner is 4.30 MPa. The refrigerant piping should ensure the safety under the maximum operation pressure. Pipes of radical thickness 0.7mm or less shall not be used.
 5. Flare connection should follow dimensions provided in manufacturer's installation manuals.
- D. Insulation: Refer to 23 07 00 - HVAC Insulation. All refrigerant lines shall be insulated end to end.
- E. Air Test:
1. Air test and vacuum dry refrigerant piping in accordance with the Manufacturer's recommendations.
 2. Always use nitrogen gas for air tightness test. Pressurize the suction gas pipe, high/low pressure gas pipe and liquid pipe from the service ports of each stop valve to 550 psi and hold pressure for 24 hours. If there is a pressure drop, check for leaks, make repairs and repeat air test.
- F. Vacuum Drying:
1. Evacuate the system from the suction gas pipe, high/low pressure gas pipe and liquid pipe stop valve service ports by using a vacuum pump for more than two hours and bring the system to 500 microns or less.

2. After maintaining system under this condition for more than one hour, check if vacuum gauge rises; if it rises, the system may either contain moisture inside or have leaks.
- G. Electrical: Installing contractor shall coordinate electrical requirements and connections for all power feeds with electrical contractor. Refer to Division 26 for additional information.
 - H. Start-Up: Start-up VRF system in accordance with manufacturer's instructions and demonstrate compliance with requirements. Replace damaged or mal-functioning controls and equipment.
 - I. Charging Refrigerant:
 1. Refrigerant shall only be charged after performing leak test and vacuum drying and after field wiring is complete.
 2. Charge system in accordance with Manufacturer's instructions.

3.3 TRAINING OF OWNER'S PERSONNEL

- A. Instruct Owner's personnel in operation and maintenance of all equipment and components in the Variable Refrigerant Flow system. Training shall include the following at a minimum:
 1. Installation and Commissioning of all components of the system.
 2. Service and troubleshooting of all components of the system.
 3. Controls installation and commissioning.

END OF SECTION 23 81 27

SECTION 23 82 16

AIR COILS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install air coils as required by the drawings and this section.
- B. Types of air coils specified in this section include the following:
 - 1. Electric Duct Coils

1.3 QUALITY ASSURANCE

- A. ARI Compliance: Units shall have certified ratings complying with ARI Standard 430.

1.4 SUBMITTALS

- A. Submittal data shall consist of drawings and/or catalog cuts giving dimensions, arrangement, construction materials, coil capacity and installation instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Electric Duct Coils
 - 1. Trane
 - 2. Berko - (Division of Marly)
 - 3. Q-Mark - (Division of Marly)
 - 4. Brasch
 - 5. Indeeco
 - 6. Raywall
 - 7. Neptronic
 - 8. Greenheck

2.2 ELECTRIC DUCT COILS

- A. General: The contractor shall furnish and install electric duct heaters of type, size, and voltage scheduled. Heaters shall be installed and wired in accordance with the manufacturer's recommendations and applicable national and local codes.
- B. Element terminals shall be stainless steel; insulators and bracket bushings shall be nonporous ceramic and securely positioned. Terminals shall be machine crimped to elements.
- C. Casing: Casings shall be fabricated of heavy gauge galvanized steel, and have inlet and outlet duct flanges.
- D. Coils: Open coil elements shall be 80% nickel and 20% chromium.
- E. Protection: All heaters shall be equipped with manual reset thermal overloads which shut down the element and motor if safe operation temperatures are exceeded.

- F. Controls: Contactors and control circuit transformers shall be factory installed and wired. The heaters shall be controlled with electronic modulating Step Controllers and shall accept an external control input. Coordinate control signal compatibility with Building Automation System Contractor.

PART 3 - EXECUTION

- 3.1** Install coils and make piping and duct connections as indicated on the drawings.

END OF SECTION 23 82 16

SECTION 23 82 39

UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install unit heaters as required by the drawings and this section.

1.3 UNIT HEATERS

- A. Unit heaters shall include the following:
 - 1. Electric Cabinet Unit Heaters

1.4 SUBMITTALS

- A. Submit shop drawings and/or catalog cuts showing technical data necessary to evaluate the equipment, to include color charts, dimensions, wiring diagrams, performance data and other descriptive data necessary to describe fully the terminal units.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Electric Cabinet Unit Heaters
 - 1. Trane
 - 2. Berko - (Division of Marly)
 - 3. Q-mark - (Division of Marly)
 - 4. Brasch
 - 5. Indeeco

2.2 ELECTRIC CABINET UNIT HEATERS

- A. Units shall have capacities and ratings and shall be of arrangement as scheduled on the drawings.
- B. Units shall be furnished complete with coils, enclosures, fans and motors as required to make complete functioning units.
- C. Units to be installed in finished areas to be furnished with bonderized, phosphatized, flow-coated baked-on primer with spray applied baked-on enamels in color as selected by Design Professional from the manufacturer's standard offering.
- D. Motors for cabinet unit heaters shall be totally enclosed, Class 'B' insulation, with built-in overload protection, and shall be prewired to terminal strip in factory mounted junction box.
- E. Filters for cabinet unit heaters shall have 1" thick woven glass replaceable media, and permanent aluminum frames.
- F. Units shall have single point, line voltage connection for incoming power for 208, 240 or 480 volt services as indicated on the plans.

G. Provide the following accessories:

1. Thermostat for remote mounting and field installation.
2. Three position fan selector switch.
3. Pilot light to indicate when heating elements are energized.
4. Disconnect switch.

PART 3 - EXECUTION

3.01 Controls: Install devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor for power wiring.

- A. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

END OF SECTION 23 82 39

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Refer to Division 00 – Procurement, Contracting and Warranty Requirements and Division 01 - General Requirements, which all apply to work under this section.

1.2 DESCRIPTION OF WORK

- A. Work shall include furnishing of all systems, equipment and material specified in this division and as called for on the electrical drawings, to include supervision, operations, methods and labor for the fabrication, installation, start-up and tests for the complete electrical installation. Include all provisions necessary for complete installation and proper operation of systems and components.
- B. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft in accordance with ANSI/NECA 1 standards.
- C. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft and in collaboration and coordination with other trades. Adjust work as necessary to avoid interference with other trades. Refer to contract documents and submittals for other trades such as Mechanical, Plumbing, Architectural for equipment being furnished as part of their scopes of work but requiring electrical connections.
- D. Definitions for “provide”, “furnish” and “install”.
 - 1. “Provide” = furnish and install
 - 2. “Furnish” = does not include installation.
 - 3. “Install” = does not include furnishing.
- E. Do not scale drawings for dimensional purposes.
- F. Refer to Architectural and Civil Landscape Drawings for final device locations and other features that may impact electrical work.
- G. Provide demolition as necessary to perform new work.
 - 1. Refer to Division 2 for Selective and General Demolition requirements.

1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
 - 1. National Electrical Code (NEC)
 - 2. National Electrical Safety Code (NESC)
 - 3. National Fire Protection Association (NFPA)
 - 4. National Electrical Manufacturers Association (NEMA)
 - 5. Standards of Institute of Electrical and Electronic Engineers (IEEE)
 - 6. International Building Code (IBC)
 - 7. Occupational Safety and Health Act (OSHA)
 - 8. Wisconsin Enrolled Commercial Building Code
 - 9. National Electrical Contractors Association (NECA) Standards
 - 10. National Electrical Testing Association (NETA)
 - 11. Americans With Disabilities Act (ADA)
 - 12. Illuminating Engineering Society of North America (IESNA)
 - 13. American National Standards Institute (ANSI)
 - 14. Underwriter’s Laboratories (UL)

15. Telecommunications Industries Association (TIA)
16. Federal Communication Commission (FCC)

- B. All Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.4 REQUIREMENTS & FEES OF REGULATORY AGENCIES

- A. Federal, State, local authority and utility requirements in force at time of execution of this project shall be part of the specifications.
- B. Contractor shall comply with the rules and regulations of the local utility companies. Contractor shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- C. Meters for incoming services shall be selected based on the project requirements. Any questions concerning this shall be referred to Design Professional prior to bidding. Contractor shall provide the appropriate meter and associated materials if not furnished by the utility company.
- D. Secure all required permits and pay for all inspections, licenses and fees required in connection with the electrical work including State of Wisconsin Electrical Inspections. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.
- E. Contractor shall make all arrangements with each utility company and pay all service charges associated with new service.

1.5 ELECTRICAL DRAWINGS

- A. The electrical drawings indicate in general the building arrangement only. Contractor shall examine construction drawings to become familiar with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.
- B. Drawings for the electrical work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.
- C. Contractor shall layout their own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of conduits and raceway so as to best fit the layout of the work.
- D. Contractor shall take their own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as couplings, pull or splice boxes may not be shown, but where such items are required by code or by other sections of the specifications or where they are required for proper installation of the work, such items shall be furnished and installed.

1.6 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.
- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.

- C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
 - 1. Obtain written permission from Owner and Architect prior to interrupting any service. Timing of interruption shall be at the discretion of the Owner and may require after hours or weekend work.
- D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.7 NEW SERVICES

- A. Determine utility installation requirements and include all costs associated with service in Base Bid. Include all costs necessary for temporary service(s) to support construction activities.

1.8 TEMPORARY SERVICES

- A. Refer to Specification Division 1 for specific requirements concerning temporary utilities.

1.9 SITE INSPECTION

- A. Contractor shall inspect the site prior to submitting bid for work to get familiar with the conditions of the site which will affect their work and shall verify points of connection with utilities, routing of outside conduit to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.10 COORDINATION AND COOPERATION

- A. It shall be Contractor's responsibility to schedule and coordinate their work with the schedule of the General Contractor to progress the work expeditiously, and to avoid unnecessary delays.
- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of their work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to their equipment, other equipment and the building. The Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that the Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and their decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided. Refer to Division 09 for painting protection.
- F. Where the final installation or connection of equipment in the building requires the contractor to work in areas previously finished by the General Contractor, the Electrical Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Electrical Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.

1.11 OPENINGS, CUTTING AND PATCHING

- A. Refer to Division 1 for additional cutting and patching information.
- B. Conduits and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and conduit or sleeve shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where conduit or sleeves pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.
- C. New structure:
 - 1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the electrical work with the General Contractor.
 - 2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.
- D. Existing Structure:
 - 1. Contractor shall provide cutting, lintels and patching, and patch painting in the existing structure, as required for the installation of their work, and shall furnish lintels and supports as required for openings.
 - 2. Cutting of structural support members will not be permitted without prior approval of the Design Professional. Extent of cutting shall be minimized; use core drills, power saws or other machines which will provide neat, minimum openings.
 - 3. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.
- E. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and conduit shall be sealed with modular mechanical rubber links tightened with bolts as made by Thunderline Corporation, Wayne, Michigan 48184. Waterproofing of conduit penetrations in exterior walls shall be coordinated with waterproofing contractor.
- F. Do not pierce structural elements such as floors, beams or columns without prior permission from Architect. Submit for Structural Engineer review all core drilled hole locations or other structural penetrations that may be required prior to execution of work.
- G. Seal penetrations through fire-rated assemblies with UL listed fire stopping system matching installation requirements per fire stopping manufacturer.
- H. Repair, replace or refinish surfaces such as lawns, paving, etc. to match existing conditions prior to commencement of work.
- I. Provide chrome escutcheons to match raceway size where raceways pass through walls, floors or ceilings in public areas.

1.12 EXCAVATING AND BACKFILLING

- A. Contractor shall do all excavating necessary for lightpole bases, underground wiring, conduit and duct banks, and shall backfill trenches and excavations after work has been inspected. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way, except where lines must cross under a wall footing. Where a line must pass under a footing, the crossing shall be made by the smallest possible trench to accommodate the conduit. Excavation shall be kept free from water by pumping if necessary.

- B. Backfill about the structures shall be placed, when practicable as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfill shall be in accordance with Specification Division 31. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit and shall be carried to a crown approximately six (6) inches above the existing grades. In backfilling trenches, selected material shall be compacted firmly around and to a depth of not less than six (6) inches over the top of work in trench. All fill and backfill and rough grading shall be compacted thoroughly in layers and shall be brought up to within six (6) inches of finished grades. All fill and backfill shall be sand or pit run sand/gravel graded from 1" size downward.

1.13 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same system, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.
- D. Provide materials that are UL listed or bear the UL mark unless the specific class of material(s) is not available with such listings. Other nationally recognized testing agencies identified as acceptable to the AHJ are acceptable.
- E. Furnish equipment with factory-applied finish coats. If equipment finish is damaged during shipment, acquire manufacturer's finish products for field touchups to satisfaction of Architect/Engineer.

1.14 SUBMITTALS

- A. Contractor shall furnish, to the Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- D. After award of contract, the contractor shall provide a completed submittal schedule including dates that the submittals will be to the Design Professional for review.

E. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	PROD SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
26 05 19	Low-Voltage Power Conductors and Cables		X			X		
26 05 33	Raceway and Boxes for Electrical Systems		X			X		
26 05 43	Underground Ducts and Raceways for Electrical Systems		X			X		
26 05 73	Short Circuit-Coordination Study/Arc Flash Hazard Analysis		X			X		1
26 09 23	Lighting Control Systems	X	X			X	X	
26 11 16	Secondary Unit Substations	X	X			X	X	
26 22 00	Low-Voltage Transformers	X	X			X	X	
26 24 13	Switchboards	X	X			X	X	
26 24 16	Panelboards	X	X			X	X	
26 24 19	Motor-Control Centers	X	X			X	X	
26 27 26	Wiring Devices		X			X		
26 28 15	Motor and Service Disconnects		X			X	X	
26 28 16	Enclosed Switches and Circuit Breakers		X			X	X	
	Fuses		X			X		
	Overload Relays		X			X		
26 29 13	Motor Starters		X			X	X	
26 29 23	Variable Frequency Motor Controllers		X			X	X	
26 32 13	Engine Generators	X	X			X	X	
26 33 23	Central Battery Equipment		X			X	X	
26 33 53	Static Uninterruptible Power Supply		X			X	X	
26 36 00	Transfer Switch		X			X	X	
26 43 13	Surge Protective Devices		X			X		
26 50 00	Lighting	X	X			X	X	
NOTES:								
1. Provide preliminary report; refer to specification section for requirements.								

F. Identify proposed materials and equipment being submitted on general catalog sheets. Indicate specific name or number of equipment being submitted as it relates to specifications or drawings.

G. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications. Submittals must be reviewed before installation of equipment or materials.

- H. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.
- I. Where identified in the individual specification section, submit line by line compliance review of specification relative to equipment and materials being submitted. Each line item shall be marked with "C", "D" or "E" in the margin of the specification. "C" indicates compliance with no exceptions. "D" indicates compliance with deviations with reasoning for deviation. "E" indicates non-compliance due to exceptions.

1.15 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted to Design Professional. Refer to Division 01 specifications for additional information.
- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
ELECTRICAL SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
 - 1. Equipment and system warranties and guarantees.
 - 2. Installation instructions.
 - 3. Operating instructions.
 - 4. Maintenance instructions.
 - 5. Spare parts identification and ordering list.
 - 6. Local service organization, address, contact and phone number.
 - 7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
- D. Items to be included shall be those listed in shop drawing section.

1.16 RECORD DOCUMENTS

- A. Refer to Division 1 for Record Document Requirements.
- B. Markup set of Contract Documents with final installed field conditions.

1.17 SUBSTITUTIONS

- A. Refer to Divisions 00 and 01. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, Design Professional will approve it in an addendum. Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.

- B. To obtain approval to use unspecified equipment, Bidding Contractors (not equipment supplier, manufacturers, etc.) shall submit written requests to Design Professional at least 10 days prior to bid due date. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, Design Professional will approve it in an addendum. Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.
- C. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.18 ACCEPTABLE MANUFACTURERS

In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.

Manufacturers, who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the Contractor and/or the manufacturer.

- A. If Contractor chooses to use a manufacturer listed as an equal, it shall be their responsibility to assure that the manufacturer has complied with the requirements in *SUBSTITUTIONS 'A'* above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- B. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.19 WARRANTY

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
 - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
 - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
 - b. The entire Electrical system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 26 sections for systems, equipment, or material requiring extended warranties beyond one year.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

1.20 CHANGES IN THE WORK

- A. Refer to Divisions 00 and 01.

1.21 COMPLETION

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by the Owner.
- B. When all the electrical work is complete Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.
- C. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

1.22 ACCESS DOORS

- A. When the Electrical Contractor provides any equipment requiring periodic servicing which will be concealed by non-accessible architectural construction, the Electrical Contractor shall provide a flush access door. The access door shall be equal to a Karp DSC-211 Universal access door or Nystrom APWB or type for the specific construction involved.
- B. Access doors in fire rated construction shall be fire rated and have U.L. label.
- C. Construction:
 - 1. Door and trim shall be 13 gauge steel, frames shall be 16 gauge steel.
 - 2. Trim shall be of one piece construction.
 - 3. Finish shall be prime coat of rust inhibitive baked grey enamel.
 - 4. Hinges shall be concealed, offset, floating hinge.
 - 5. Locks shall be flush, screwdriver operated with stainless steel cam-and-studs.

1.23 CONCRETE EQUIPMENT PADS

- A. Provide equipment housekeeping pads for all floor mounted equipment. Anchor equipment to concrete equipment pads according to equipment manufacturer's recommendations.
 - 1. Construct concrete bases of dimensions indicated or as required to be 4 inches larger in both directions than supported unit. Pads to be a minimum of 4" in height unless noted otherwise.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts according to manufacturer's recommendations and to elevations required for proper attachment to supported equipment.
 - 6. Use minimum 3000-psi compressive strength concrete with #3 rebar 12" O.C. in accordance with Division 03 – Concrete.

PART 2 - PRODUCTS

2.1 MATERIALS FOR DEMOLITION

- A. All materials removed shall be the property of the removing contractor and shall be removed from the site unless otherwise specified. Contractor shall remove and turnover devices, equipment, etc. identified by the Owner to be retained.

PART 3 - EXECUTION

3.1 GENERAL DEMOLITION

- A. Demolition shall be accomplished by the proper tools and equipment for the work to be removed. Personnel shall be experienced and qualified in the type of work to be performed.
- B. Examination
 - 1. Verify field measurements and circuiting arrangements are as shown on Drawings.
 - 2. Verify that abandoned wiring and equipment serve only abandoned facilities.
 - 3. Demolition Drawings are based on casual field observation. Report discrepancies to Owner before disturbing existing installation.
- C. Preparation
 - 1. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
 - 2. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
 - 3. Existing Electrical Services: Maintain existing system in service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
 - 4. Existing Fire Alarm System: Maintain existing system in service. Disable system only to make switchovers and connections. Notify Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
 - 5. Existing Telecommunications Systems: Maintain existing systems in service. Disable systems only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system.
- D. Demolition and Extension of Existing Electrical Work
 - 1. Demolish and extend existing electrical work under provisions of this Section.
 - 2. Remove, relocate, and extend existing installations to accommodate new construction. Extend existing installations using materials and methods as specified.
 - 3. Remove abandoned wiring to source of supply.
 - 4. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
 - 5. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
 - 6. Disconnect and remove abandoned panelboards and distribution equipment.
 - 7. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
 - 8. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
 - 9. Repair adjacent construction and finishes damaged during demolition and extension work.
 - 10. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
 - 11. Clean and repair existing materials and equipment which remain or are to be reused.
- E. Fluorescent Lamp and Ballast Disposal
 - 1. Unless noted otherwise, all existing fluorescent lamps and ballasts within light fixtures to be removed shall be assumed to contain mercury and PCB's respectively. These items need to be disposed of by a mercury and PCB Disposal Contractor, who shall be a subcontractor to Electrical Contractor. This Disposal Contractor shall have all local, state, and federal authorization for handling, transporting, and processing these materials. Disposal Contractor shall have pollution insurance and shall generate a Certificate of Disposal. Ballasts and all contaminated materials shall be incinerated. Lamps shall be recycled.
 - 2. Available Disposal Contractors
 - a. Subject to compliance with requirements, below are available Contractors:
 - 1) A-tec Recycling, Inc.

- 2) ALTA Resource Management Services, Inc.
- 3) Full Circle Ballast Recyclers
- 4) Midwest Lamp Recycling, Inc.
- 5) Local contractor that has been contracted in this type of work for at least 5 years.

F. Work by Others

1. Unless specifically noted under other contracts, Electrical Contractor shall assume all required work shall be performed by him. In general, the following will be performed by others:
 - a. General Contractor will remove any bases, floor fill, wall work and footings; neatly patch, match, complete and finish all affected surfaces.
 - b. Mechanical Contractor will disconnect all mechanical services and remove pipe back to behind finish surfaces, close and cap ends of pipe.

G. Cleaning and Repair of Existing Components

1. Clean and repair existing equipment and materials that will remain or be reused. Replace damaged components where necessary.
2. Clean exposed surfaces and re-torque all electrical connections.
3. Revise panel circuit directories for panelboards that are used to serve new loads.
4. Remove existing luminaires and clean all surfaces prior to reinstallation.

H. Owner's Right of Salvage

1. Owner may designate and have salvage rights to any material herein demolished by the Contractor. Turnover all materials to be salvaged at a place and time designated by Owner. Maintain condition of salvaged materials for re-use. Repair or replace damaged materials at no additional cost to Owner. Remove and dispose all materials that are not identified to be salvaged.

3.2 START-UP, TESTS AND DEMONSTRATIONS

- A. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner. Notify Owner, Architect, Engineer or Inspector at least 10 days prior to beginning testing.
- B. Follow manufacturer's instructions for start-up and adjustment. Contractor shall provide services from a factory certified representative where specified or contractor does not have qualified personnel.
- C. Contractor shall test the electrical grounding system resistance in accordance with Specification Section 26 0526 – Grounding and Bonding for Electrical Systems and submit a report to Design Professional stating the results.

- D. Prior to acceptance of the electrical installation, the Contractor shall demonstrate to the Owner, or their designated representatives, all essential features and functions of all systems installed, and shall instruct the Owner in the proper operation and maintenance of such systems. Owner instruction shall be provided for the following systems:

Sections	Description	Hrs. on Site	Hrs. off Site	Presented By	Others Present	Remarks
26 22 00 26 24 13 26 24 16 26 24 19 26 28 15	Electrical Dist. System	4		Contractor		
26 29 13 26 24 19	Motor Controls	2		Contractor		
26 32 13 26 36 00	Emergency Generator	4		Manufacturer's Representative	Contractor	1
26 09 23 26 50 00	Building Lighting Controls	2		Manufacturer's Representative	Contractor	
REMARKS:						
<ol style="list-style-type: none"> 1. Perform complete system test at time of instruction. 2. Refer to 26 09 23 for training requirements. 3. Any unused hours shall be used at Owner's discretion during the first year of occupancy. 						

- E. Contractor shall submit to the Design Professional a certificate signed by the Owner stating the date, time, and persons instructed and that the instruction has been completed to the Owner's satisfaction. An example of a certificate form is as follows:

CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that the contractor has demonstrated the hereafter listed systems to the Owner's representatives in accordance with the Contract documents and that the instruction has been completed to the Owner's satisfaction.

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: _____

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

_____ signature

_____ date

Owner's Representative:

_____ signature

_____ date

3.4 DELIVERY AND STORAGE

- A. Deliver and store products per Division 1 requirements.
- B. Store in dry and clean space(s). Leave products in factory shipping materials and/or protect from water, dust and other debris.
- C. Provide environmental heating as necessary to prevent moisture damage.

3.5 EQUIPMENT ACCESS

- A. Maintain equipment clearances and access, repair or removal for maintenance. Relocate equipment, devices, raceways, etc. to allow maintenance access at no additional cost to the Owner.
- B. Refer to Architectural elevations for device locations. Identify locations that may have limited access prior to installation of equipment or devices.
- C. Verify location of door latch prior to installation of light switches.

3.6 SUPPORTS

- A. Provide supporting steel as necessary for installation of equipment including hangers, support frames, beams, etc.
- B. Use steel plug type concrete anchors of equipment supports. Lead, plastic or other materials are not permitted.
- C. Do not support equipment or luminaires from metal roof decking.
- D. Protect threaded rods, bolts and any other sharp edges mounted below 7'-0" above finished floor to protect personnel from injury.

3.7 CLEANING

- A. Prior to assembly of electrical equipment, all loose dirt, scale, oil and other foreign matter on internal and exterior surfaces shall be removed by means consistent with good electrical practices.
- B. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.
- C. Electrical equipment shall be thoroughly cleaned on the interior and exterior of equipment. This includes but is not limited to removal of wiring trimmings within electrical panels and dirt/debris from activation boxes.
- D. All light fixtures shall be wiped clean with all fingerprints and dust removed.

END OF SECTION 26 05 00

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 - Common Work Results for Electrical are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all material, tools, labor, and supervision necessary to install all wiring systems.
- B. This section describes the basic materials and methods of installation for general wiring systems of 600 volts and less. Wiring for a higher voltage rating, if required, shall be as specified in other sections or called for on the drawings.

1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wire, cable, and connectors.
- B. UL Compliance: Comply with UL standards pertaining to wire, cable, and connectors.
- C. UL Labels: Provide electrical wires, cables and connectors which have been UL-listed and labeled.
- D. NEMA/ICEA Compliance: Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of wire and cable.
- E. ANSI/ASTM: Comply with applicable portions of ANSI/ASTM standards pertaining to construction of wire and cable.
- F. The materials used for wiring systems shall be the products of a manufacturer regularly engaged in the manufacturing of the specified material.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for each product specified.

PART 2 - PRODUCTS

2.01 WIRE AND CABLE

- A. All wire and cable for power, lighting, control, and signal circuits shall have copper conductors of not less than 98% conductivity and shall be insulated to 600 V. Conductor sizes #12 AWG and smaller shall be solid, conductor sizes #10 AWG and larger shall be stranded.
- B. Minimum size conductors shall be #12 AWG for power and lighting.
- C. Type of wire and cable for various applications shall be as follows:
 - 1. Type THHN/THWN-2, or XHHW-2 (90 deg. C) - use for branch circuits, Class 1 control circuits, panel and equipment feeders in dry locations. Use XHHW-2 between VFD and motor.
 - 2. Type XHHW-2 (90 deg. C) - use for branch circuits, panel and equipment feeders located underground and in wet and dry locations.
 - 3. Type XLPE (105 deg. C) twisted conductors – use for Class 2 and 3 circuits.

4. Type SO – use for cord drops and portable appliance connections. Use wire mesh, stainless-steel strain relief at terminations.

2.02 CONDUCTOR COLOR CODING

- A. Wiring systems shall be color coded. Conductor insulation shall be colored in sizes up through #8 AWG. Conductors #6 AWG and larger shall be colored or have black insulation and shall be phase color coded with one-half inch band of colored tape at all junctions and terminations. Colors shall be assigned to each conductor as described below and carried throughout all main and branch circuit distribution. When necessary to use tape, use colored tape on black wire. Do not use colored tape on colored wire.

	120/240V - Delta	120/208V - Wye	277/480V - Wye
Phase 'A' Conductor	Black	Black	Brown
Phase 'B' Conductor	Orange**	Red	Orange
Phase 'C' Conductor	Red	Blue	Yellow
Neutral Conductor	White*	White*	Grey*
Equipment Grounding Conductor	Green	Green	Green
Isolated Grounding Conductor		Green w/Yellow Stripe	Green w/Yellow Stripe

* For branch circuits with non-shared neutral conductors, provide colored tracer to match associated phase conductor. Tracers shall be Black, Red, Blue, Brown, Orange, or Yellow.

** Use red and black for phases which are 120V to neutral. Use orange for "wild leg".

2.03 CONNECTORS

- A. Twist-on Wire Connectors.

1. Dry Locations. 600V rated, UL 486C listed, Ideal Industries 451/452/454 or equal by 3M or Thomas and Betts. Use for #8 and smaller.
2. Wet locations. 600V rated, UL 485D listed with pre-filled silicone sealant. Ideal industries 61/62/63 series or equal by 3M or Thomas and Betts. Use for #8 and smaller. To be used for all above ground splices in exterior locations and interior wet locations.
3. Underground locations. 600V rated, UL 485D listed for direct burial with pre-filled silicone sealant. Ideal Industries 60/64/66 series or equal buy 3M or Thomas and Betts. Use for #8 and smaller. To be used for all below ground and in-slab locations.

- B. Push-in Wire Connectors.

1. Dry Locations. 600V rated, UL 486C listed, Ideal Industries 32/33/34 or equal by Wago, 3M or Thomas and Betts. Use for #10 and smaller.

- C. Conductor Taps and Splices.

1. Dry Locations. 600V rated, UL 486A/B listed, insulated mechanical termination. IlSCO ClearTap PCT or equal by Burndy. Use for #6 and larger.
2. Wet and Underground Locations. 600V rated, UL 486D listed, watertight mechanical termination suitable for direct burial in earth. IlSCO SafetySub PDSS or equal by Burndy or 3M. Use for #6 and larger.
3. Insulation piercing taps are not allowed.
4. Split bolt connectors and splices are not allowed.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Wire shall not be installed in the conduit system until the building is enclosed and masonry work is completed.
- B. Conduit shall be swabbed free of moisture and debris prior to pulling in wiring. Pull mouse through conduits prior to pulling conductors.

3.02 INSTALLATION

- A. All cable for major feeders shall be continuous from origin to termination, unless otherwise indicated.
- B. Branch circuit conductor sizes shall be increased to maintain a maximum 3% voltage drop.
 - 1. 120V, 20A homeruns shall be sized as follows based on one-way circuit length:
 - a. 0-80': #12 AWG
 - b. 81'-140': #10 AWG
 - c. 141'- 210': #8 AWG
 - d. 211' and over: #6 AWG
 - 2. 277V, 20A homeruns shall be sized as follows based on the one-way circuit length:
 - a. 0-200': #12 AWG
 - b. 201'-300': #10 AWG
 - c. 301' and over: #8 AWG
- C. Conductors for emergency power systems shall be kept in entirely independent of all other wiring and equipment. Emergency system wiring shall not occupy the same raceway, wireway or junction box,
- D. Conductors for 208V and 480V systems shall be installed in separate raceway systems.
- E. Splices shall be made only in accessible junction boxes or handholes.
- F. All power feeder cable shall be pulled with the use of approved pulling compound or powder. Compound must not deteriorate conductor or insulation.
- G. If conductor insulation is damaged during installation, replace entire conductor.
- H. Use pulling means, including fish tape, cable or rope which cannot damage raceway.
- I. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members and follow surface contours, where possible.
- J. Keep branch circuit conductor splices to a minimum.
- K. The continuity of circuit conductors shall not be dependent on service connections such as lamp holders, receptacles, etc., where the removal of such devices would interrupt the continuity.
- L. Provide separate green equipment ground conductor throughout entire electrical system.
- M. Isolated ground conductors shall be kept isolated from the equipment grounding system from the outlet back to where the system is derived.
- N. All branch circuits shall have dedicated neutrals.
- O. Leave at least 6" of slack for terminations at wiring devices.
- P. For all vibration type installations (i.e. motors, etc.), provide stranded type conductors.

Q. Support cables above accessible ceilings from structure. Do not place cables on ceiling panels.

3.03 FIELD QUALITY CONTROL

- A. Prior to energizing system, test cable and wire for continuity of circuitry, and for short circuits. Correct malfunctions when detected.
- B. After wire terminations are complete, energize circuitry and demonstrate function in accordance with requirements.

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 - Common Work Results for Electrical are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of grounding work is indicated by drawings and shall comply with NEC.
- B. Applications of grounding work in this section include the following:
 - 1. Underground metal water piping including new water service.
 - 2. Metal building frames.
 - 3. Grounding electrodes.
 - 4. Grounding rods.
 - 5. Separately derived systems.
 - 6. Enclosures.
 - 7. Equipment.
- C. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring. Provide grounding products which are UL-listed and labeled.
- B. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical grounding and bonding.
- C. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.

PART 2 - PRODUCTS

2.1 GROUNDING SYSTEMS

- A. Materials and Components
 - 1. General: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.
 - 2. All components shall be listed under ANSI/UL 467 – “Grounding and bonding Equipment”.
 - 3. Raceways: Provide raceways, and electrical boxes and fittings complying with Division 26, Section 26 0533 – Raceway and Boxes for Electrical Systems.

4. Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC.
- B. Connectors
1. Lugs: Grounding and bonding conductors shall terminate in two-hole, long barrel irreversible compression lugs, Burndy YGA series or equal by Blackburn, IlSCO, Erico, Harger or Anderson.
 2. Exothermic welds: Graphite mold designed for the specific connection type required. Weld metal used for grounding connections shall contain copper oxide, aluminum and not less than 3% tin as the wetting agent. Exothermic weld products by Erico, Harger or approved equal.
 3. Ground clamps for pipes: Bronze with pad for 2-hole lug, Burndy GAR-TC series or equal by Blackburn, IlSCO, Erico, Harger or Anderson.
- C. Ground bars: Ground bars shall be 4" wide, 1/4" thick solid copper with insulating bushings and 7/16" holes. Hole spacing to accommodate 3/4", 1" and 1-3/4" lugs. Ground bars shall be a minimum of 12" long, refer to plans for specific length.
1. Ground bars for telecommunications shall be manufactured to TIA-607-B.
- D. Grounding Rods
1. Ground Rods:
 - a. Copper clad steel, 3/4" dia. x 10' for service entrance.
 - b. Copper clad steel, 5/8" dia x 8' for other applications.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL GROUNDING

- A. General: Install electrical grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding system with other work.
- C. Install bonding jumpers with ground clamps on water meter piping to electrically bypass water meters.
- D. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- E. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.
- F. Bury ground rods vertically with rod top a minimum of 2 feet below grade, or with rod top terminated in a gravel filled ground well. If extensive rock formation is encountered, inform the Design Professional and relocate ground rods, or provide supplemental ground rods as directed by the Design Professional.
- G. A No. 1/0 AWG minimum stranded copper wire shall be furnished and exothermically welded to all of the ground rods.

- H. Protect ground conductors from physical and environmental damage. Wherever possible, and where indicated, grounding electrode and bonding conductors shall be enclosed in a non-metallic raceway. Where ground conductors are subject to physical damage, install in galvanized rigid steel conduit with grounding bushings on each end. Locate exposed conductors which must extend from a concrete surface as close as possible to a corner. Where conductors are required to be exposed, as in the connection to the main ground bus, support ground conductors by corrosion resistant metallic hardware at 4-foot intervals or less.
- I. Exothermic Welding
 - 1. Clean and dry the surface to be welded. Wire brush or file the point of contact to a clean bare metal surface.
 - 2. Use welding cartridges and molds for the type of weld recommended by the manufacturer and perform welding in accordance with the manufacturer's recommendations. Worn or damaged molds not to be used.
 - 3. Test all welds by striking with a 2 pound steel hammer. Replace any defective welds.
 - 4. Where exothermic welds are made to a galvanized surface, remove the galvanizing using a grinding wheel to expose a clean surface. After welding, touch up the steel surface with zinc rich primer.
- J. Provide separate green ground conductor throughout entire electrical system sized as required by the NEC.
- K. Conduit Grounding
 - 1. Bond all metallic conduit systems together to provide a continuous electrical ground path. Bond metallic conduits to other conduit components using insulated ground bushings when required. Connect ground bushings to the grounding system using conductors sized in compliance with NEC.
 - 2. Provide ground conductors in non-metallic conduits in accordance with the NEC.
- L. All portions of the metal building structure that are not electrically continuous shall be bonded to the service entrance grounding electrode system.
- M. Bond natural gas piping to the grounding system in accordance with the NEC and International Fuel Gas Code with a #6 AWG conductor to the main ground bar.

3.2 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding system, test ground resistance with earth test megger. Results shall be submitted to the Design Professional on a report form similar to that which follows:

EARTH RESISTANCE
FIELD REPORT

PROJECT: _____

JOB NUMBER: _____

PAGE _____

OWNER: _____

DATE OF TEST: _____ CONDITIONS: _____

TEST LOCATION: _____

TEST METHODS: _____

TEST INSTRUMENT: _____

SOIL RESISTIVITY/TYPE: _____

COMMENTS (If applicable):

TESTING RESULTS:

Earth Resistance Testing:
Description of systems tested _____

Resistance
to earth

Test No.

A) _____

B) _____

C) _____

D) _____

E) _____

COMPLETED BY: _____ COPY TO: _____

COMPANY: _____

- B. Where tests show resistance to ground is over 3 ohms, take appropriate action to reduce resistance to 3 ohms or less by driving additional ground rods or by chemically treating soil encircling ground rod.
 - 1. Retest to demonstrate compliance.

- C. Medium Voltage System Grounds:
 - 1. Test entire ground system for satisfactory continuity.
 - 2. Subject completed system to megger test at each pull point, each building, and at switchyard to ensure ground does not exceed 5 ohms.
 - 3. Tests may be accomplished by Triangulation Method.

END OF SECTION 26 05 26

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Provide materials, labor and supervision as necessary to provide hangers and supports for conduit, fixtures and equipment.

1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical supporting devices.
- B. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA Std. Pub. No. FB 1, "Fittings and Supports for Conduit and Cable Assemblies".
- C. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.
- D. UL Compliance: Provide electrical components which are UL-listed and labeled.

PART 2 -PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES

- A. Manufacturer: Subject to compliance with requirements, provide channel systems of one of the following:
 - 1. B-Line Systems, Inc.
 - 2. Thomas & Betts, Superstrut
 - 3. Unistrut Div.; Tyco International
 - 4. Globestrut
- B. General: Provide supporting devices; complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation; and as herein specified. Where more than one type of device meets indicated requirements, selection is Installer's option.
- C. Conduit Cable Supports: Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct for rigid metal conduit; type wire as indicated; construct body of malleable iron casting with hot dip galvanized finish.
- D. U-Channel Strut Systems: Provide U-channel strut system for supporting electrical equipment, 16-gauge hot dip galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with standard green finish, and with the following fittings which mate and match with U-channel:
 - 1. Fixture hangers.
 - 2. Channel hangers.
 - 3. End caps.
 - 4. Beam clamps.
 - 5. Wiring stud.
 - 6. Thinwall conduit clamps.
 - 7. Rigid conduit clamps.

8. Conduit hangers.
9. U-bolts.

PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES

- A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- C. Conduit hangers and support devices shall be approved type for the method of supporting required. All hangers and supports shall have galvanized finish or other approved corrosion resistance finish. In general, hangers and supports shall be as follows:
 1. Where single or multiple run of conduit is routed on surface of structure; use conduit clamps mounted on U-channel strut so as to maintain not less than 1" clearance between conduit and structure.
 2. Where single run of conduit is suspended from overhead; use split ring conduit clamp suspended by 3/8" steel drop rod.
 3. Where multiple parallel runs of conduit are suspended from overhead; use split ring conduit clamps uniformly spaced and supported on trapeze hangers fabricated of U-channel strut, suspended by not less than two steel drop rods.
 4. Where circuit voltage is above 600 volts, conduit clamps shall be provided with insulating bushings of dielectric strength as required.
 5. Where conduit is buried in concrete floor topping; anchor conduit to structural floor with one-hole jiffy clamps.
 6. Maximum hanger and support spacing shall be in accordance with NEC.
- D. Hangers and supports shall be anchored to structure as follows:
 1. Hangers and supports anchored to poured concrete, use malleable iron or steel concrete inserts attached to concrete forms.
 2. Hangers or supports anchored to precast concrete, use self-drilling expansion shields. Expansion shields may be used where concrete inserts have been missed or additional support is required in poured concrete.
 3. Hanger or supports anchored to structural steel, use beam clamps and/or steel channels as required by structural system.
 4. Hangers or supports anchored to metal deck, use spring clips or approved welding pins. Maximum permissible load on each hanger shall not exceed 50 pounds.
 5. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls.
 6. Use sheet metal screws in sheet metal studs and wood screws in wood construction.
- E. The following is not permitted:
 1. Attaching supports and hangers to piping, ductwork, mechanical equipment, or conduit.
 2. Use of powder-actuated anchors.
 3. Drilling of structural steel members.
- F. Fixtures on plastered or acoustical ceilings shall not be supported directly on ceiling tile. Provide metal bar hangers or U-channel strut attached to ceiling supports.
- G. Where disconnect switches and panels cannot be mounted on wall, provide support racks fabricated of structural steel or U-channel strut.

- H. Provide concrete bases and pads for transformers, switchgear, free standing panels, generators, outdoor lighting poles and other equipment requiring bases, except where drawings indicate that such bases and pads are to be furnished by the General Contractor. Pads shall be 3.5" tall and extend 4" beyond footprint of equipment. Furnish all equipment anchor bolts and installation for their proper and accurate location. All concrete work and reinforcing shall comply with General Specifications.

END OF SECTION 26 05 29

SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all materials, tools labor and supervision necessary to fabricate and install complete conduit systems.
- B. Conduit systems shall be provided for all wiring, except where the drawings or other sections of the specifications indicate that certain wiring may be installed in cable trays, surface raceway, underfloor raceway, wireways and/or auxiliary gutters.
- C. Types of raceways in this section include the following:
1. Rigid metal conduit.
 2. Intermediate metal conduit.
 3. Electrical metallic tubing.
 4. Flexible metal conduit.
 5. Liquid-tight flexible metal conduit.
 6. Rigid non-metallic conduit.
- D. Provide factory painted red conduit for fire alarm system.
- E. Contractor shall furnish all material, tools, labor and supervision necessary to install electrical boxes and fittings as required by drawings and specifications.
- F. Types of electrical boxes and fittings in this section include the following:
1. Outlet boxes.
 2. Junction boxes.
 3. Pull boxes.
 4. Wireways
 5. Activation boxes.
 6. Handholes
- G. Telecommunications Raceway Requirements:
1. The term “telecommunications” includes all low voltage technology systems including voice and data, access control, video surveillance, intrusion detection, audio video, induction loop, paging, intercom, nurse call, school bell and/or clock systems. The term does not include fire alarm system, which is addressed separately in the plans and specifications.
 2. Contractor shall provide and install telecommunications boxes and conduits, including wall sleeves unless otherwise noted.
 3. Below grade building entrance conduits within the building footprint shall be schedule 40 electrical PVC unless otherwise noted. Long sweep ninety degree elbows for under building footprint conduits shall be fiberglass sweeps with PVC schedule 40 conduit connectors built into the ends of the sweeps. Sweeps of 4” diameter shall be 36” minimum radius.
 4. Below grade conduits for low voltage system cabling are not acceptable unless specifically directed. Below grade entrance conduits and floor boxes in slab on grade are exceptions to this rule.

5. Underground conduits outside the building footprint shall be continuous orange HDPE (high density polyethylene) with 1250 pound braided mule tape used as pull string unless otherwise noted. Round pull string or other rope is not acceptable for pulling due to risk of raceway damage. HDPE manufacturer approved water proof couplers shall be used for conduit type transition. HDPE to HDPE connection shall be hot fusion splice.
6. HDPE shall be minimum SDR 17 wall thickness for 2" diameter and smaller. The wall thickness shall be minimum SDR 11 for sizes larger than 2" diameter.
7. All below grade conduits shall be plugged at each end during construction to keep water, mud, rodents, etc., out.
8. All below grade entrance conduits shall be plugged on each end with removable mechanical plugs to keep water from entering the building for the life of the building. These plugs shall be installed inside the building above slab, and also at the first hand-hole outside the building (or where the conduits terminate underground). These plugs shall also seal around the utility entrance cables, including in and around all sub-ducts for a complete water tight seal. These mechanical plugs shall be as found on www.innerduct.com or engineer approved equivalent. Coordinate with the utility to determine size of cables for the plug inserts required. This work shall be completed before the Owner occupies the building.
9. All below grade exterior conduits shall have a tracer wire with adequate slack loop at each end for owner to conveniently connect and trace. All tracer wires shall protrude from closed hand holes so tracing may be accomplished without lifting the hand hole lid.
10. Interior building, above grade conduits and sleeves shall be EMT unless otherwise noted. PVC is never acceptable above grade.
11. All interior conduits shall have bushings installed during conduit installation. Completed individual installations shall have bushings installed same business day.
12. All interior conduits shall have pull strings, except sleeves which are less than 4' long. EMT conduits shall receive standard round cable pull string (multi-strand plastic twine type).
13. Minimum interior conduit size for all information jacks (voice data cabling) shall be 1" unless otherwise noted.
14. Minimum interior conduit size for audiovisual shall be 1" unless otherwise noted. Junction (pull) boxes shall be added at a maximum of 100' of raceway distance, and also for a maximum of 180 degrees of bend radius.
15. Minimum interior conduit size for video surveillance, intrusion detection, paging, intercom, nurse call, school bells and/or clock systems shall be 3/4" unless otherwise noted.
16. Access control system conduit sizes at the door location shall be per the access control detail found on the drawings. The conduit from the door location to the access control head end which contains all conductors needed for all access control functions at that door (may be individual conductors but is often one large composite cable) shall be minimum 3/4".
17. Boxes for all low voltage systems in stud walls shall be metallic 5"x5"x2.875" with single gang mud ring unless otherwise noted.
18. Wiremold surface raceway for all low voltage systems shall be minimum V2400 unless noted otherwise.
19. Wiremold surface boxes for all low voltage shall be minimum 2.5" deep single gang, unless otherwise noted.
20. Conduits inside walls which feed the low voltage side of dual compartment Wiremold shall be minimum 1.25"
21. Contractor shall provide and install hand holes for cable pulling in buried raceway at a maximum interval of 500'.

1.3 QUALITY ASSURANCE

- A. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
- B. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL-listed and labeled.
- C. NEC Compliance: Comply with requirements as applicable to construction and installation of raceway systems.
- D. The materials used in the fabrication of the raceway system shall be products of a manufacturer regularly engaged in the manufacturing of the specified material.

- E. NEC compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.
- F. UL Compliance: Provide electrical boxes and fittings which have been UL-listed and labeled.
- G. ANSI/NEMA Standards Compliance: Comply with ANSI C 134.1 (NEMA Standards Pub No. OS 1) as applicable to sheet-steel outlet boxes, covers and box supports.

1.4 SUBMITTALS

- A. Raceway Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of raceway listed below. Include data substantiating that materials comply with requirements for the following:
 - 1. Raceways and Fittings
 - 2. Surface Metal Raceway
- B. Activation Box Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations for each type of activation box required. Include data substantiating that units comply with requirements.
- C. In-Ground Handhole Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations for each type of handhole required. Include data substantiating that units comply with requirements.

PART 2 - PRODUCTS

2.01 RACEWAYS

- A. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements, and comply with applicable portions of NEC for raceways. Conduit shall be used where concealed in permanent wall construction or in ceiling plenums. Surface raceway shall be used where exposed in finished regularly occupied areas.
- B. Rigid Conduit: Full weight, threaded, rigid steel conduit, galvanized inside and out by hot dip or electro galvanized process. Additional protection by electrostatically applied baked coating. Thread protective caps and couplings. Use for all feeders larger than 2 1/2" in size.
- C. Intermediate Metal Conduit (IMC): May be used as approved by code where rigid conduit is specified, except shall not be used for conduit buried in earth fill.
- D. Electrical Metallic Tubing: Thin wall, electrically welded cold rolled steel conduit, galvanized inside and out by electro galvanized process. Baked clear elastic enamel coating in and out. Use for installations in stud walls, masonry walls, above suspended ceilings and where exposed. Size limited to 2 1/2" and smaller.
- E. Flexible Metal Conduit: Formed of one continuous length of spirally wound electro galvanized steel strip. Use for final connections to all motor operated equipment such as unit heaters, fans, air handling units, pumps, generators, generator enclosures and connections to dry type transformer, connections from junction boxes to lighting fixtures in accessible ceiling, and for wiring within casework and millwork. 6' maximum length.
- F. Liquidtight Flexible Metal Conduit: Formed of one continuous length of spirally wound steel strip, with water and oil tight neoprene jacket. Use for final connection to equipment listed in paragraph "E" above when located in wet areas.
- G. PVC Conduit: Conduit shall be Carlon PV-Duit, Type 40, 90 deg.C. Conduit shall be composed of Polyvinyl Chloride and shall conform to NEMA Standards. Conduit, fittings and cement shall be produced by the same manufacturer. May be used where installed in earth fill or in poured concrete walls, columns, floors, or under concrete slab.

- H. Rigid Aluminum Conduit: Full weight, threaded, rigid aluminum conduit. Thread protective caps and couplings.
- I. MC cable will not be allowed.

2.02 CONDUIT FITTINGS

- A. Rigid Conduit Fittings:
 - 1. Fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be malleable iron, steel or aluminum alloy. Iron or steel fittings shall be zinc or cadmium plated. Aluminum fittings shall not contain more than 0.4 percent copper. Aluminum fittings shall be used with aluminum conduit only.
 - 2. Locknuts shall be of the bonding type with sharp edges for digging into the metal wall of an enclosure.
 - 3. Bushings shall be of the metallic insulating type and consist of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - 4. Sealing fittings shall be of the threaded cast iron type. Sealing fittings used to prevent passage of water vapor shall be of the continuous drain type.
 - 5. Set screw fittings are not allowed.
- B. Metallic Tubing Fittings: Compression type galvanized or zinc coated malleable iron or steel, water and concrete tight where exposed to wet locations or imbedded in concrete. Steel set screw type acceptable in all dry location applications. Die-cast fittings are not allowed.
- C. Flexible Metal Conduit Fittings: External squeeze or set screw type galvanized or zinc coated malleable iron or steel with nylon insulated throats. Internal screw type fittings are not allowed.
- D. Liquidtight Flexible Conduit Fittings: Galvanized malleable iron or steel, with watertight gaskets, "O" ring and retainer, and nylon insulated throats.
- E. Condulet Fittings: Exposed conduit fittings shall be condulet type for all sharp turns, tees, etc.
- F. Surface Metal Raceway Fittings: Provide types that match and mate to raceways provided.
- G. Provide insulated bushings for all conduits terminations.

2.03 WALL OUTLET BOXES

- A. General: Boxes shall be Raco, Steel City, Appleton or equal, catalog numbers based on Raco, unless otherwise indicated. In general, the type of boxes shall be as follows:
 - 1. In Stud Walls: For single outlet use 4" square by 2-1/8" deep box. Boxes to be provided with raised covers of depth as required for thickness of wall materials.
 - 2. Surface Mounted Wall Outlets for conduit: Use 4" square by 1-1/2" deep box #192 with raised cover.
 - 3. Surface Mounted Wall Outlets for surface metal raceway: Use single gang boxes 1-1/2" deep Wiremold #V57xx series.
 - 4. Suspended Ceiling: Use octagon boxes, depth as required for application, securely fastened to structure. Outlets Installed Outdoors or in Wet Locations: Use Bell Product 53XX Series outlet box.

2.04 ACTIVATION BOXES

- A. Activation Boxes: Provide boxes as scheduled on the drawings.
- B. Activation boxes shall be provided with barriers to separate high and low potential voltages.
- C. Activation boxes shall be, complete with necessary gaskets, plates, spacers, mud caps, covers, fasteners, brackets and ancillary components appropriate for their installation. Follow manufacturer's specific written instructions for each type of installation.

- D. Furnish electrical outlets with duplex receptacles per specification Section 26 2726 – Wiring Devices.
- E. Manufacturers: Subject to compliance with requirements, the following manufacturers are acceptable:
 - 1. Wiremold
 - 2. FSR Inc.
 - 3. Hubbell
 - 4. Steel City

2.05 PULL BOXES, AND JUNCTION BOXES

- A. Construction, sizes and installation of pull boxes and junction boxes shall comply with NEC, Article 314.
- B. Pull and junction boxes not specifically described in NEC, Article 314, shall be fabricated of heavy gauge galvanized steel with screw or hinged covers, and equipped with corrosion resistant screws and hardware.
- C. Pull and junction boxes for installation in poured concrete floors shall be flush type, cast iron, with watertight gasketed covers. Boxes for installation in floors with tile or carpet floor covering shall have recessed covers to accommodate the floor covering.
- D. Pull boxes and junction boxes for outdoor installation shall be raintight.
- E. Pull boxes, and junction boxes designated '4X' shall be NEMA 4X water tight and corrosion resistant.

2.06 METAL WIREWAYS

- A. Construction, sizes and installation metal wireways shall comply with NEC, Article 376.
- B. General: Provide electrical raceways of types, grades, sizes and weights (wall thicknesses), number of channels, for each type of gutter indicated. Provide complete assembly of raceway including, but not necessarily limited to, couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as needed for complete system. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements, and comply with applicable provisions of NEC for electrical raceways.
- C. Wireways shall be constructed as a complete assembly of raceway including, but not necessarily limited to, couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as needed for complete system. Gutters shall have hinged covers. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements.
- D. Wireways shall have hinged covers unless noted otherwise.
- E. Wireways for outdoor installation shall be raintight.
- F. Wireways designated '4X' shall be NEMA 4X water tight and corrosion resistant.

2.07 IN-GROUND HANDHOLES

- A. UL or ETL Listed, polymer concrete construction, open bottom stackable. Quazite PG style or equal.
 - 1. Manufacturer: Subject to compliance with requirements, the following manufacturers are acceptable:
 - 2. Quazite
 - 3. HiLine
 - 4. Armormcast
 - 5. New Basis
- B. All stainless steel hardware with minimum two fasteners per lid.

- C. Extra heavy duty covers with non-skid surface, tier 22, 22,500 lb. vertical and 800 lbs/sq. ft. lateral design loads, unless noted otherwise.
- D. Minimum size to be 11"x18", unless noted otherwise. Larger handholes may be required at select locations.

PART 3 - EXECUTION

3.1 INSTALLATION OF RACEWAY

- A. In general, all horizontal runs of branch circuit conduit shall be installed in ceiling plenum. Raceway for convenience outlets, wall mounted fixtures and other wall outlets shall be routed overhead and dropped through wall to the outlet. Branch circuit raceway shall not be installed in or below concrete floor slabs except where conditions will not permit the raceway to be installed overhead. Conduit shall be used where concealed in permanent wall construction or in ceiling plenums. Surface raceway shall be used where exposed in finished regularly occupied areas where walls are existing.
- B. Feeder conduits to panelboards and other major loads may be installed in fill below concrete slabs on grade.
- C. Conduits that are run in fill below concrete slabs on grade shall be installed so as not to interfere with welded wire mesh (wwm), vapor barrier, or concrete placement.
- D. Generally, all conduit shall be concealed, except in crawl spaces, tunnels, shafts, mechanical equipment rooms, and at connection to surface panels and free standing equipment, and as otherwise noted.
- E. Exposed conduit and conduit concealed in ceiling space shall be routed in lines parallel to building construction.
- F. All conduit runs above suspended acoustical ceilings shall be routed so as not to interfere with tile panel removals with 4'0" to 6'0" flexible conduit drops from an independent junction box, accessible from below the ceiling, to ceiling mounted equipment.
- G. Minimum size conduit shall be 3/4" trade size. Where specified size is not called for on drawings or in the specifications, conduit shall be sized per NEC.
- H. Utilize approved thread lubricant for rigid steel and aluminum conduits to ensure equipment grounding paths.
- I. Utilize approved thread sealant for all underground and wet locations threaded conduit joints.
- J. Install the conduit system mechanically and electrically continuous from outlet to outlet and to all cabinets, junction or pull boxes. Conduit shall enter and be secured to all cabinets and boxes in such a manner that all parts of the system will have electrical continuity.
- K. All conduit penetrations to the exterior of the building including the service entrance, telecommunications, site feeds, grounding electrode and spare conduits shall be sealed at one or both ends against the intrusion of water and gasses. The seal shall be identified for use with the cable insulation installed. All seals shall be removable.
- L. Installation of PVC conduit shall comply with the NEC with regard to grounding and expansion fittings.
- M. PVC conduit shall not be installed above grade unless noted otherwise.
- N. Support conduit raceway systems in accordance with requirements as set forth in the National Electric Code.
- O. All connections to NEMA 3R enclosures shall maintain the enclosure listing regardless of the equipment location.
- P. Provide liquidtight flexible metal conduit for the last 3' of feeder/circuit for all vibration type equipment (i.e. motors, transformers, etc).

3.2 INSTALLATION OF BOXES AND FITTINGS

- A. Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.

3.3 OUTLET BOX INSTALLATION

- A. Outlet boxes shall be installed for all fixtures, switches, receptacles and other devices.
- B. Approximate locations of outlets are shown on the plans, but each outlet location as shown shall be checked by Contractor before installing the outlet box.
- C. Wall boxes installed flush in common wall shall not be back-to-back or through-wall type. Boxes located on opposite sides of a common wall that are closely connected by conduit shall have the conduit openings plugged with duct seal.
- D. Install boxes and conduit bodies in those locations to ensure ready accessibility of electrical wiring.
- E. Outlet boxes shall be installed plumb and square with wall face and with front of box or cover located within 1/8" of face of finish wall. Boxes in masonry shall be set with bottom or top of the box tight to the masonry unit.

3.4 PULL BOX, JUNCTION BOX & WIREWAY INSTALLATION

- A. Install pull boxes, junction boxes and auxiliary wiring gutters where indicated on drawings and where required to facilitate installation of the wiring.
- B. For concealed conduit, install boxes flush with ceiling or wall, with covers accessible and easily removable. Where flush boxes are installed in finish ceilings or walls, provide cover which shall exceed the box face dimensions by a sufficient amount to allow no gap between box and finished material.
- C. Boxes shall not be located in finished, occupied rooms, without prior approval of Design Professional.

3.5 ACTIVATION BOX INSTALLATION

- A. Install activation boxes flush with surrounding wall or floor surface, factor in lids and covers in addition to wall/floor finishes when setting boxes.
- B. Coordinate raceway into boxes with Telecom and AV Contractors to limit number of bends and entry into appropriate sides of boxes.
- C. Coordinate exact placement of boxes with Architectural details, do not scale drawings for locations.

3.6 IN-GROUND HANDHOLE INSTALLATION

- A. Install all handholes flush with surrounding grade. Adjust handholes as required for finished grade.
- B. Do not install handholes at low grade points. Install at locations to allow drainage away from box.
- C. Provide 1" clean compacted fill beneath handholes for drainage. Clean fill shall extend 8" beyond the sides of the handhole enclosure, and a minimum of 12" deep.

END OF SECTION 26 05 33

SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.
- B. Trenching, methods and procedures; Section 31 2000 – Earth Moving.

1.02 DESCRIPTION OF WORK

- A. This section specifies manholes, handholes and ductlines to form a complete underground raceway system, including but not limited to the underground raceways of power and signal service equipment in buildings from exterior pad mounted transformers, switchgear, and other similar exterior power or signal service equipment.

1.03 QUALITY ASSURANCE

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Underwriters Laboratories, Inc. (UL):

651-81 Schedule 40 and 80 Rigid PVC Conduit
- C. National Fire Protection Association (NFPA):

70-02 National Electrical Code (NEC)
- D. National Electrical Manufacturers Association (NEMA):

TC 2-83 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

TC 3-83 PVC Fittings For Use With Rigid PVC Conduit and Tubing
- E. American Concrete Institute (ACI):

318-83 Building Code Requirements for Reinforced Concrete

1.04 SUBMITTALS

- A. Submit in accordance with Section 01 3300 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Include duct materials and hardware. Proposed deviations from details on the drawings shall be clearly marked on the submittals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Concrete: ACI-318, 2000 psi minimum 28 day compressive strength.

B. Duct Lines:

1. Size, except where otherwise shown on the drawings, ducts and conduits not less than 4-inch trade size.
2. Ducts (concrete encased), plastic Schedule 40 suitable for use with 90 degree C rated cables.

PART 3 - EXECUTION

3.1 TRENCHING

- A. Refer to Section 31 2000 – Earth Moving for excavating, shoring sheeting, bracing, and backfilling.
- B. Work with extreme care near existing ducts, conduits, cables, and other utilities to avoid damaging them.
- C. Cut the trenches neatly and uniformly.
- D. For Concrete Encased Ducts:
 1. After excavation of the trench, stakes shall be driven in the bottom of the trench at four foot intervals to establish the grade and route of the duct bank.
 2. The walls of the trench may be used to form the side walls of the duct bank provided that the soil is self-supporting and that concrete envelope can be poured without soil inclusions. Forms are required where the soil is not self-supporting.
 3. After the concrete encased duct has sufficiently cured, the trench shall be backfilled to grade with earth.

3.2 DUCT LINE INSTALLATION

- A. Duct lines shall be in accordance with the NEC, as shown on the drawings, and as specified.
- B. Curved sections in duct lines shall consist of long sweep bends.
- C. Underground conduit stub-ups to equipment, mounted on outdoor concrete slabs, shall be galvanized rigid steel, and shall extend a minimum of five feet away from edge of slab. Install insulated grounding bushings on the terminations. The steel conduits shall be coupled to the ducts with suitable adapters, and the whole encased with three inches of concrete.
- D. Upon completion of the duct bank installation, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the line. The mandrel shall be not less than 12 inches long, and shall have a diameter 1/2-inch less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.
- E. Seal the ducts and conduits at outdoor terminations for equipment with a suitable non-hardening compound to prevent the entrance of moisture and gases.
- F. Concrete Encased Ducts:
 1. Install concrete encased ducts for high voltage systems.
 2. Duct lines shall consist of a pair of duct assemblies encased in concrete and installed with top of duct bank not less than 24 inches below established grade. Ducts shall be uniform in size and material throughout the installation.
 3. Rigid, unplasticized, polyvinyl chloride spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of three inches above bottom of trench during the concrete pour. Spacer spacing shall not exceed five feet.
 4. Clearances between individual ducts:
 - a. For like services, not less than three inches.
 - b. Provide plastic spacers to maintain clearances.

- c. Provide nonferrous tie wires to prevent displacement of the ducts during pouring of concrete. Tie wires shall not act as a substitute for spacers.
5. Couple the ducts with proper couplings. Stagger couplings in rows and layers to ensure maximum strength and rigidity of the duct bank.
6. Extend the concrete envelope encasing the ducts not less than three inches beyond the outside walls of the outer ducts and conduits.
7. Install reinforcing steel bars at the top and bottom of each concrete envelope of all ducts underneath roadways and parking areas.
8. Keep ducts clean of earth, sand, or gravel during construction, and sealed with tapered plugs upon completion of each portion of the work.

3.3 RESTORATION

- A. After concrete encased ducts and manhole have been properly installed and the concrete has had time to set, the trench and other excavations shall be backfilled in no more than 8 inch thick layers with excavated material not larger than 4 inches in diameter and thoroughly tamped and compacted to at least the density of the surrounding undisturbed soil. If necessary to obtain the desired compaction, the backfill material shall be moistened or aerated as required.
- B. Trenches and excavations shall not be excessively wet and shall not contain pools of water during backfilling operations.
- C. The trench and excavation shall be completely backfilled and tamped level with the adjacent surface, except where sod is to be placed over the trench the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.
- D. Any excess excavated material shall be removed and disposed of in accordance with instructions issued by the Design Professional.
- E. Reconditioning of Surface: The surface disturbed during the installation of duct line or manhole shall be restored to its original elevation after the backfilling is completed. Sod that is damaged shall be replaced by sod of a quality equal to that removed. Where the surface is disturbed in a newly seeded area, the restored surface shall be re-seeded with the same quantity and formula of seed as that used in the original seeding.

END OF SECTION 26 05 43

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Contractor shall provide identification for wiring systems and equipment as called for in this section.
- B. Types of electrical identification specified in this section include the following:
 - 1. Conduit color banding.
 - 2. Buried cable warnings.
 - 3. Cable conductor identification.
 - 4. Operational instructions and warnings.
 - 5. Danger signs.
 - 6. Equipment/system identification signs.

1.3 QUALITY ASSURANCE

- A. UL Compliance: Comply with applicable portions of UL safety standards pertaining to electrical marking and labeling identification systems.
- B. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION MATERIALS

- A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.
- B. Color-Coded Conduit System
 - 1. General: Provide manufacturer's standard colored conduit for EMT installations as noted below. For rigid aluminum, rigid steel, and IMC conduit, use colored electrical tape to band conduits within 6" of termination at each switchboard, panelboard, distribution board, pull box and junction box. Where conduit is exposed and painted to match adjacent surfaces, band with colored electrical tape.
 - 2. Colors:
 - a. Normal Power: gray/silver (uncolored)
 - b. Emergency: yellow*
 - c. Fire alarm: red*
 - d. Division 27 systems: purple**
 - e. Division 28 systems excluding fire alarm: purple**
 - * Factory colored conduit required for EMT conduit
 - ** Field applied electrical tape banding at conduit terminations required. Factory colored conduit optional for EMT conduit.
 - 3. For exposed conduits in finished spaces, refer to architectural for paint to match room finish.
 - 4. For branch circuits, mark panel name and circuit numbers on all junction/pull boxes.

- C. Underground-Type Plastic Line Marker
 - 1. General: Manufacturer's standard permanent, bright colored, continuous-printed plastic tape; not less than 6" wide x 4 mils thick intended for underground service. Provide tape with printing which most accurately indicates type of service of buried cable/conduit.
- D. Cable/Conductor Identification Bands
 - 1. General: Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.
- E. Self-Adhesive Tape for Receptacle Circuit Identification
 - 1. General: Provide clear self-adhesive or pressure-sensitive, pre-printed, flexible vinyl tape for panel name and circuit number.
- F. Engraved Plastic-Laminate Signs
 - 1. General: Provide engraving stock melamine plastic laminate, in sizes and thickness indicated, engraved with engraver's standard letter style of sizes and wording indicated, black and white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - a. Thickness: 1/16", for units up to 20 sq. in. or 8" lengths; 1/8" for larger units.
 - b. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

- A. General Installation Requirements
 - 1. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
- B. Conduit Identification
 - 1. Conduit above accessible ceiling spaces shall be identified per 2.01 B.
 - 2. Where electrical conduit is exposed in spaces with exposed mechanical piping which is identified by a color-coded method, apply color-coded identification on electrical conduit in a manner similar to piping identification.
 - 3. Identify junction and pullboxes of systems with stencil lettering for panel and circuit numbers or system type.
- C. Underground Cable/Conduit Identification
 - 1. General: During back-filling/top/soiling of each exterior underground electrical, signal or communication cable or conduit, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.
- D. Cable/Conductor Identification
 - 1. General: Apply cable/conductor identification on each cable and conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents and similar previously established identification for project electrical work.

E. Operational Identification and Warnings

1. General: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

F. Equipment/System Identification

1. General: Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, 1/2" high lettering on 1-1/2" high sign (2" high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work.
 - a. Panelboards, electrical cabinets and enclosures.
 - b. Access panel/doors to electrical facilities.
 - c. Major electrical switchgear.
 - d. Motor control centers, disconnects & starters.
 - e. Power transfer equipment.
 - f. Transformers.
 - g. Inverters.
 - h. Generators.
2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrate.
3. Provide labeling of Enclosed Circuit Breakers, Switchboards, Panelboards and Disconnects per NEC Articles 110, 700 and 702 for multiple services and essential electrical system.
4. All receptacles and light fixtures shall be labeled with panel and circuit number. Final location of label shall be field coordinated. If labeling is to be on outside of cover, Contractor shall use clear dyno-tape with black lettering that matches other tags.
5. All panelboards shall be labeled with panel ID, conduit size, feeder wire size, origin and size of overcurrent protection device serving panelboard and phase schedule. Format shall be as follows:
6. "Panel XX, 1.25"C, 4#3, 1#8, Fed from Dist. Bd. XX by 100A/3P
7. Phase A: Black, Phase B: Red, Phase C: Blue"
8. All new panelboards shall be labeled (5/32" or larger) with the following:
9. "Caution – This equipment has a minimum short circuit design requirement of ___KA. All devices installed must have a rating equal or higher than the design requirement."
10. All safety switches shall have a permanent label attached to inside of cover describing the fuse size, type, current limiting ability and devices controlled.

END OF SECTION 26 05 53

SECTION 26 05 73
SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 SCOPE

- A. The contractor shall furnish short-circuit, protective device coordination studies and arc flash analysis which shall be prepared by the equipment manufacturer or third party Engineering Services Organization.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

1.2 RELATED SECTIONS

- A. 26 2416 – Panelboards
- B. 26 2816 – Enclosed Switches and Circuit Breakers
- C. 26 2913 – Enclosed Controllers
- D. 26 2923 – Variable-Frequency Motor Controllers
- E. 26 3600 – Transfer Switches

1.3 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
 - 2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - 3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
 - 4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
 - 5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
 - 6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations
- B. American National Standards Institute (ANSI):
 - 1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
 - 2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
 - 3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
 - 4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories
 - 5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents
- C. The National Fire Protection Association (NFPA)
 - 1. NFPA 70 - National Electrical Code, latest edition
 - 2. NFPA 70E – Standard for Electrical Safety in the Workplace
 - 3. Submittals for review/approval
- D. The short-circuit and protective device coordination studies shall be submitted to the Design Professional prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Design Professional may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.4 SUBMITTALS FOR CONSTRUCTION

- A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies, where required, shall be provided on CD in PDF format.
- B. A preview of the report shall be submitted to the Design Professional indicating short circuit calculations and arc flash levels prior to any electrical gear being released.
- C. The report shall include the following sections:
 - 1. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations.
 - 2. Descriptions, purpose, basis and scope of the study
 - 3. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
 - 4. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings.
 - 5. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout.
 - 6. Incident energy and flash protection boundary calculations
 - 7. Study shall include closed transition operation of automatic transfer switches and/or generator paralleled with utility and worst-case short circuit rating shall be included in analysis for each piece of equipment. The closed transition and normal operation short circuit ratings shall both be used to explore the worst-case arc fault rating for each piece of electrical equipment.
 - 8. Comments and recommendations for system improvements, where needed.
 - 9. Executive Summary including source of information and assumptions made.

1.5 QUALIFICATIONS

- A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies with a minimum of 5 years of recent experience performing similar analyses. The Registered Professional Electrical Engineer shall be a full-time employee of the Engineering Services Organization.

PART 2 - PRODUCTS

2.1 STUDIES

- A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or third party Engineering Services Organization. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the motor control centers and power distribution panelboards. The study shall also include variable frequency drives, disconnect switches, transformers, electrical distribution equipment and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution equipment.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.2 DATA COLLECTION

- A. Contractor shall furnish all field data as required by the power system studies. The Design Professional performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- B. Source combination may include present and future utility supplies, motors, and generators.
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.
- D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.
- B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.
- C. Provide the following:
 - 1. Calculation methods and assumptions
 - 2. Selected base per unit quantities
 - 3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted.
 - 4. Source impedance data, including electric utility system and motor fault contribution characteristics.
 - 5. Typical calculations
 - 6. Tabulations of calculated quantities
 - 7. Results, conclusions, and recommendations
- D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
 - 1. Electric utility's supply termination point
 - 2. Incoming distribution panelboard
 - 3. Low voltage distribution panel
 - 4. Disconnect switch
 - 5. Variable frequency drive
 - 6. Standby generators and automatic transfer switches (include normal and emergency sides in parallel for closed transition switches)
 - 7. Branch circuit panelboards
 - 8. Other significant locations throughout the system
- E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
- F. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short circuit ratings.
 - 2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses.
 - 3. Adequacy of transformer windings to withstand short-circuit stresses.
 - 4. Cable and busway sizes for ability to withstand short-circuit heating.

5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.
- G. In such cases where the short circuit study results in a requirement for greater AIC ratings than those listed in the contract documents, contact the design engineer for possible solutions. Current limiting fusible technology may be added to the electrical system to limit the amount of available fault current. The provider of the short circuit calculation shall recognize current limiting fusible technology and re-run the short circuit calculations.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.
- B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
- D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the curve sheets, where applicable:
 1. Electric utility's protective device
 2. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.
 3. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters.
 4. Conductor damage curves
 5. Ground fault protective devices, as applicable
 6. Pertinent motor starting characteristics and motor damage points.
 7. Pertinent generator short-circuit decrement curve and generator damage point
 8. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each panelboard, etc.
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2018.
- B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.
- C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- D. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 8 cal/cm². Where values of greater than 8 calories per centimeter exist, advise Engineer on options for reduction of energy that exceed the contractual requirements. Include maintenance settings by setting the instantaneous to minimum where available on breaker(s).
- E. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

- F. Study shall include maintenance switch settings where applicable.
- G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.
- H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2018.

2.6 REPORT SECTIONS

- A. Input Data:
 - 1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
 - 2. Short-circuit reactance of rotating machines with associated X/R ratios
 - 3. Cable type, construction, size, # per phase, length, impedance and conduit type
 - 4. Bus duct type, size, length, and impedance
 - 5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
 - 6. Reactor inductance and continuous ampere rating
 - 7. Aerial line type, construction, conductor spacing, size, # per phase, and length
- B. Short-Circuit Data:
 - 1. Source fault impedance and generator contributions
 - 2. X to R ratios
 - 3. Asymmetry factors
 - 4. Motor contributions
 - 5. Short circuit kVA
 - 6. Symmetrical and asymmetrical fault currents
- C. Recommended Protective Device Settings:
 - 1. Phase and Ground Relays:
 - a. Current transformer ratio.
 - b. Current setting.
 - c. Time setting.
 - d. Instantaneous setting.
 - e. Specialty non-overcurrent device settings.
 - f. Recommendations on improved relaying systems, if applicable.
 - 2. Circuit Breakers:
 - a. Adjustable pickups and time delays (long time, short time, ground).
 - b. Adjustable time-current characteristic.
 - c. Adjustable instantaneous pickup.
 - d. Recommendations on improved trip systems, if applicable.
- D. Incident energy and flash protection boundary calculations.
 - 1. Arcing fault magnitude
 - 2. Device clearing time
 - 3. Duration of arc
 - 4. Arc flash boundary
 - 5. Working distance
 - 6. Incident energy
 - 7. Hazard Risk Category
 - 8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

- A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the Contractor.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Notify Owner in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

- A. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. The label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and shall include the following information:
 - 1. Location designation
 - 2. Nominal voltage
 - 3. Flash protection boundary
 - 4. Hazard risk category
 - 5. Incident energy
 - 6. Working distance
 - 7. Engineering report number, revision number and issue date
- C. Labels shall be machine printed, with no field markings.
- D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - 1. For each 600, 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided
 - 2. For each motor control center, one arc flash label shall be provided.
 - 3. For each low voltage switchboard, one arc flash label shall be provided.
 - 4. For each switchgear, one flash label shall be provided.
 - 5. For medium voltage switches one arc flash label shall be provided
- E. Labels shall be field installed by the Contractor.

END OF SECTION 26 05 73

SECTION 26 09 23
LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results fro Electrical are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Provide materials, equipment, labor and supervision necessary for a complete operational lighting control system as required by the drawings and this section.
- B. This section applies to all work under this division. This shall include, but not necessarily be limited to, the following:
 - 1. Furnish, install, and terminate all system equipment and cabling as applicable and per drawings.
 - 2. Furnish and install any cabinets and cable management as required and as indicated.
 - 3. Furnish any other material required to form a complete and operational system.
 - 4. Provide As-Built drawings per Division 0 and/or Division 1 specification.
 - 5. Provide Owner training and testing documentation.
 - 6. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
 - 7. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.
- B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL-listed and labeled.
- C. NEMA Compliance: Comply with NEMA standards for general- and specific-purpose wiring devices.
- D. ASHRAE Compliance: Comply with ASHRAE 90.1-2013 section 9.
- E. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.4 SUBMITTALS

- A. Submit manufacturer's product data literature for each lighting control component required. For occupancy sensors and related components, submit Manufacturer's device layout indicating recommended device placement, product data and project specific wiring diagrams. Submittals shall include the Sequence of Operation for each area of lighting control.

1.5 WARRANTY

- A. The control system designated on the drawings and plans and herein specified shall be guaranteed to be free from original defects in both material and workmanship for a period of five (5) years. This warranty shall become effective starting the date of project substantial completion.

1.6 SYSTEM DESCRIPTION

A. System Architecture:

1. The lighting control system shall be a non-networked, distributed lighting control system. The system shall have no central monitoring, control or time functions. Each individual room or area shall have a standalone control system that is not dependent on a network for any reason including programming.
2. All system adjustments for time delays, high-level trim, low-level trim, fade times, blink warnings, photo sensor sensitivity, daylight setpoints, receptacle control time delays, vacancy mode, occupancy mode, etc. shall be programmable and adjustable without the use of a ladder.

B. Lighting control system for manual and automatic control of interior lighting systems.

1. Space Control – Provide occupancy/vacancy control with manual occupant input as noted on the lighting control sequence schedule.
2. Daylit Areas – All luminaires in the daylit zone shall be controlled separately from luminaires outside of daylit zones. Luminaires in the primary daylit zones shall be controlled separately from luminaires in secondary daylit zones.
3. Daytime setpoints for total ambient illumination (combined daylight and electric light) level that initiate dimming shall be programmed to be not less than 125% of the nighttime maintained designed illumination levels.
4. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system will be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn fixtures back on at dimmed level, rather than turning full-on prior to dimming.

C. Additional controls.

1. Provide contact closure HVAC interface for each controlled area. Control relays are to operate whenever occupancy is detected regardless of manual switch input or photosensor input.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide lighting control systems of one of the following:

1. WattStopper Digital Lighting Management – DLM
2. Hubbell Building Automation – NX
3. Leviton – SectorFlex
4. Cooper Greengate
5. Acuity Controls – nLight

2.2 SINGLE / DUAL RELAY WALL SWITCH OCCUPANCY SENSORS (STAND-ALONE)

- #### A. Dual Technology: Manual-ON, Automatic-OFF dual technology (passive infrared and ultrasonic) wall switch occupancy sensor. Furnish the model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled. 120/277VAC rated.

2.3 WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

- #### A. Description: Wall or ceiling mounted dual technology digital (passive infrared and ultrasonic) occupancy sensor as indicated on the drawings. Furnish the system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, occupancy sensors and accessories which suit the lighting and electrical system parameters.
- #### B. The manufacturer shall review electrical drawings and adjust sensor types and placement as required for proper covers based on the specific characteristics of the proposed sensor.

2.4 WALL SWITCHES AND DIMMERS

- A. Description: Low voltage momentary pushbutton switches in 1, 2, 3, 4, and 5 button configuration compatible with wall plates with decorator opening. Wall switches shall include the following features:
 - 1. Engraving where indicated on the drawings.
 - 2. LED indicator lights indicating status.
 - 3. Dimmers shall indicate light level with multiple LEDs.
- B. Switches and dimmers shall be able to function as noted below:
 - 1. Load and Scene button function may be reconfigured for individual buttons.
 - 2. Individual button function may be configured to Toggle, On only or Off only.
 - 3. Individual scenes may be locked to prevent unauthorized change.

2.5 ROOM CONTROLLERS

- A. Room Controllers shall be provided to match the room lighting load and control requirements. The control units will include the following features:
 - 1. Dual voltage (120/277 VAC, 60 Hz)
- B. On/Off Room Controllers shall include:
 - 1. One or two relay configuration
 - 2. Relay controller listed for connection to receptacles, for occupancy-based control of plug loads within the space.
 - a. One relay configuration only, rated at 20A, 120VAC.
 - b. Automatic-ON/OFF configuration
- C. On/Off/Dimming Room Controllers shall include:
 - 1. One, two or three relay configuration
 - 2. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
 - 3. The following dimming attributes may be changed or selected via programming:
 - a. Establish preset level for each load from 0-100%
 - b. Set high and low trim for each load
 - 4. Relay controller listed for connection to receptacles, for occupancy-based control of plug loads within the space.
 - a. One relay configuration only, rated at 20A, 120VAC.
 - b. Automatic-ON/OFF configuration

2.6 PHOTOSENSORS

- A. Photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone. Open loop photosensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES

- A. Install components as indicated on the drawings and as called for below.

- B. Low-voltage lighting control cables shall not share raceway or cable tray with telecommunications wiring. All cable shall be neatly routed and tie-wrapped to structural components. Excess wire shall be neatly coiled and secured to structure. Provide a 6' coil of cable at each ceiling mounted device for ease of relocation if conflicts arise. Under no circumstances shall cable be supported by piping, conduit, ductwork, ceiling tile or ceiling support wires. Cable shall be neatly routed in line with building lines.
- C. Where installed above accessible ceiling, all components shall be located in easily accessible areas. Any controller located in an area above a non-removable ceiling tile or where obstructed by piping or duct work shall be relocated. All locations shall be recorded on as-built drawings.
- D. Low voltage lighting control cable shall not use the same conduit sleeves as fire alarm or telecommunications cable. Provide dedicated sleeves. Where installed within non-accessible permanent construction or in exposed areas, provide continuous raceway to accessible location.
- E. It is the Contractor's responsibility to determine the ceiling type for each space and provide accessories as required for installation of devices in ceiling.
- F. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.
- G. It is the Contractor's responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the Owner's facility, to verify placement of sensors and installation criteria.
- H. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.
- I. Calibrate all sensor time delays and sensitivity to provide proper detection of occupants and energy savings.
 - 1. Adjust time delay so that controlled area remains lighted for 15 minutes after occupant leaves area or as indicated in the Sequence of Operations.
 - 2. Adjust lighting system to provide maximum lighting levels as indicated on the drawings.
- J. Provide 120V circuits as required for lighting control components.

3.2 FACTORY COMMISSIONING

- A. Upon completion of the lighting control(s) installation, the lighting control system (all sensors and control equipment) shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system. The electrical contractor shall modify sensor locations and wiring as directed by the factory technician as required to achieve required functionality.
- B. Upon completion of the lighting control system fine tuning the factory authorized technician shall provide the proper training to the Owner's personnel in the adjustment and maintenance of the sensors.
- C. Re-commissioning. After 90 days from Owner occupancy, review system performance with the Owner and recalibrate all sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report of re-commissioning activity.
- D. Provide written or computer-generated documentation on the commissioning of the system including room by room description. Report to include:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)

3.3 TRAINING

- A. Provide three (3) two-hour training sessions for the Owner. The first training session is to be at the time of initial system startup. The second session is to be post-occupancy. The third session is to be used at Owner's discretion. The training is to include, but not limited to the following:
1. Detailed review of the system architecture, individual components, and wiring requirements.
 2. System programming method included examples and demonstrations. These are to include adjustments for time delays, high-level trim, low-level trim, fade times, blink warnings, receptacle control time delays, vacancy mode, occupancy mode, etc.
 3. Occupancy sensitivity adjustments for both PIR and ultrasonic setting, adjustments for an automatic learning mode and the ability to disconnect, and selection between PIR and Ultrasonic modes for dual technology devices.
 4. System troubleshooting including types of component failures, associated system failure and repair/replacement and reprogramming procedures.

3.4 SPARE PARTS

- A. Spare Parts: Provide the following list of spare equipment (for each type used) to Owner to match equipment used in project.
1. Occupancy Sensor, ceiling mounted – quantity: 2
 2. Single Room 0 – 10V Controller – quantity: 2
 3. Single Room Controller – quantity: 2
 4. Closed-loop photosensor – quantity: 2
 5. Control Cables – quantity: 100'
 6. Digital Wall Switch, 2-button- Quantity: 2
 7. Digital Wall Dimmer - Quantity: 2
 8. Any specialty tool required for programming - Quantity: 1

END OF SECTION 26 09 23

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to install lighting panelboards and distribution panelboards as specified in this section and as called for on the drawings.
- B. Types of panelboards and enclosures in this section include the following:
 - 1. Lighting and appliance panelboards.
 - 2. Power distribution panelboards.

1.3 QUALITY ASSURANCE

- A. UL Compliance: Comply with applicable UL safety standards pertaining to panelboards and accessories, and enclosures; provide units which have been UL-listed and labeled.
- B. NEC Compliance: Comply with NEC as applicable to installation of panelboards, cabinets and cutout boxes.
- C. NEMA Compliance: Comply with NEMA Stds. Pub. No. 250, "Enclosures for Electrical Equipment (1000 volt maximum)", Pub. No. 1, "Panelboards", and installation portion of Pub. No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of panelboard required. Include data substantiating that units comply with requirements.
- B. Shop Drawings: Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not necessarily limited to, circuit breakers, fusible switches, fuses, ground-fault circuit interrupters and accessories.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 - 1. Schneider Electric/Square D (Basis of Design)
 - 2. ABB/GE Industrial Solutions
 - 3. Eaton
 - 4. Siemens

2.2 PANELBOARDS

- A. General: Except as otherwise indicated, provide panelboards, enclosures and components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information; equip with number of unit panelboard devices as required for complete installation.
1. All Multi-Section Panels: Same dimensions.
 2. Provide two keys for each panel.
 3. Provide copper ground bar.
 4. All panels shall have a designed short circuit rating label.
- B. Lighting and Appliance Panelboards:
1. Panelboard bus structure and main lugs or main breakers shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests, conducted in accordance with UL Standard 67. Bussing shall be distributed phase sequence type.
 2. The bus assembly shall be enclosed in a steel cabinet. Wiring gutter space shall be in accordance with UL Standard 67 for panelboards. The rigidity and gauge of steel to comply with UL Standard 50 cabinets. Provisions for additional circuit breakers shall be such that field addition to connectors or mounting hardware will not be required to add circuit breakers to the panelboards.
 3. If ground-fault interrupting breakers (GFI), switched neutral or other special types of breakers require additional pole spaces, size of panel shall be increased accordingly to give the scheduled numbers of poles for spare breakers and blank spaces.
 4. Fronts shall include doors and have flush, stainless steel, cylinder tumbler-type locks with catches and spring-loaded door pulls. The flush lock shall not protrude beyond the front of the door. All panelboard locks shall be keyed alike. Fronts shall have adjustable indicating trim ring clamps which shall be completely concealed steel hinges. Fronts shall not be removable with door in the locked position. A circuitry directory frame and card with a clear plastic covering shall be provided on the inside of the door.
 5. Terminals for feeder conductors to the panelboard mains and neutral shall be UL listed as suitable for conductor specified.
 6. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule. Series connected interrupting ratings are not acceptable. This short circuit current rating shall be established by testing with the overcurrent devices mounted on the panelboard. The short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of applying the specified panelboard short circuit current or greater. Testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.
 7. Bus Bar: Aluminum or Copper.
 8. Provide two 1" C and three 3/4" C stubs out of all flush mounted panelboards to accessible ceiling space.
 9. Panelboards shall have door-in-door covers.
- C. Power Distribution Panelboards; Circuit Breaker Type:
1. Panelboards to be used for main circuit distribution and power circuit distribution shall be similar to lighting panelboards with the following additions:
 - a. Cabinet doors over 48" long shall be equipped with three-point latch and vault lock. End walls shall be removable.
 - b. Main lugs or main breakers shall be barriered on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall be barriered.
 - c. When required, panelboards shall be suitable for use as service equipment.
 - d. Bus Bar: Copper.

2.3 CIRCUIT BREAKERS

- A. General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
- B. Circuit Breakers - Branch Circuit Panelboards:
 - 1. Branch circuit breakers up to 150 amperes shall be Square D Type QOB or equal. Breakers shall be bolt-on type toggle action with quick-make, quick-break mechanism. Trip indication shall be clearly shown by the breaker handle taking a position between on and off when the breaker is tripped. All multi-pole breakers shall be single-operated handle, internal common trip. Breakers having handle ties but not factory labeled "common trip" will be rejected. UL Class A ground fault circuit protection shall be provided on 120V AC branch circuits as specified on the plans or panelboard schedule. This protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection for branch circuit wiring. Single pole 15 and 20 ampere circuit breakers shall be UL listed as "Switching Breakers" at 120V AC and carry the SWD marking. Tandem or "piggyback" breakers providing two circuits from one pole space are prohibited.
- C. Circuit Breakers - Distribution Panelboards:
 - 1. Molded case circuit breakers shall be rated 15 through 2500 amperes. Breakers covered under this specification may be applied in switchboards, panelboards, motor control centers, combination motor starter, busway plug-in units or individual enclosures.
 - 2. Molded case circuit breakers shall have overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle indication. Two and three-pole breakers shall be common trip. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole. Units shall be constructed to accommodate the supply connection at either end. Operating handles shall assume a center position when tripped. All breakers shall be calibrated for operation in an ambient temperature of 40 deg. C. A button shall be provided on the cover for mechanically tripping the circuit breaker.
 - 3. Breakers shall have removable lugs. Lugs shall be UL listed for copper/aluminum conductors. Breakers shall be UL listed for installation of mechanical screw type lugs.

2.4 SURGE PROTECTIVE DEVICE (SPD)

- A. Provide SPD where indicated on drawings per section 26 4313.

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELBOARDS

- A. General: Install panelboards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Securely anchor panelboards to structure and make feeder and branch circuit connections as indicated in specifications and on the drawings.
- C. Each panelboard directory shall be typewritten to identify the load fed by each circuit. Spare breakers and circuits to be left blank with circuit breaker in off position.

END OF SECTION 26 24 16

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Provide materials, equipment, labor and supervision necessary to install wiring devices as required by the drawings and this section.
- B. Types of wiring devices this section include the following:
 - 1. Straight blade receptacles
 - 2. GFI receptacles
 - 3. Wall switches
 - 4. Wiring device accessories

1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.
- B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL-listed and labeled.
- C. NEMA Compliance: Comply with NEMA standards for general- and specific-purpose wiring devices.

1.4 SUBMITTALS

- A. Submit manufacturer's name and product data literature for each type of wiring device required.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 - 1. Hubbell, Inc.
 - 2. Leviton Manufacturing Co., Inc.
 - 3. Pass & Seymour / Legrand

2.02 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Device Color:
 - 1. Device color shall be selected by the architect at the time of submittal review.
 - 2. Device color may not be consistent throughout the building. Select areas may require special colors. Refer to Architectural elevations and finishes.
 - 3. Device model numbers indicated below to not include a color suffix. Model numbers listed do not indicate brown device color.
 - 4. Where a device is shown connected to an emergency circuit, it shall have a "red" body.

- B. Modular Connectors: Devices that are manufactured for use with modular plug-in connectors (snap connect, plug tail, etc.) may be substituted. Plug in connectors shall meet the following conditions:
 - 1. Connectors shall comply with UL498 and shall be made with stranded building wire.
- C. Tamper Resistant:
 - 1. Devices marked 'TR' shall be tamper resistant. Provide tamper resistant versions of the model specified.
 - 2. Refer to Part 3 - Execution section for required locations.
- D. Weather Resistant:
 - 1. Devices located at exterior and wet locations shall be weather resistant. Provide weather resistant versions of the model specified.
 - 2. Refer to Part 3 - Execution section for required locations.

2.03 STRAIGHT BLADE RECEPTACLES

- A. Heavy Duty Convenience Receptacles 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Hubbell HBL5361 (simplex), 5362 (duplex).
 - 2. Pass & Seymour 5361 (simplex), 5362 (duplex)
 - 3. Leviton 5361 (simplex), 5362 (duplex)

2.04 GFCI RECEPTACLES

- A. Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596. Configuration 5-20R. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection. Self-testing, 4 to 6mA trip. Hubbell is basis of design. Other listed manufacturers are acceptable.
 - 1. Heavy duty standard. Hubbell GFRST20
 - 2. Heavy duty tamper resistant: Hubbell GFTRST20
 - 3. Heavy duty weather resistant. Hubbell GFWRST20
 - 4. Heavy duty tamper resistant and weather resistant: Hubbell GFTWRST20
 - 5. Heavy duty faceless. Hubbell GFBFST20

2.05 WALL SWITCHES

- A. Heavy duty industrial grade switch. Comply with NEMA WD 1, and FS W-S-896. Hubbell is basis of design. Other listed manufacturers are acceptable.
 - 1. Single pole toggle light switch - 20 amp, 120-277 volt, Hubbell #1221 series.
 - 2. Double pole toggle light switch - 20 amp, 120-277 volt, Hubbell #1222 series.
 - 3. Three-way toggle light switch - 20 amp, 120-277 volt Hubbell #1223 series.
 - 4. Four-way toggle light switch - 20 amp, 120-277 volt, Hubbell #1224 series.
 - 5. Double-pole double-throw center off light switch - 20 amp, 277 volt, Hubbell #1386 series.
 - 6. Momentary contact switch - 15 amp, 120-277 volt, Hubbell #1556 series.

2.06 WIRING DEVICE ACCESSORIES

- A. Cover Plates:
 - 1. Smooth High-Impact Thermo plastic (nylon, unbreakable), Hubbell NP Series or equal.
 - 2. Plates for surface outlets shall be of the raised cover type utilizing 4" square boxes.

3. Outlets Installed Outdoors and in Wet Locations:
 - a. Weatherproof Flip Cover ("WP"): Weatherproof device covers shall consist of cast metal cover plate and cap over each opening. The cap shall be permanently attached to the cover plate by a spring hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.
 - 1) Horizontally mounted devices shall have cover plate aligned for same mounting, equal to Hubbell CWP series.
 - 2) Vertically mounted devices shall have cover plate aligned for same mounting, equal to Hubbell WP series.
 - b. Weatherproof Cord and Plug Cover ("WPD"): Extra duty, while-in-use, NEMA 3R cover. Heavy-duty die cast metal construction, UL 514D. Hubbell WP26 series or equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES

- A. Install wiring devices as indicated on the drawings and as called for below.
- B. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
- C. In masonry walls, switches and receptacle heights shall be adjusted as required so outlets are at nearest mortar joint to specified height.
- D. Where light switches are located adjacent to doors, they shall be installed on "knob" side of door, unless indicated otherwise.
- E. All GFI type receptacles shall be installed where GFI notation is shown on plans. No downstream protection of receptacles will be allowed from load side of other GFI type receptacles unless specifically noted on drawings.
- F. All GFI receptacles shall be accessible for testing. Where a GFI receptacle is located behind equipment, a faceless GFCI device shall be provided in an adjacent accessible location.
- G. All receptacles within 6' of the edge of a sink shall be GFI type, Contractor shall notify Engineer prior to installation if the drawings do not indicate these as GFI.
- H. Prior to roughing-in outlet boxes, Contractor shall verify from general construction drawings, door swings, type of wall finishes and locations for counters and work benches.
- I. Receptacles shall be installed with ground terminal up. Horizontal receptacles shall be installed with the grounded (neutral) terminal up.
- J. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
- K. All receptacles installed in damp and wet locations shall be weather resistant.
- L. All non-locking 15A and 20A receptacles in the following locations shall be tamper resistant regardless of mark on plans:
 1. Corridors, lobbies, interview rooms and waiting rooms.
 2. Public spaces, i.e. accessible to general public

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles (10% of devices):

1. Line Voltage: Acceptable range is 105 to 132 V.
2. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
3. Using the test plug, verify that the device and its outlet box are securely mounted.
4. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 26 27 26

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1- GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. In general, disconnect switches and circuit breakers are indicated on the drawings, and it shall be the Electrical Contractor's responsibility to furnish and install all disconnect switches for equipment and motors furnished for their scope of work, and for equipment and motors furnished by others.
- B. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to install equipment as specified in this section and as called for on the drawings. All components necessary for a complete installation including, but not limited to fuses, fuse clips, channel strut support, lugs, etc. are to be included by the contractor.
- C. Types of switches and circuit breakers in this section include the following:
 - 1. Fusible and non-fusible disconnect switches.
 - 2. Motor rated toggle disconnect switches
 - 3. Enclosed circuit breakers
 - 4. Fuses

1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical motor and circuit disconnect switches.
- B. UL Compliance and Labeling: Provide motor and circuit disconnect switches which have been UL-listed and labeled.
- C. NEMA Compliance: Comply with applicable requirements of NEMA Stds. Pub. No. KS 1.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of motor and circuit disconnect switch required.

PART 2- PRODUCTS

2.1 FUSIBLE AND NON-FUSIBLE DISCONNECT SWITCHES

- A. Manufacturers:
 - 1. Schneider Electric/Square D (Basis of Design)
 - 2. ABB/GE Industrial Solutions
 - 3. Eaton
 - 4. Siemens
- B. Fusible Switch: NEMA KS 1, Heavy Duty, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Non-fusible Switch: NEMA KS 1, Heavy Duty, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors. Provide for all 4-wire feeds.
 - 3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open. Provide for all switches on the load side of a VFD and elevator disconnects.
- E. Disconnects installed indoors shall have NEMA 1 enclosures, disconnects installed outdoors or in wet locations shall have raintight NEMA 3R enclosures. Disconnects specifically identified by '4X' shall have a stainless steel NEMA 4X enclosure.
- F. Disconnects used for service entrance equipment shall be labeled for such use.
- G. All disconnects shall be of the fuse type, except where drawings indicate non-fuse type (NF).

2.2 MOTOR RATED TOGGLE DISCONNECT SWITCHES

- A. Manufacturers:
 - 1. Schneider Electric/Square D (Basis of Design)
 - 2. ABB/GE Industrial Solutions
 - 3. Eaton
 - 4. Siemens
 - 5. Hubbell
 - 6. Pass & Seymour
- B. Description: Motor rated non-fused switch for ON-OFF control of single or three-phase motors and equipment where overload protection is not required. Square D class 2510, type K or equal.
 - 1. Compact construction.
 - 2. NEMA 1 enclosure or as noted with handle guard provision able to be locked in the open position.
 - 3. Two or three pole configurations, 600V rated.

2.3 ENCLOSED CIRCUIT BREAKERS

- A. General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with fully connected rating to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A to 600A.
 - 2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 3. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type HACR for heating and air conditioning loads.
 - d. Ground-Fault Protection (where indicated): Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip (where indicated): 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
- C. Breakers shall have removable lugs. Lugs shall be UL listed for copper/aluminum conductors. Breakers shall be UL listed for installation of mechanical screw type lugs.

- D. Enclosed circuit breakers installed indoors shall have NEMA 1 enclosures, enclosed circuit breakers installed outdoors or in wet locations shall have raintight NEMA 3R enclosures.
- E. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors. Provide for all 4-wire feeds.
 - 3. Permanent provision for locking in the open position,
- F. Enclosed circuit breakers used for service entrance equipment shall be labeled for such use.

2.4 FUSES

- A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time/current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and construction in accordance with published product information, and with industry standards and configurations.
- B. Branch Circuits: For switch rating 600 amperes or less: Low peak current limiting fuses, Type LPN(S)-R, with interrupting rating of 200,000 amperes RMS.
- C. Motors Above One-half (1/2) Horsepower: For fuse rating 600 amperes or less, dual element time delay, Type FRN(S)-R, with interrupting rating of 200,000 amperes RMS. Size fuses per Article 430 of the National Electric Code.
- D. Motors One-half (1/2) Horsepower or Less: Single phase 150 volts or less, Fustat fuses for motor running protection sizes. Single phase or three phase over 150 volts, Fustron fuses for motor running protection, with interrupting rating of 100,000 RMS. Size fuses per Article 430 of the National Electric Code.
- E. Fuses for all feeders, branch circuits, motors and other equipment shall be selected in types and ratings in accordance with NEC to provide a coordinated system of overcurrent protection, thus in case of a fault or harmful overload, only the fuses nearest the fault or overload will open.
- F. Provide one spare set of three (3) of each size and type of fuse used on project.

PART 3- EXECUTION

3.1 INSTALLATION OF ENCLOSED SWITCHES AND CIRCUIT BREAKERS

- A. Install motor and circuit disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Install disconnect switches as follows:
 - 1. Heavy Duty Switches. All applications including motors, feeders, service entrance, and equipment.
 - 2. Motor Rated Toggle Disconnect Switch. May be used for motors and equipment 30 Amps or less where fuse protection is not required. Applications include heat pumps, pumps and fans, where not downstream of a VFD,
 - 3. Enclosed Circuit Breakers: Where specifically indicated.
- C. Install disconnect switches used with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated.
- D. Install fuses in switches protecting equipment rated in accordance with nameplate maximum overcurrent protection noted on the equipment.
- E. Where a disconnect switch is installed downstream of a VFD, the disconnect switch shall be provided with make-before-break auxiliary contacts with control wires to the VFD to signal the VFD.

- F. Maintain all clearances required the by the National Electrical Code.
- G. Where NEMA 3R equipment is specified for use in interior locations, installation shall maintain the weatherproof listing of the equipment.

END OF SECTION 26 28 16

SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 -GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of motor starter work is indicated by drawings and schedules.
- B. Types of motor starters in this section include the following:
 - Magnetic
Combination
 - Fractional HP Manual

1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to wiring methods, construction and installation of motor starters.
- B. UL Compliance and Labeling: Comply with applicable requirements of UL 508, "Electric Industrial Control Equipment", pertaining to electrical motor starters. Provide units which have been UL-listed and labeled.
- C. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to motor controllers/starters and enclosures.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on motor starters.
- B. Shop Drawings: Submit dimensioned drawings of motor starters showing accurately scaled equipment layouts and spatial relationship to associated motors, and connections to electrical power panels and feeders.
 - 1. Include electrical ratings, dimensions, mounting, material, running overcurrent protection, branch circuit overcurrent protection, wiring diagrams, starting characteristics, interlocking, and accessories.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following (for each type and rating of motor starter):
 - 1. Schneider Electric/Square D (Basis of Design)
 - 2. ABB/GE Industrial Solutions
 - 3. Eaton
 - 4. Siemens
 - 5. Allen-Bradley

2.2 MOTOR STARTERS

- A. General: Except as otherwise indicated, provide motor starters and ancillary components which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation. Where more than one type of equipment meets indicated requirements, selection is Installer's option.
- B. Magnetic Starters with Solid State Overloads: Provide full voltage alternating current magnetic starters of types, ratings and electrical characteristics indicated; equip with solid state overload relays. Trip current rating will be established by selection of overload relay and shall be adjustable (3 to 1 current range). The overload shall be self-powered, provide phase loss and phase unbalance protection, and be ambient insensitive. It will also be available in Trip Class 10 or 20 and have a mechanical test function. Electrical interlocks as required for the control sequences indicated; enclosure of NEMA type suitable for environmental conditions where installed; control transformer within each enclosure where required to provide 120 volt control voltage; manual reset on the door of each enclosure; selector switches, pilot lights, push buttons and other devices and accessories as shown on the drawings or otherwise required.
- C. Combination Starters: Provide full-voltage alternating-current combination starters, consisting of starters and disconnect switches mounted in common enclosures of types, sizes, ratings, and NEMA sizes indicated. Equip starters with features as described in B above. Operating handle for disconnect switch mechanism shall indicate and control switch position with enclosure door open or closed; capable of being locked in OFF position and mechanically interlocked to prevent opening unless switch within the enclosure is open. Construct and mount starters and disconnect switches in single NEMA type enclosure suitable for environmental conditions where installed.
- D. Fractional HP Manual Starters: Provide manual single-phase fractional HP motor starters, of types, ratings and electrical characteristics indicated; equip with thermal overload relay of the melting alloy type for protection of 120 VAC motors of 1/2 HP and less. Provide starters with quick-make, quick-break trip free toggle mechanisms, green pilot lights, and with toggle operated handle with handle lock-off; mount starter in NEMA type enclosure suitable for environmental conditions where installed.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR STARTERS

- A. Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate with other work including motor and electrical wiring/cabling work, as necessary to interface installation of motor starters with other work.
- C. Install fuses in fusible disconnects.

3.2 ADJUST AND CLEAN

- A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL

- A. Subsequent to wire/cable hook-up, energize motor starters and demonstrate functioning of equipment in accordance with requirements; where necessary correct malfunctioning units.

END OF SECTION 26 29 13

SECTION 26 29 23
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Variable speed AC motor controllers and all power wiring. Control wiring and system control components by others.
- B. Variable speed AC motor controllers shall be of the "Variable/Adjustable Frequency" or "Inverter" type drives based on solid state electronics. The adjustable frequency AC drive shall convert 3 phase, 60 Hertz input power to an adjustable AC frequency and voltage 3 phase output for controlling the speed of any NEMA MG 1 Design B squirrel cage induction motor. The adjustable frequency drive shall have the following basic design:
 - 1. Converter - Converter shall consist of a modular assembly consisting of a diode rectifier and capacitor assembly which will first convert, then filter and maintain a fixed DC voltage source from the fixed voltage and frequency input.
 - 2. Inverter - Inverter shall consist of a modular assembly consisting of power semiconductors for generation of a sine-coded pulse width modulated (PWM) output waveform.
 - 3. Regulator - Regulator shall consist of a modular assembly. The regulator shall be fully digital and incorporate a microprocessor to control all inverter, converter, and external interface functions.
 - 4. Interface - Interface shall consist of terminal strips for all input and output signals.
- C. All control instrument components shall be electronic and of industrial control quality and furnished with variable speed motor controllers complete as outlined in these specifications and drawings.
- D. The variable speed motor controller supplier shall provide all necessary factory and/or field labor for complete calibration and adjustment of the adjustable frequency drives and control components, and shall be responsible for setting all control set points, operating sequences, and alarming systems within the specified control systems to produce the overall system performance as specified.

1.3 SUBMITTALS

- A. Submittal data shall include but not be limited to drawings and/or catalog cuts giving physical dimensions, wiring diagrams (control and power diagrams), construction materials, capacities, ratings, control sequencing, manufacturers recommended installation instructions, and any other pertinent information.
- B. Provide operating and maintenance manuals.
- C. Provide recommended spare parts list and prices. Also, the address of the manufacturer's closest parts stocking location shall be provided.
- D. Include manufacturer's standard product warranty (for not less than a one year period) for replacement of materials and equipment.

- E. Submit electrical harmonics calculations to comply with criteria set forth in Electrical Harmonic Mitigation Requirements indicated below. See Electrical Documents for information about electrical distribution system and components to be used in study including kVA, impedance, panels serving VFDs, etc.

1.4 START-UP SERVICE

- A. The supplier of the variable speed motor controller shall have a factory trained service representative provide start up service and commissioning.
- B. Contractor shall coordinate controller parameters with other contractors.

1.5 TRAINING

- A. The supplier of the variable speed motor controller shall have a factory trained service representative provide eight (8) hours of on-site training for the Owner's personnel advising of the proper methods of maintenance and operation of the controller.
- B. Additional training time as deemed necessary by the Owner's authorized representative may be obtained from the supplier on a negotiated basis with the Owner.

1.6 ELECTRICAL HARMONIC MITIGATION REQUIREMENTS

- A. Provide harmonic mitigation equipment as necessary to comply with this section.
- B. Comply with IEEE 519-2014 requirements for voltage and current distortion limits at the point of common coupling.
 - 1. Voltage total harmonic distortion shall not exceed 8% of fundamental input voltage at full load and no individual harmonics greater than those listed in section 5.1 Table 1.
 - 2. Current total harmonic distortion shall not exceed 5% at full load and no individual harmonics greater than those listed in section 5.1 Table 2.
- C. Provide harmonic analysis at point of common coupling defined as follows: primary side of service transformer for current and secondary side of service transformer for voltage.
 - 1. Analysis shall assume the following:
 - a. Transformer loading of 75% of nameplate with 5.5% impedance.
 - b. Infinite utility fault capacity if actual utility fault capability is unknown.
 - c. Motors operating at 80% of nameplate current.
 - d. Total horsepower connected to a VFD should be used.
 - 2. Include VFDs for other equipment identified under other specification sections such as chillers, packaged equipment, elevators, etc. Coordinate with other contractors as necessary to obtain information.
- D. Contractor shall provide necessary documents and information to VFD manufacturer to facilitate study.
- E. Provide all input line reactors, bus reactors, harmonic filters, etc. necessary to meet IEEE 519 and include costs in base bid.
- F. Base VFD type on results of IEEE-519 study with minimum configuration as follows (NOTE: total horsepower connected to a VFD shall be used when calculating harmonic mitigating technology, e.g. (4)15HP fans = 60HP):
 - 1. Less than 40HP – 6 pulse drive with 5% reactor.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. The variable speed AC motor controllers shall meet all requirements of this section. Subject to compliance with requirements, acceptable manufacturers are as follows:
1. Toshiba/Houston
 2. ABB
 3. Danfoss
 4. Yaskawa
 5. Schneider Electric/Square D

2.2 CONTROLLERS

- A. General: For the purpose of this Part, the word "controller" shall mean variable speed AC motor controller, i.e. VFD.
- B. The controller shall be mounted in a NEMA ventilated enclosure appropriate for environment. The enclosure size shall be adequate to dissipate the heat generated by the controller within the limits of the specified environmental operating conditions. The door shall be hinged, secured with latch. "Bolt-on" doors are not acceptable.
- C. Ambient service temperature rating shall be from 0°C to 40°C for normal operating conditions. The controller shall operate at less than 90% relative humidity non-condensing. The controller shall operate at an altitude less than 1000 meters (3300 feet) above sea level.
- D. Input power rating shall be 3 Phase, voltage as scheduled per drawings +/- 10%, 60 Hertz +/- 3%.
- E. The controller shall be mounted in a NEMA 1 enclosure.
- F. The controller shall have a door interlocked incoming AC disconnect with external operator handle which is capable of being locked in the "off" position. The disconnect shall shutdown all input power to both the drive and the bypass circuitry, where applicable.
- G. The controller shall have the input fused internally with standard fuses.
- H. Controller shall have an output frequency range of 5 to 120 Hertz. The frequency regulation shall be +/- .5% of maximum frequency.
- I. The controller shall provide thermal overload relays on the inverter output for motor protection for each motor controlled.
- J. The controller shall maintain power factor to .95 or greater throughout its speed range for each motor controlled.
- K. The controller shall have as a minimum the following protective features:
1. Short circuit protection.
 2. Under/over voltage protection.
 3. Automatic restarting after a power outage or momentary overvoltage.
 4. Ground fault protection, but there shall be no automatic restart into ground fault.
 5. Overcurrent protection.
 6. Supply voltage phase loss protection.
 7. Over temperature protection.

- 8. Start into rotating motor protection. The controller shall catch a spinning load without tripping.
- L. The controller shall be rated for 100% continuous current. The controller shall be capable of providing 110% of rated current for a minimum period of one minute. The controller shall have adjustable current limit. The controller shall have current limited stall prevention during acceleration, deceleration, and run conditions.
- M. The controller shall have process follower inputs for 4-20 mA. Provide bias and gain adjustments for the follower.
- N. The controller shall provide adjustable linear acceleration and deceleration control, each separately adjustable. The ramp time shall be adjustable from 0.1 to 30 seconds. Longer ramp times shall be optionally available.
- O. The controller shall provide maximum and minimum frequency control, each separately adjustable.
- P. Fault indicators shall indicate the following fault conditions:
 - 1. Overcurrent.
 - 2. Short circuit.
 - 3. Undervoltage.
 - 4. Overvoltage.
 - 5. Overtemperature.
 - 6. Regulator function error.
 - 7. Ground fault.

In addition to the fault indicators, the controller shall provide normally open Form C fault contacts to allow remote monitoring of drive conditions.

- Q. The controller shall have as a minimum the following operator controls mounted on the front panel:
 - 1. Manual/Auto selector.
 - 2. Start/Stop switch.
 - 3. Inverter/Line switch.
 - 4. Speed potentiometer.
 - 5. Fault reset.
 - 6. Speed Indicator.
- R. The controller shall provide adjustable carrier frequency.
- S. The controller shall have an internal line reactor and EMI/RFI filters.

2.3 INPUT LINE REACTORS

- A. Size per harmonic analysis with 5% minimum rating.
- B. Mount internal to VFD enclosure.
- C. Internal DC bus chokes are also acceptable if performance is equivalent to specified input line reactors.

2.4 PASSIVE HARMONIC FILTERS (WHERE REQUIRED BY IEEE 519 ANALYSIS)

- A. Size inductors and capacitors to tune out harmonics from 6-pulse drives.
- B. Mount internal to VFD enclosure.

- C. Include contactor to take capacitor out of circuit if controller is operating at low power output while leaving inductor in circuit. Set point shall be field programmable and set to 50% initially.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONTROLLERS

- A. Install controllers as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate with other work including motor and HVAC controls work, as necessary to interface installation of controllers with other work.
- C. The controllers shall be mounted and installed on the mechanical equipment room walls whenever possible. When the controllers cannot be wall mounted, the controllers shall be installed on four inch housekeeping pads. Installation of units directly on the floor will not be acceptable.
- D. Each controller shall have a dedicated raceways for the input power feeder, output power feeder and controls. Raceways shall be separated by at least 6" from other controller feeders and controls raceway.
- E. Where a disconnect switch is provided between the controller and the motor, provide control wiring to interlock the disconnect switch OPEN contact with the controller for controller shutdown.
- F. Provide 4" high concrete equipment pad for floor mounted controllers.

3.2 OPERATION

- A. Manual/Auto System Operation
 - 1. Selector switch in MANUAL mode - operation shall be from the door mounted potentiometer and the system shall be operable from 0-100% on the potentiometer operating between the minimum and maximum speeds as set in the inverter.
 - 2. Selector switch in AUTO mode - operation shall be from the input follower signal, with output speed being proportional to the input signal. A remote set of Form C start/stop contacts (furnished by the Temperature Controls Contractor) shall control the inverter.
- B. Start/Stop
 - 1. Switch used to initiate command to start or stop the drive; operates in manual mode.
- C. Inverter/Line
 - 1. Selector switch in the LINE mode shall disconnect the adjustable frequency system and bypass for direct across-the-line motor operation to the 3 phase, 60 Hertz supply.
 - 2. Selector switch in the INVERTER mode shall disconnect the 3 phase, 60 Hertz supply and the system shall operate in the mode as established by the inverter Manual/Auto switch.
- D. Automatic Restart
 - 1. In the event of a loss of supply line power, or an overvoltage/undervoltage condition of more than 5%, or in the event of a shutdown signal from the temperature control or fire detection system, the system shall shut down. When line power is restored, the system shall automatically restart after a time delay, providing the start contact is a maintained contact in the closed position and all external interlocks are satisfied.

2. For motors started frequently, the system shall provide start at almost zero RPM and gradually increase to required speed.

3.3 ADJUST AND CLEAN

- A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch up scratched or marred surfaces to match original finish.
- C. The carrier frequency shall be adjusted to optimize motor and VFD operation while reducing motor noise.

3.4 FIELD QUALITY CONTROL

- A. Subsequent to wire/cable hook-up, energize controllers and demonstrate functioning of equipment in accordance with requirements; where necessary correct malfunctioning units.

END OF SECTION 26 29 23

SECTION 26 32 13
ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical General Provisions are applicable to work required of this section.
- B. Section 26 36 00 – Transfer Switches.

1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to install generators as specified in this section and as called for on the drawings.
- B. Types of standby generator system equipment required for project include the following:
 - 1. Natural gas engine-driven generators.
- C. The intent of these specifications is to establish a level of quality and desired function of the equipment specified.
- D. These specifications include furnishing and installing a continuously rated, for standby use, engine-generator set delivered to the site complete with all necessary accessories as may be hereinafter set forth. The term "continuously rated for standby use" shall mean that the set will be for standby service but once started shall be capable of carrying a full load on a continuous basis for an indefinite period of time.
- E. Refer to Division-3 sections for concrete and grout work required in connection with engine-generator sets.
- F. Piping and accessories required in conjunction with engine-generator units are specified in Division-23 sections.
- G. Other than silencer, exhaust system including pipe, hangers, etc. is specified in Division-23 section.
- H. Ventilation louvers, ductwork and associated controls are specified in Division 23 section.

1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with applicable standby generator requirements of NEC including, but not limited to, emergency and standby power generating systems.
- B. NFPA Compliance: Comply with applicable requirements of NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines", NFPA 110 – Standard for Emergency and Standby Power Systems
- C. UL Compliance: Comply with applicable requirements of UL 2200, "Stationary Engine Generator Assemblies". Provide standby generator system components which are UL listed and labeled.
- D. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG 1, "Motors and Generators", and MG 2, "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators".
- E. IEEE Compliance: Comply with applicable portions of IEEE Standard 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings", pertaining to standby power and IEEE 446, "Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications"

- F. The set shall be tested by the manufacturer of the set, as hereinafter specified. Certified test reports of the complete assembly shall be available from the engine manufacturer showing the plant's power rating, voltage and frequency regulation, and other pertinent data.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on engine-driven electric generator systems and components including, but not limited to, batteries, battery racks, battery charger, vibration isolation, exhaust silencer, exhaust backpressure capability, exhaust system components, control panels, fuel system components, fuel consumption rates at various loads, detailed interconnection drawings, temporary generator connection cabinet, generator enclosures (if necessary), circuit breakers, etc.
- B. Include manufacturer's standard product warranty for replacement of materials and equipment used in standby engine-driven generator system.
- C. Shop Drawings: Submit dimensioned drawings of standby generators showing accurately scaled basic dimensions including auxiliary components, fuel connections and exhaust connections.
- D. Specification compliance including line by line review of each requirement in this specification. Each line shall be marked C=comply, D=deviation or NC=not compliant. Indicate justification for each item that that is not marked "C".
- E. Submit load testing reports for each generator after completion of installation.

1.5 WARRANTY

- A. The engine-generator as designated on the drawings and plans and as herein specified, shall be guaranteed to be free from original defects in both material and workmanship for a period of two years of normal use and service, except damages from other causes. This guarantee shall become effective starting the date of commissioning.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide systems of one of the following:
 - 1. Caterpillar Inc.
 - 2. Cummins Inc.
 - 3. Kohler Co.
 - 4. MTU Onsite Energy
 - 5. Generac

2.2 ENGINE-GENERATOR SET

- A. Engine-Driven Generator: EPA certification for Emergency Stationary use.
- B. Factory-assembled and -tested, engine-generator set.
- C. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
 - 1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.
- D. Capacities and Characteristics:
 - 1. Engine power shall be capable of providing full rated capacity at 104°F and altitude of 1000 feet.

2. Power Output Ratings: Electrical output power rating for Standby operation of not less than as noted on the generator schedule.
3. Alternator shall be capable of accepting maximum scheduled starting SKVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
4. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of components. The engine-generator nameplate shall include information of the power output rating of the equipment.

E. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent voltage drop variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.
3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Not more than 15 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.
6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.
8. Start Time: Comply with NFPA 110, Type 10 for 10 second maximum start time, system requirements.
9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

2.3 ENGINE

- A. Engine Features: The engine shall be heavy duty, spark ignition, water cooled, multi-cylinder, 4 stroke, designed for cold quick start, capable of delivering full load output in not more than ten seconds.
- B. Rated Engine Speed: 1800RPM.
- C. Lubrication System: The following items are mounted on engine or skid:
 1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.
 2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Engine Fuel System: The engine fuel system including components shipped loose shall be installed in strict compliance to the engine manufacturer's instructions.

- E. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.
- F. Cooling System: Closed loop, liquid cooled
1. The generator set manufacturer shall provide prototype test data for the specific cooling system proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 40 deg C as measured at the generator air inlet.
 2. Shall dissipate the heat through a unit mounted radiator with a fan. The fan shall be engine driven.
 3. Cooling capacity shall be not less than the cooling requirements of the engine-generator set and its lubricating oil while operating continuously at 110 percent of its specified rating.
 4. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent de-ionized water, with anticorrosion additives as recommended by engine manufacturer.
 5. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 6. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 8. The cooling system shall insure that the maximum cooling water temperature is safely within the normal working temperature range when the set is operating continuously at full load at maximum ambient temperature. when the air intake temperature of the engine room may rise to 120 deg. F. The engine outlet water temperature under such conditions shall not exceed 200 deg. F.
- G. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.
- H. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.
1. Provide heavy duty diesel batteries of sufficient capacity for three crank cycles of 15-second followed by 15 seconds of rest (75 seconds total).
 2. Batteries shall be sealed lead-acid type certified for NFPA 110, Level 1.
 3. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.
 4. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
 5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.
 6. Provide battery heater with thermostatic control to regulate the output temperature to within battery manufacturer's recommended limits.
 7. Provide battery rack with vibration isolators if mounted on generator set.
- I. Battery Charger – integral to generator housing or remote mounted indoors: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:
1. Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 2. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 3. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

4. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 5. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.
 6. Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet.
- J. Exhaust System:
1. The engine exhaust line shall be fitted with expansion bellows and a critical type silencer to give efficient silencing with maximum tolerable back pressure. Silencer shall be furnished with generator package.
 2. Pressure drop and back pressure in the complete exhaust system shall be small enough for satisfactory operation of the engine-generator set while it is delivering 110 percent of its specified rating.
 3. Exhaust temperature shall not be greater than 1,399 degrees.
 4. Provide condensate trap with drain plug at low point of muffler.
- K. Electrical heaters, for maintaining the engines coolant temperature at the temperature recommended by the manufacturer of the engine, shall be factory installed.
1. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for heater capacity and performance.
 2. Designed for operation on a single phase, 60Hz power connection. Heater voltage shall match circuit characteristics shown on the project drawings.
 3. Installed with isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss.
 4. Provided with a 24VDC thermostat, installed at the engine thermostat housing
 5. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104F/40C in a 60F/15C ambient, in compliance with NFPA110 Level 1 requirements

2.4 CONTROL AND MONITORING

- A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
- B. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- C. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
- D. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
- E. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.

- F. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
1. AC voltmeter (3-phase, line to line and line to neutral values).
 2. AC ammeter (3-phases).
 3. AC frequency meter.
 4. AC kW output (total and for each phase). Display shall indicate power flow direction.
 5. AC kVA output (total and for each phase). Display shall indicate power flow direction.
 6. AC Power factor (total and for each phase). Display shall indicate leading or lagging condition.
 7. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
 8. Emergency Stop Switch: Switch shall be a red "mushroom head" pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
 9. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
 10. DC voltmeter (alternator battery charging).
 11. Engine-coolant temperature gauge.
 12. Engine lubricating-oil pressure gauge.
 13. Running-time meter.
 14. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall allow adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.)
 15. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR, reverse kW, overload (kW) short circuit, over current, loss of voltage reference, and over excitation shut down protection. There shall be a ground fault alarm for generator sets rated over 1000 amps, overload warning, and overcurrent warning alarm.
 16. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
 17. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
 18. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.
 19. Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.
 20. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).
- G. Remote Alarm Annunciator: Comply with NFPA 110, Level 1. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Flush mounted. Provide engine start/stop capability adjacent to annunciator panel.
- H. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation. Mount at entrance to generator enclosure.

- I. Alternator Control Functions:
 - 1. The generator set shall include an automatic microprocessor-based voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from disoperation due to load induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three phase true RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The voltage regulation system shall be full wave rectified, with pulse-width modulated output design. The system shall include a torque matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. The 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 an alphanumeric LED readout in the generator operator panel to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.
- J. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.
- K. The generator set shall be provided with a network communication module to allow real time communication with the generator set control by remote devices. The control shall communicate all engine and alternator data; alarm, shutdown and status conditions; and allow starting and stopping of the generator set via the network in both test and emergency modes.

2.5 GENERATOR, EXCITER, AND REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H
- D. Temperature Rise: 130C
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.
- G. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, 3-phase true RMS sensing, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.
- H. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding. Alternators operating at voltage higher than 690VAC shall be provided with form-wound stator coils.
- I. Subtransient Reactance: 12 percent maximum, based on the rating of the engine generator set.
- J. The generator shall be supplied with a thermostatically controlled strip heater to prevent the accumulation of moisture and dampness and to maintain the stator windings above the dew point. The heater shall be wired to be "on" at all times that the generator set is not operating.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:
1. Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 2. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110% of rated current for more than 10 seconds.
 3. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.
 4. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.
 5. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.
 6. The protective system provided shall not include an instantaneous trip function.
- B. Generator Circuit Breakers: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous. Provide ground fault alarm only.
 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 4. Mounting: Adjacent to or integrated with control and monitoring panel.

2.7 FUEL STORAGE

- A. Natural Gas
1. See Divisions 22 & 23.

2.8 VIBRATION ISOLATION DEVICES

- A. Spring-type Vibration Isolators: Each generator shall be furnished with Ace Mounting Co., Inc. 812 Series, 3" deflection. Quantities determined by generator vendor for the engine-generator supplied.

2.9 OUTDOOR WEATHERPROOF ENCLOSURE

- A. Enclosure shall be UL2200 listed.
- B. Construction:
1. Constructed of minimum 14 ga galvanized steel or aluminum to ASTM A-446.
 2. Wind Rating: Wind rating shall be 150 mph minimum
 3. Include discharge gravity dampers, intake motorized dampers (spring operated to open & motor closed), hood with silencer.
 4. Louvers: Equipped with galvanized bird screen to permit air circulation when engine is not running while excluding birds and rodents.
 5. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.
 6. Extend coolant and oil drains with shut off valves.
 7. Hardware: All hardware and hinges shall be stainless steel.
 8. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
 9. Provide 2 coats of primer and 2 coats of finish paint.

- C. Exhaust System: Provide critical type silencer mounted within enclosure.
- D. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load. Refer to the generator schedule for maximum log average sound pressure level measured positions around the perimeter of the unit at a distance of 23 ft.
- E. Electrical provision:
 - 1. Package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing.
 - 2. External Electrical Connections: All power and control interconnections shall be made within the perimeter of the enclosure.
 - 3. Provide DC lighting with 60-minute spring round timer switch and fused connection to the engine-starting batteries.
 - 4. Provide internal AC lighting, switches, internal GFCI service receptacle, and external GFCI service receptacle.
 - 5. Provide externally mounted emergency stop switch.
- F. Provide enclosure insulation and unit heater to maintain enclosure temperature to minimum 40 degrees F when generator is not operating and serves Emergency/Life Safety loads per NFPA 110, Level 1. Heater shall be disabled while the engine is running.

2.10 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.

2.11 TEMPORARY GENERATOR MAINTENANCE CABINET

- A. Manufacturer Temporary Generator Maintenance Cabinet: Subject to compliance with requirements, provide products of one of the following:
 - 1. ESL Power Systems
 - 2. HIPOWER
 - 3. Lex Products
 - 4. Power Products Inc.
 - 5. Powertron
 - 6. Trystar
- B. General: Except as otherwise indicated, provide a manual transfer cabinet with temporary generator connections and ancillary components which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation. Where more than one type of equipment meets indicated requirements, selection is Installer's option.
- C. The temporary generator maintenance cabinet shall be equipped as follows:
 - 1. Basis-of-design: ESL Power Systems Stormswitch.
 - 2. Voltage: As noted on drawings
 - 3. Manual transfer switch shall consist of (2) two mechanically-interlocked molded case circuit breakers, cam-style male connectors, power distribution block and grounding terminals, all housed within a padlockable enclosure.

4. Manual transfer switch enclosure shall be Type 3R, constructed of continuous welded, powder coated steel or aluminum. The main access shall be through an interlocked, hinged door. Access to cam-style plugs shall be via hinged or drawn flange cable entry openings in the bottom of enclosure. A hinged flap door shall be provided to cover the cable openings when cables are not connected; the hinged flap door shall allow cable entry only after the main access door has been opened. Enclosure shall be powder coated after fabrication.
5. Cam connectors shall not be accessible unless all molded case circuit breakers are in the "OFF" position and the main access door is open.
6. Temporary generator cam-style male connectors (inlets) shall be UL Listed single-pole separable type and rated 400 amps at 600VAC. Cam-style male connectors shall be color coded. Camstyle male connectors shall be provided for each phase and for ground, and neutral. Each of the phase cam-style male connectors within the enclosure shall be factory-wired to a molded case circuit breaker or switch. The ground cam-style male connectors shall be bonded to the enclosure, and a ground lug shall be provided for connection of the facility ground conductor.
7. Provide multiple sets of connectors when switch capacity of over 400A is specified.
8. Breakers: 100% rated molded case, 4-pole. The permanent generator circuit breaker shall be a molded case switch with no overcurrent protection.
9. Switch shall include a switch position contact to be interconnected with the generator controller & generator annunciator. Disconnecting the permanent generator shall initiate visual notification at the generator control panel and remote annunciator.
10. Listing: UL 1008. Shall meet requirements of NEC 700.3.
11. Where 4-pole circuit breakers are used, provide placard on cabinet exterior "BOND NEUTRAL TO GROUND AT ROLL-UP GENERATOR".

PART 3 - EXECUTION

3.1 INSTALLATION OF ENGINE-GENERATOR SYSTEMS

- A. Install engine-generator sets as indicated, in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine-generator sets fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of standby engine-generator systems and accessories.
- B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- C. Prior to starting the engine-generator, the manufacturer's representative shall review the installation to ensure it is installed in accordance with the manufacturer's instruction. This includes, but is not limited to, exhaust connections, fuel piping, and ventilation clearances. Any irregularities or concerns shall be submitted to the engineer in writing.
- D. Coordinate with other work, including fuel tanks, piping and accessories, as necessary to interface installation of standby generator system work with other work.
- E. All service connections, fuel, water, electric, etc. to the engine shall be through flexible connection devices. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

3.2 INSTALLATION OF TEMPORARY GENERATOR CONNECTION AND MANUAL TRANSFER CABINET

- A. Install transfer switch as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Provide monitoring wiring from auxiliary position contact to the generator/generator annunciator. Generator annunciator shall indicate when the permanent generator is disconnected.

- C. Coordinate with other work including generator and electrical wiring/cabling work, as necessary to interface installation of transfer switch.

3.3 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for system components as indicated.
- B. Where engine-generator is a separately derived source, bond to facility grounding electrode conductor.

3.4 TESTING

- A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system. Tests shall include:
 - 1. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.
 - 2. Installation acceptance tests to be conducted on site shall include a "cold start" test, a 2-hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110.
 - 3. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.
- B. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.
- C. Installation acceptance tests to be conducted on site shall include a "cold start" test, a 2-hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110.
- D. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.
- E. Test temporary generator and connection cabinet including connecting a temporary generator and transferring power.

3.5 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration. Training date shall be coordinated with the facility owner.

3.6 SYSTEM SERVICE CONTRACT

- A. The supplier of the standby power system must provide a copy of and make available to the owner his standard service contract which, at the owner's option, may be accepted or refused. This contract shall be included in the operation and maintenance manual supplied at the end of the project. The contract shall be for the complete services rendered over a period of one year.

END OF SECTION 26 32 13

SECTION 26 36 00
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.
- B. Section 26 32 13 – Engine Generators.
- C. Section 26 43 13 – Surge Protective Devices for Low-Voltage Electrical Power Circuits

1.2 DESCRIPTION OF WORK

- A. Provide automatic transfer switches as indicated on drawings and schedules.

1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to wiring methods, construction and installation of transfer switches.
- B. UL Compliance and Labeling: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches".
- C. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to automatic transfer switches and enclosures.
- D. Automatic transfer switches shall be sourced from a single manufacturer.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on transfer switches.
- B. Shop Drawings: Submit dimensioned drawings of transfer switches showing accurately scaled equipment layouts and spatial relationship to associated equipment.
 - 1. Include electrical ratings, dimensions, mounting, material, branch circuit overcurrent protection, wiring diagrams, interlocking, and accessories.

1.5 WARRANTY

- A. The transfer switches as designated on the drawings and plans and as herein specified, shall be guaranteed to be free from original defects in both material and workmanship for a period of two years of normal use and service, excepting damages from other causes. This guarantee shall become effective starting the date of substantial completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer Automatic Transfer Switches: Subject to compliance with requirements, provide products of one of the following:
 - 1. ASCO Power Technologies/Schneider Electric
 - 2. Russelectric/Siemens
 - 3. ABB/GE Industrial Solutions/Zenith
 - 4. Caterpillar

5. Cummins
6. Kohler

2.2 AUTOMATIC TRANSFER SWITCHES

- A. General: Except as otherwise indicated, provide transfer switches and ancillary components which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation. Where more than one type of equipment meets indicated requirements, selection is Installer's option.
- B. Automatic Transfer Switches shall be equipped as follows:
 1. The switch shall be rated for the voltage and amperage as shown on the plans and shall have 600 volt insulation on all parts in accordance with NEMA standards.
 2. Switch(es) shall have withstand rating that is greater or equal to withstand ratings of upstream breakers.
 3. Switch(es) shall have transition type as shown on drawings.
 4. For closed transition switch(es), provide shunt trip signal and interlock to upstream emergency breakers to trip upon fail to transfer condition.
 5. The current rating shall be a 24 hour continuous rating when the switch is enclosed in an unventilated enclosure, and shall conform to NEMA temperature rise standards.
 6. The current rating shall be based on all classes of loads, i.e., resistive, tungsten, ballast and inductive loads.
 7. The thermal capacity of the main contacts shall not be less than 20 times the continuous duty rating for a minimum of 3 electrical cycles as established by certified test data.
 8. Temperature rise test shall be in accordance with UL 1008 except that it shall be conducted at the conclusion of the overload and endurance tests.
 9. The automatic transfer switch shall be a double throw switch operated by a reliable electrical mechanism momentarily energized. There shall be a direct mechanical coupling to facilitate transfer in 3 cycles or less.
 10. The normal and emergency contacts shall be mechanically interlocked such that failure of any coil or disarrangement of any part shall not permit a neutral position.
 11. For switches installed in systems having ground fault protective devices, a 4th pole shall be provided. This additional pole shall isolate the normal and emergency neutrals. The neutral pole shall have the same withstand and operational ratings as the other poles and shall be arranged to break last and make first to minimize neutral switching transients.
 12. The contact structure shall consist of a main current carrying contact which is a silver alloy with a minimum of 50% silver content. The main current carrying contacts shall be protected by refractory arcing contacts on all sizes.
 13. All relays shall be continuous duty industrial type with wiping contacts rated at 10 amperes minimum.
 14. All coils, relays, timers and accessories shall be readily front accessible.
 15. Main and arcing contacts shall be fully visible without major disassembly to facilitate inspection and maintenance.
 16. A manual handle shall be provided for maintenance purposes.
 17. A disconnect switch shall be provided to defeat automatic operation during maintenance, inspection or manual operation.
 18. The switch shall be mounted in a suitable NEMA enclosure to meet application requirements as indicated on the plans.
 19. Sensing Relays shall be provided as follows:
 - a. Provide voltage sensing relays in each phase of the auxiliary power supply.
 - b. Provide a voltage frequency sensing relay in one phase of the auxiliary power supply.
 20. The following accessories shall be included with the transfer switch:
 - a. Auxiliary Contacts
 - b. Battery Trickle Chargers
 - c. Plant Exerciser
 - d. Engine Starting Contact
 - e. Fan Contact
 - f. Cranking Controls
 - g. Time Delay Engine Start
 - h. Frequency Sensors
 - i. Frequency Meter

- j. Pilot Lights
 - k. Meters
 - l. Running Time Meter
 - m. Solid State Adjustable Voltage Sensing Relays
 - n. In Phase Monitor
 - o. Selector & Disconnect Switches
 - p. Time Delay Retransfer To Normal
 - q. Time Delay Engine Overrun
 - r. Time Delay Emergency
 - s. Manual test switch
 - t. Fail To Transfer – trip upstream breaker contact
 - u. Elevator Pre-Transfer Signal
21. Service Entrance surge protective device per 26 4313.
22. The following accessories shall be included with the transfer switch:
- a. Indicating lights:
 - b. Provide a signal light for normal source position.
 - c. Provide a signal light for emergency source position.
 - d. Lights shall be different colors.
 - e. Provide laminated black phenolic nameplates with white letters to indicate transfer switch position.
 - f. Manual Test Switch: Shall simulate normal source failure.
 - g. Engine starting contacts.
 - h. Time Delay Relays:
23. Provide time-delay relays to accomplish the functions hereinafter specified.

C. Auxiliary Contacts:

- 1. Provide contacts as necessary to accomplish the functions shown on the drawings, hereinafter specified, and designated in other sections of these specifications.
- 2. Contacts shall have a minimum rating of ten amperes and be positive acting on pickup and dropout.
- 3. Provisions for Remote Indicators and Controls:
- 4. Provisions shall be made for remote pilot lamps to show transfer position.
- 5. Make provisions for remote manual test switch to simulate normal source failure.
- 6. Make provisions for remote contact to bypass retransfer time delay to normal source.

D. Surge Protection

- 1. Provide integral service entrance surge protective device per 26 4313.

E. Elevator Interface

- 1. Provide contacts to indicate emergency power status to elevator controller and indicate pre-transfer back to normal signal. Pre-transfer signal shall be initiated prior to transfer of switch from emergency to normal and vice versa.

2.3 SYSTEM OPERATION

- A. A voltage decrease in one or more phases of the normal power source to less than 70 percent of normal shall initiate the transfer sequence. The transfer switch shall start the engine-generator unit after a time-delay of two or three seconds to permit override of momentary dips in the normal power source. The time-delay shall be field adjustable.
- B. The transfer switch shall transfer the load from normal to emergency source when the frequency and voltage of the engine-generator unit have attained 90 percent of rated value.
- C. The transfer switch shall retransfer the load from emergency to normal source upon restoration of normal supply in all phases to 90 percent or more of normal voltage an after a time-delay. The time-delay shall be field adjustable from five to twenty-five minutes (preset for twenty-five minutes). Should the emergency source fail during the timing, the transfer switch shall immediately transfer to normal when the source is available.

PART 3 - EXECUTION

3.1 INSTALLATION OF AUTOMATIC TRANSFER SWITCHES

- A. Install automatic transfer switches as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate with other work including generator and electrical wiring/cabling work, as necessary to interface installation of automatic transfer switch.
- C. Provide pre-transfer signal wiring from ATS to elevator controller. Final termination at elevator controller by Elevator Contractor.
- D. Engine start circuits shall be kept entirely independent of all other wiring.

3.2 ADJUST AND CLEAN

- A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch up scratched or marred surfaces to match original finish.

3.3 TESTS AND CERTIFICATIONS

- A. The automatic transfer switch manufacturer shall certify sufficient arc interrupting capabilities for 50 cycles of operation to operate between a normal and emergency source that are 120 degrees out of phase at 480 volts for the following load currents and power factors:

600% of nominal at .50 power factor
20% of nominal at .50 power factor
- B. The automatic transfer switch manufacturer shall submit test data for each size switch, showing it can withstand, without damage, fault currents of the magnitude and the duration necessary to maintain the system integrity.
- C. Upon completion of automatic transfer switches, test units with associated system components to demonstrate capability and compliance with requirements.

END OF SECTION 26 36 00

SECTION 26 43 13

SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.
- B. Section Includes: Surge Protective Devices (SPD) for Service Entrance and Branch Panel applications.

1.2 REFERENCES

- A. ANSI/IEEE C.62.41 and C62.45
- B. UL 1449 – 4th Edition
- C. UL 1283
- D. NEC – NFPA 70
- E. NEMA LS1
- F. NFPA
- G. OSHA
- H. IEEE Std. 1100

1.3 SUBMITTALS

- A. Shop Drawings: Provide Shop Drawings with wiring diagrams, installation information, testing and maintenance procedures, and operational information for the transient protection system. Shop Drawings shall be submitted to Design Professional for approval before starting actual fabrication.
- B. Submittals for Approval: Provide the following test data submittals:
 - 1. Manufacturer will provide UL-1449, Fourth Edition data card showing the Voltage Protection Rating (VPR) and “Engineering Considerations” for the specific catalog number submitted. “Typical” UL 1449 data is not acceptable. Test data shall be provided to demonstrate the short circuit current rating has been tested on a complete device.

PART 2 - EQUIPMENT

2.1 SERVICE ENTRANCE SPD

- A. Environmental
 - 1. General Requirements:
 - a. No audible noise shall be generated.
 - b. No appreciable magnetic fields shall be generated. System shall be capable of use directly in computer rooms in any location without danger to disc units, disk packs, or tapes.
 - c. Operating Conditions:
 - 1) 30 – 130 Degrees F
 - 2) 15 – 85 Percent Humidity Non-Condensing

- d. Enclosure: The unit shall have a heavy duty NEMA 12 dust-tight, drip-tight enclosure unless specified otherwise.
- e. Units mounted at service entrance equipment shall be Type 1 and 20kA I-nominal rated.

B. General Requirements

- 1. SPD shall be rated to match equipment voltage, 60 Hertz, 3-phase, 4-wire system and shall be connected in parallel with the main distribution panels
- 2. Quality: The manufacturer shall be ISO 9001 certified, demonstrating world-class quality systems for the design and manufacture of the SPD units.
- 3. Unit shall be UL 1449, 4th Edition Listed. A SPD that is a UL "Recognized" component will not be accepted.
- 4. Each surge suppression element (MOV) shall be individually fused so that a failure of one element and/or fuse shall not affect other surge suppression elements. SPD shall have a short-circuit rating of 200kAIC.
- 5. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of each phase of the unit.
- 6. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.

C. Manufacturers and Specific Product Requirements

- 1. Acceptable Manufacturers: Subject to compliance with requirements of the Contract Documents, acceptable manufacturers are as follows:
 - a. ASCO Power Technologies
 - b. ABB / Current Technology
 - c. Raycap
 - d. Mersen
 - e. Transdector/LEA
 - f. Schneider Electric/Square D
 - g. Siemens
 - h. Eaton
- 2. Unit shall provide maximum Voltage Protection Rating as indicated by UL 1449.
- 3. The SPD will be modular in design. Separate and replaceable suppression modules will protect each mode (L-N, L-G, and N-G).
- 4. The service entrance SPD will be capable of surviving 15,000 ANSI/IEEE, Category C3 (10kA) impulses without failure or degradation of original performance characteristics of more than 10%
- 5. Unit shall have a maximum surge current rating of 125kA per mode (125,000 amperes L-N, 125,000 amperes L-G, and 125,000 amperes N-G), based on ANSI/IEEE C62.41 standard 8 by 20 microsecond current waveform.
- 6. Unit shall be UL 1283 listed as an electromagnetic interference filter and provide 50 Ohm noise attenuation of at least 40 dB at 100 kHz, 30 dB at 1 MHz, 35 dB at 10 MHz, and 50 dB at 100 MHz.
- 7. Unit shall include a built-in, push-to-test feature that tests the integrity of all modules, MOVs and fuses in the system
- 8. Unit shall have an audible alarm with an alarm on/off switch to silence the alarm and a push-to-test switch to test the alarm function.
- 9. Warranty: Manufacturer shall provide a product warranty for a period of not less than 10 years from date of installation. Warranty shall cover unlimited replacement of system protection modules during warranty period. The first 5 years of this warranty will include any field labor required to perform repair or replacement work.

2.2 BRANCH PANEL SPD

A. Environments

- 1. General Requirements:
 - a. No audible noise shall be generated.
 - b. No appreciable magnetic fields shall be generated. System shall be capable of use directly in computer rooms in any location without danger to disc units, disk packs, or tapes.

- c. Operating Conditions:
 - 1) 30 – 130 Degrees F
 - 2) 15 – 85 Percent Humidity Non-Condensing
2. Enclosure: The unit shall have a heavy duty NEMA 12 dust-tight, drip-tight enclosure.

B. General Requirements

1. Branch Panel Equipment (where indicated on drawings): Rated to match equipment voltage, 60 Hertz, 3-phase, 4-wire distribution board or panelboard.
2. Quality: The manufacturer shall be ISO 9001 certified, demonstrating world-class quality systems for the design and manufacture of the SPD units.
3. Unit shall be UL 1449 4th Edition Listed. A SPD that is a UL “Recognized” component will not be accepted.
4. Each surge suppression element (MOV) shall be individually fused so that a failure of one element and/or fuse shall not affect other surge suppression elements. SPD shall have a short-circuit rating of 200kAIC.
5. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of each phase of the unit.
6. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.

C. Manufacturers and Product Requirements

1. Acceptable Manufacturers: Subject to compliance with requirements of the Contract Documents, acceptable manufacturers are as follows:
 - a. ASCO Power Technologies
 - b. ABB - Current Technology
 - c. Raycap
 - d. Mersen
 - e. Transdector/LEA
 - f. Schneider Electric/Square D
 - g. Siemens
 - h. Eaton
 - i. Internally mounted SPD manufactured and provided by the manufacturer of the gear in which it is mounted
2. Unit shall provide maximum Voltage Protection Rating (VPR) as indicated by UL 1449.
3. The branch panel SPD will be capable of surviving 10,000 ANSI/IEEE, Category C3 (10kA) impulses without failure or degradation of original performance characteristics of more than 10%
4. Unit shall have a maximum surge current rating of 80kA per mode (80,000 amperes L-N, 80,000 amperes L-G, and 80,000 amperes N-G), based on ANSI/IEEE C62.41 standard 8 by 20 microsecond current waveform.
5. Unit shall be UL 1283 listed as an electromagnetic interference filter and provide 50 Ohm noise attenuation of at least 40 dB at 100 kHz, 30 dB at 1 MHz, 35 dB at 10 MHz, and 50 dB at 100 MHz.
6. Unit shall be provided with an integral, non-fused disconnect switch which causes no interruption to the protected load for testing and maintenance. Disconnect system shall not require removal or replacement for warranty or other repairs.
7. Unit shall have an audible alarm with an alarm on/off switch to silence the alarm and a push-to-test switch to test the alarm function.
8. A resettable counter shall be provided to totalize transient voltage surges in both the normal and common mode. The readout shall be at least a six-digit LCD located on the unit front cover and provided with a 10-year battery back-up to maintain counts in the event of power loss.
9. Warranty: Manufacturer shall provide a product warranty for a period of not less than 5 years from date of installation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Requirements:

1. Contractor shall install suppression system immediately next to or on top of service equipment where so approved by the Design Professional.
2. Conductors between suppressor and point of attachment to service equipment shall be sized in accordance with manufacturer's Shop Drawings and conductor lengths shall be as short as possible, preferably not exceeding 24".
3. Use SPD low-impedance cable listed for the application to enhance clamping voltage where unit is not mounted on or within equipment that it's protecting.

B. Grounding: Suppressor ground shall be bonded to the equipment grounding busbar.

END OF SECTION 26 43 13

SECTION 26 50 00

LIGHTING

PART 1 - GENERAL

1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. Provide lighting fixtures, accessories, labor and supervision necessary to install complete lighting system as required by the drawings and this section.
- B. Types of lighting fixtures in this section include the following:
 - 1. Solid State (LED)
 - 2. Exit Signs
 - 3. Emergency
 - 4. Exterior Luminaires

1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to installation and construction in building lighting fixtures.
- B. NEMA Compliance: Comply with applicable requirements of NEMA standard publications pertaining to lighting equipment.
- C. Listings: Provide lighting fixtures which have been listed and labeled. Listing or labeling shall be by UL, ETL Intertek or other nationally recognized agency.
- D. CBM Labels: Provide fluorescent-lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on interior building lighting fixtures.
- B. Shop Drawings: Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in luminaire "type" alphabetical order, with proposed fixture and accessories clearly indicated on each sheet. Shop drawing booklet shall include lamp and ballast data sheets.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers shall be as listed in the light fixture schedule on the drawings.
- B. Basis of Design Product: The design for each luminaire is based on the product named and described in the light fixture schedule on the drawings. Provide either the named product or a comparable product by one of the equivalent manufacturers listed. Equivalent manufacturers shall match the basis of design product in both form and function. The Architect and Engineer have the final acceptance of equivalent products. Where equivalent products are not determined to match the basis of design, the basis of design product shall be provided at no additional cost to the Owner. Upon request, equivalent manufacturers shall submit lighting calculations and ies files to prove performance of product and samples for table top viewing.

2.2 SOLID STATE LIGHTING / LIGHT EMITTING DIODE (LED) LUMINAIRES

A. General:

1. Luminaire manufacturer shall have a minimum of five (5) years' experience in the manufacture and design of LED products and systems.
2. All LED sources used in the LED luminaire shall be of proven quality from established and reputable LED manufacturers. Acceptable LED lamp manufacturers unless otherwise noted are:
 - a. Cree, Inc.
 - b. Philips Lighting
 - c. Nichia Corporation
 - d. Norlux
 - e. Opto Technology, Inc.
 - f. Osram Optron Semiconductor
 - g. Samsung

B. LED Warranty

1. Luminaire manufacturer provide a five (5) year written warranty.

C. Replacement and Spares:

1. Manufacturer shall provide written guarantee of the following:
 - a. Manufacturer shall be able to provide compatible replacement parts that are designed to fit into original luminaire for ten (10) years.
 - b. Replacement LED array/module shall be within 3 MacAdam color ellipse, within 10% of lumen output, 7% of correlated color temperature (CCT) and equivalent distribution of original array/module.
 - c. Replacement LED array/module shall utilize equal to or less than amount of wattage of original array/module.
2. LED driver and array/module shall be replaceable in field.

D. Products and Components – Performance:

1. All LED components shall be mercury-free and lead-free.
2. LEDs shall comply with ANSI/NEMA/ANSI C78.377-2008 – Specifications for the Chromaticity of Solid State Lighting Products. Color shall remain stable throughout the life of the light source.
3. LEDs shall comply with IESNA LM-80 – Standards for Lumen Maintenance of LED Lighting Products.
4. LEDs shall have a minimum rated source life of 50,000 hours under normal operating conditions or as noted on the lighting fixture schedule. LED “rated source life” is defined as the time when a minimum of 70% of initial lumen output remains, as defined by IESNA LM-70.
5. Luminaire assembly shall include a method of dissipating heat so as to not degrade life of source, electronic equipment, or lenses. LED luminaire housing shall be designed to transfer heat from the LED board to the outside environment. Luminaire housing shall have no negative impact on life of components. Upon request, manufacturer shall provide junction temperature limitations and test reports of installed LED in fixture.
6. Method of dissipating heat shall be passive, active cooling systems are not allowed.
7. High power LED luminaires shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware.
8. LEDs shall be adequately protected from moisture or dust in interior applications.
9. For wet and damp use, LED-based luminaires itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure. Such protection shall have no negative impact on rated life of source or components, or if so, such reductions shall be explicitly brought to the attention of the designer.
10. All hardwired connections to LED luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

11. Manufacturer shall provide Luminaire Efficacy (lm/W), total luminous flux (lumens), luminous intensity (candelas) chromaticity coordinates, CCT and CRI. Optical performance, polar diagrams, and relevant luminance and illuminance photometric data. Provide data in IES file format in accordance with IES LM-79-2008, based on test results from an independent Nationally Recognized Testing Laboratory. Provide information upon special request.

E. LED drivers shall meet the following requirements:

1. Drivers shall have a minimum efficiency of 85%.
2. Minimum/Maximum Ambient Temperature: -20°C/55°C interior locations, -40°C/55°C exterior locations,
3. Input Voltage: 120 to 277 (±10%) V or as scheduled.
4. Power Supplies: Class I or II output.
5. Dimming Type: 0-10V control with current source driver, current sinking drivers are not allowed.
6. Surge Protection for exterior fixtures: The system must survive 250 repetitive strikes of "C Low" (C Low: 6kV/1.2 x 50 µs, 10kA/8 x 20 µs) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. "C Low" waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.
7. Power Factor (PF): ≥ 0.90.
8. Total Harmonic Distortion (THD): ≤ 20%.
9. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
10. Drivers shall be reduction of hazardous substances (ROHS)-compliant.
11. Mean Time Between Failure (MTBF): 100,000 hours based on 90% survival.

2.3 EXIT SIGNS

- A. Housing to be per light fixture schedule (thermoplastic, edge lit or cast aluminum) for wall, end or ceiling mounting. Illumination to be by long life, low watt LED lamps. Battery, where specified, to be maintenance free, sealed nickel-cadmium type and shall operate sign for 90 minutes after loss of power.

2.4 EMERGENCY FIXTURES

- A. Housing and lamping per light fixture schedule. Self contained complying with UL 924. Battery to be premium grade, lead-acid or nickel cadmium, maintenance free battery and shall operate sign for 90 minutes after loss of power.

2.5 EXTERIOR LUMINAIRES

A. General:

1. Poles shall be as shown on the drawings, and as specified. The pole and arm assembly shall be designed for wind loading of 100 mph with an additional 30% gust factor, supporting luminaire(s) and accessories such as shields, banner arms, and banners.
2. Poles shall have handhole having a minimum clear opening of 2.5 x 5 in. Handhole covers shall be secured by stainless steel captive screws.
3. Provide a steel-grounding stud opposite handhole openings, designed to prevent electrolysis when used with copper wire.
4. Provide a base cover that matches the pole in material and color to conceal the mounting hardware pole-base welds and anchor bolts. Plastic base covers are not allowed.
5. Hardware and Accessories: All necessary hardware and specified accessories shall be the product of the pole manufacturer.
6. Provide manufacturer's standard finish and color, as scheduled on the drawings. Provide custom finishes only where specifically indicated on the drawings.

B. Pole Types:

1. Aluminum: Provide aluminum poles manufactured of corrosion-resistant AA AAH35.1 aluminum alloys conforming to AASHTO LTS-4. Poles shall be seamless extruded or spun seamless type. Poles 12' or greater in height shall be provided with an internal, factory installed, vibration damper.

2. Steel: Provide steel poles having minimum 11-gauge steel with minimum yield/strength of 48,000 psi. Poles 12' or greater in height shall be provided with an internal, factory installed, vibration damper.
 3. Prestressed Concrete: Provide prestressed concrete, raceway-type, lighting poles of the size and type indicated. Provide luminaire brackets as required for complete assemblies.
- C. Foundations for Poles:
1. Foundations shall be cast-in-place concrete, having 3000 psi minimum 28-day compressive strength.
 2. Place concrete in spirally-wrapped treated paper forms for round foundations, and construct forms for square foundations.
 3. Rub-finish and round all above-grade concrete edges to approximately 0.25 in radius.
 4. Anchor bolt assemblies and reinforcing of concrete foundations shall be as shown on the drawings. Anchor bolts shall be in a welded cage or properly positioned by the tie wire to stirrups.
 5. Prior to concrete pour, install ground electrode.

PART 3 - EXECUTION

3.1 INSTALLATION OF INTERIOR LIGHTING FIXTURES

- A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of the National Electric Code (NEC), NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. All low-voltage luminaires using remote drivers or power supplies shall be installed as follows:
 1. Installation shall be in compliance with the manufacturer's instructions including distance limitations.
 2. Remote drivers and power supplies shall be located in accessible locations and clearly noted on as-built plans. Where plywood is used for power supply mounting, plywood shall be UL Listed fire resistant.
 3. Unless specifically noted "Class 2", all low-voltage wiring between remote drivers or power supplies and luminaires shall be considered Class 1 and installed in accordance with NEC Article 725. Wiring shall be 600V rated and installed in conduit.
 4. All remote drivers and power supplies not specifically labeled "Class 2" on the power supply housing shall be installed in a ventilated metal enclosure. Where the power supply includes cooling fan or convection cooling, ventilation openings in enclosure shall be provided to not impede power supply cooling.
- C. Coordinate with other electrical work as appropriate to properly interface installation of interior lighting fixtures with other work.
- D. Coordinate fixture location with reflected ceiling plan.
- E. Recessed fixtures in removable ceilings shall be connected to the branch circuit with flexible conduit and branch circuit wire from an accessible junction box. Where fluorescent fixture housings are connected together, use 90 deg.C wire for branch circuit feed through fixture channels.
- F. All fixtures shall be grounded. All lamp sockets shall be wired so that the outer shell is connected to the neutral grounded conductor.
- G. Fixtures recessed in furred ceiling shall be installed so that they can be removed from below the ceiling.
- H. For all dimmed light fixtures, "burn in" or "season" prior to dimming as recommended by the lamp manufacturer.
- I. Luminaires located in suspended ceilings shall be connected with a maximum 6 foot length of flexible metal conduit and building wire.
- J. Housing, trim, and lens frame shall be true, straight and parallel to each adjacent fixtures and features.
- K. Contractor shall include all materials and labor necessary for the final aiming and adjusting of adjustable light fixtures. Adjustment of light fixtures may be required to occur after sunset at a time designated by the Engineer.

- L. Round fixtures or fixtures smaller than the ceiling grid shall have at least two (2) 3/4 inch (19 mm) metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture.
- M. Troffer, recessed and semi-recessed fixtures shall be installed at a minimum per the manufacturer's instructions and the requirements below. Fixtures shall not be supported directly on the ceiling material. Support fixtures with metal bar hangers or strut channels attached to the ceiling tees. Coordinate with Ceiling Contractor to ensure ceiling tees can support the weight of the light fixtures.
- N. Suspended Linear or Pendant mounted fixtures shall be independently supported from the building structure by wires, straps or rods.
- O. Fixture whips shall be in accordance with section 26 05 33 Raceway and Boxes for Electrical Systems.

3.2 INSTALLATION OF EXTERIOR LIGHTING FIXTURES

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole. Install poles plumb and level.
- B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.
- C. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
- D. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on drawings, but not less than one-sixth of pole height. Dig holes large enough to permit use of tampers in the full depth of hole. Backfill in 6 inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
- E. Coordinate locations and elevations of base mounted site fixtures with site plans, do not scale electrical drawings for placement of light poles.

END OF SECTION 26 50 00

SECTION 27 00 10
TELECOMMUNICATIONS GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL

- A. Refer to Division 00 – Procurement, Contracting and Warranty Requirements and Division 01 - General Requirements, which all apply to work under this section.

1.2 DESCRIPTION OF WORK

- B. This section applies to all work under the telecommunications contract. This shall include, but not necessarily be limited to, the following:
1. Pre-Register Project with structured cabling plant manufacturer if applicable.
 2. Furnish and install a complete voice and data-wiring infrastructure.
 3. Furnish, install, and terminate all UTP cable and fiber as applicable and per drawings.
 4. Furnish and install all wall plates, jacks, patch panels, and patch cords as required and as indicated.
 5. Furnish and install any cabinets, racks and ladder rack as required and as indicated.
 6. Furnish any other material required to form a complete system.
 7. Perform permanent link testing (100% of links) and certification of all components.
 8. Furnish test results of all cabling to the owner on disk and paper format, listed by each closet, then by workstation ID.
 9. Provide Owner As-builts in the form of one electronic copy and two hard copies of a labeled map of the building(s) showing the structured cabling plant.
 10. Adhere and comply with all requirements of the Contractor Agreement for the structured cabling plant manufacturer to be used.
 11. Provide Owner training and testing documentation.
- C. The work shall include all materials, equipment and labor required for complete and properly functioning telecommunications systems.
- D. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- E. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
1. National Electrical Code
 2. Local Electrical Code
 3. National Fire Protection Association
 4. National Electrical Manufacturers Association
 5. Standards of Institute of Electrical and Electronic Engineers
 6. Applicable Building Codes
 7. Occupational Safety and Health Act
 8. Wisconsin Administrative Codes
 9. ANSI TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 10. ANSI TIA-526-14-C Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 11. ANSI TIA-568-D.1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
 12. ANSI TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
 13. ANSI TIA-568-C.3 Optical Fiber Cabling Components Standard
 14. ANSI TIA-568-C.4 Broadband Coaxial Cabling and Components Standard
 15. ANSI TIA-569-D Telecommunications Pathways and Spaces
 16. ANSI TIA-570-C Residential Telecommunications Infrastructure Standard

17. ANSI TIA-598-D Optical Fiber Cable Color Coding
18. ANSI TIA-606-B Administration Standard for Commercial Telecommunications Infrastructure
19. ANSI TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
20. ANSI TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
21. National Fire Protection Agency (NFPA - 70), National Electrical Code (NEC)

- B. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.4 REQUIREMENTS & FEES OF REGULATORY AGENCIES

- A. Contractor shall comply with the rules and regulations of the local serving utility companies and shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Secure and pay for all permits, licenses, fees and inspections.

1.5 DRAWINGS

- A. Drawings for the work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.
- B. Contractor shall layout his own work and shall be responsible for determining the exact quantities and locations for equipment.
- C. Contractor shall take own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.
- D. Because of the scale of the drawings, certain basic items for a complete installation are not shown, but where such items are required by code (or referenced standards) where they are required for proper installation and operation of the work, such items shall be furnished and installed.

1.6 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.
- B. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- C. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.7 SITE INSPECTION

- A. Contractor shall inspect the site prior to submitting bid for work to become familiar with the conditions of the site which will affect the work and shall verify points of connection with utilities and/or existing system wiring.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.8 COORDINATION AND COOPERATION

- A. It shall be Contractor's responsibility to schedule and coordinate work with the schedule of General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.

- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. The Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications, or between the requirements set forth for the various contractors, shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by Design Professional and his/her decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires Contractor to work in areas previously finished by Owner, the Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall be responsible for patching and refinishing of such areas which may be damaged in this respect.
- G. Where two or more specified items/systems in the specifications and/or the drawings are in conflict, that requiring the highest order of workmanship and the most financially expensive products shall take precedence. Such questions shall be referred to the Design Professional for final decision.

1.9 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same items, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.

1.10 SUBMITTALS

- A. Contractor shall furnish, to the Design Professional, complete sets of submittals. Contractor shall review and sign submittals before submitting. Contractor shall provide submittals via electronic process (.PDF format) unless otherwise instructed. Refer to Division 01 specifications for additional requirements.
- B. Submittals shall be bound into sets per specification section (not division). The content of the submittal shall cover related items for a complete system as much as practical and items shall be identified with symbols or "plan marks" used on drawings whenever possible. Incomplete, piecemeal or unbound submittals will be rejected.

- C. Each submittal shall include a cover sheet providing the Approved Contractors company name, address, phone number and contact person (person to contact if there are questions about the submittal). The cover sheet shall also have adequate white space for the design professional review stamp as well as up-stream contractor stamps. The company providing the submittal shall be the same as that which meets the APPROVED CONTRACTOR requirements paragraph found later in this specification section (submittals without this identifying contractor information on the cover page will be rejected to ensure the Approved Contractor process is being followed).
- D. Design Professional will review submittals solely to assist contractors in correctly interpreting the plans and specifications.
- E. Contract requirements cannot be changed by submittals. Contract documents remain in force even if equipment is submitted which differs from contract drawings and specifications and that submittal is stamped as reviewed (or any other stamp verbiage).
- F. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- G. After award of contract, the contractor shall provide a completed submittal schedule including dates that the submittals will be to the Design Professional for review.

H. Submit required information on all items in the project for the following systems (see table). Submittals shall be sorted and separately identified per specification section listed below.

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
27 00 10	Contractor Certifications					X		Note 1
27 00 10	Manufacturer Certification					X		Note 2
27 00 10	UTP No-Paint Notification					X		Note 7
27 10 00	Grounding Equipment		X			X		
27 10 00	Grounding Cabling		X			X		
27 10 00	Grounding Hardware		X			X		
27 11 00	UTP Cabling/Equipment		X			X	X	Note 6
27 11 00	Fiber Cabling/Equipment		X			X	X	Note 6
27 11 00	IDC/Lightning Blocks		X			X	X	Note 6
27 11 00	Data Racks/Cabinets		X			X	X	Note 6
27 11 00	Cable Management		X			X	X	Note 6
27 11 00	As-Built at Closeout							Note 3
27 12 00	Tester, UTP/Fiber		X			X		Note 4
27 12 00	Test Report at Closeout					X		Note 5

Notes:

1. Division 27 Contractor shall submit copies of the Contractor Certifications under section 27 00 10 (BICSI or IBEW/NECA Certifications) showing compliance with the specification. See Approved Contractors paragraph for details.
2. Division 27 Contractor shall submit Manufacturer Certification under section 27 00 10. See Approved Contractors paragraph in this section for details, and further requirements listed in Cabling and Equipment specification section.
3. Division 27 Contractor shall submit As-Built as specified in Cabling and Equipment section.
4. Division 27 Contractor shall submit product information on UTP Tester and Fiber Tester. See testers specified in Testing and Documentation section.
5. Division 27 Contractor shall submit Test Report as specified in Testing and Documentation section.
6. Grounding and Bonding or Cabling and Equipment section submittals will not be opened or reviewed by the Design Professional until the Division 27 00 10 Contractor Certifications (see Note 1) and Division 27 Manufacturer Certifications (see Note 2) have been received and found to be acceptable by the Design Professional.
7. Division 27 Contractor shall submit the "Do Not Paint The UTP" written notification (addressed to the General Contractor) for review by the Design Professional. This written notification is specified in the Telecommunications Cabling and Equipment section. The submittal process may be used as the vehicle to inform the General Contractor of the "Do Not Paint The UTP" requirement (and the mandatory corrections required if this were to happen, outlined in the Telecommunications Cabling and Equipment section) if the General Contractor acknowledges receipt of the written notification.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted to the Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.
- B. Submit manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
TELECOMMUNICATIONS SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME, ADDRESS AND PHONE NUMBER OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Each section shall contain the following information for equipment furnished under this contract:
 - 1. Equipment and system warranties and guarantees.
 - 2. Installation instructions.
 - 3. Operating instructions.
 - 4. Maintenance instructions.
 - 5. Spare parts identification and ordering list.
 - 6. Local service organization, address, contact and phone number.
 - 7. Submittals with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.

1.12 TESTS AND DEMONSTRATIONS

- A. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner.

1.13 TRAINING AND DEMONSTRATIONS

- A. Prior to acceptance of the telecommunications installation, the Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.
 - 1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
 - 2. Prepare the instruction format for a minimum of four Owner Representatives.
- B. Equipment training:
 - 1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
 - 2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
 - 3. Training shall be performed by qualified factory trained technicians.

4. Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

C. System training:

1. Training sessions shall include hands-on demonstrations of system wide start-up, operation in all possible modes, shut-down and emergency procedures.

D. The following are minimum requirements for Owner instruction:

Section	Description	Hrs. on Site	Presented By	Others Present	Remarks
27 40 00	Audiovisual System	4	Contractor		

- E. Each Contractor shall submit a certificate (in the project closeout submittals), signed by Owner stating the date, time and persons instructed and that the instruction has been completed to Owner's satisfaction. An example of a certificate form is as follows:

CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that the contractor has demonstrated the hereafter listed systems to Owner's representatives in accordance with the Contract documents and that the instruction has been completed to the Owner's satisfaction.

A. Project:

B. System(s):

C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

D. Owner's representatives receiving instruction:

Owner: _____

NAMES	DATE	HOURS

E. Acknowledgement of demonstration:

Contractor's Representative:

_____ signature

_____ date

Owner's Representative:

_____ signature

_____ date

1.14 PERMITS, FEES, ETC.

- A. Secure all required permits and pay for all inspections required in connection with the telecommunication systems work. Contractor shall post all bonds and obtain all licenses required by the State, City, County, and Federal Agencies.

1.15 SUBSTITUTIONS

- A. To obtain approval to use unspecified equipment, Bidding Contractors (not equipment supplier, manufacturers, etc.) shall submit written requests to Design Professional at least 10 days prior to bid due date. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent to include a cost comparison between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, Design Professional will approve it in an addendum. The Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.16 APPROVED CONTRACTORS

- A. **MANUFACTURER CERTIFICATION:** Contractor shall be a manufacturer certified installer for the structured cabling plant. A copy of the current annual manufacturer certification shall be provided with 27 00 10 submittals. Contractor is responsible for workmanship and installation practices in accordance with the manufacturer requirements and shall be authorized to provide an extended Manufacturer's Product Warranty with his installation. The specific warranty program that is acceptable for each solution is listed with the connectivity solution in specification section 27 11 00 TELECOMMUNICATIONS SYSTEMS CABLING AND EQUIPMENT. Contractors shall provide proof upon request that they have maintained the Manufacturers Certification in good standing for at least six months prior to the overall project bid. Temporary or short term certifications (less than the standard 12 month annual certification described above) or case-by-case certifications are not acceptable.
- B. **CONTRACTOR CERTIFICATION:** Contractor shall meet one of the following two paragraphs and provide appropriate documentation in the 27 0010 submittals:
 - 1. Contractor shall have BICSI Registered Installers and Technicians on staff and assign them to this project. The project shall be staffed at all times by Installers and Technicians who, in the role of lead craft-persons, will be able to provide leadership and technical resources for the remaining craft-persons on the project. A minimum of 30 percent of personnel shall be BICSI registered telecommunications installers. Of that number 15 percent shall be registered at the Technician Level, at least 40 percent shall be registered at the Installer Level 2, and the balance shall be registered at the Installer Level 1. Contractor shall provide BICSI certifications showing employee name, level, and expiration date. BICSI certificate for the highest level attained shall be submitted.
 - 2. Contractor shall have employees on staff and assigned to the project that are currently indentured in or have successfully completed the IBEW/NECA three-year Telecommunications Installer/Technician registered apprenticeship program. Contractor shall maintain a ratio of 1 Technician to 1 indentured Apprentice. Contractor shall provide documentation verifying the indentured status of Apprentices, and the Department of Labor Certificates of Completion for the Installer/Technicians.
- C. Contractor pulling the telecommunications cabling (if different from the prime Telecommunications Contractor) shall meet all the same BICSI or IBEW/NECA requirements, and requirements of this specification, as the prime Telecommunications Contractor.
- D. Contractor shall be located within 125 miles of the construction site to establish a potential two hour response time for ongoing customer needs after construction completion.

1.17 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the drawing schedules, are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers, who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of Contractor and/or the manufacturer.
- C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.18 QUALITY ASSURANCE

- A. Contractor shall be a company specializing in telecommunication cable and/or accessories with a minimum of five years documented experience in installation of cable and/or accessories similar to those specified below.

1.19 WARRANTY AND SERVICES

- A. The entire telecommunications system including all sub-systems shall be guaranteed against defect in materials and installation for a minimum of one year. Any malfunctions which occur within the guarantee period shall be promptly corrected without cost to Owner. This guarantee shall not limit or void any manufacturer's express or implied warranties.
- B. A Manufacturer Product Warranty shall be provided which warrants functionality of all components used in the system for 20 years from the date of registration. The Manufacturers Product Warranty shall warrant the installed horizontal and/or backbone copper, and both the horizontal and the backbone optical fiber portions of the cabling system.
- C. Continuing Maintenance: The contractor shall furnish an hourly rate with the proposal submittal, which shall be valid for a period of one year from the date of acceptance. This rate will be used when cabling support is required to affect moves, adds, and changes to the system (MACs). MACs performed by an approved Contractor shall be added to the warranty.
- D. Final Acceptance & System Certification: Completion of the installation, in-progress and final inspections, receipt of the test and as-built documentation, and successful performance of the cabling system for a two-week period will constitute acceptance of the system. Upon successful completion of the installation and subsequent inspection, the end user shall be provided with a numbered certificate registering the installation.

1.20 CHANGES IN THE WORK

- A. A Contract Change Order is a written order to Contractor signed by Owner and Contractor, issued after the execution of the Contract, authorizing a change in the Work or an adjustment in the Contract Sum or the Contract Time. The Contract Sum and the Contract Time may be changed only by Contract Change Order.
- B. Owner, without invalidating the Contract, may order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, with the Contract Sum and the Contract Time being adjusted accordingly. All such changes in the Work shall be authorized by Contract Change Order and shall be performed under the applicable conditions of the Contract Documents.

- C. The cost or credit to Owner resulting from a change in the Work shall be determined by mutual acceptance of a lump sum properly itemized and supported by sufficient substantial data to permit evaluation. Change Orders shall be submitted with each item listed individually with a material cost and labor unit extension. Overhead and profit, as mutually agreed upon between Owner and Contractor shall be added to material and labor cost figures.
- D. It shall be the responsibility of Contractor before proceeding with any change to satisfy himself that the change has been properly authorized on behalf of Owner.

1.21 GROUNDING AND BONDING OF SYSTEMS

- A. All low voltage systems shall be subject to the Telecommunications Grounding and Bonding specification section 27 1000. For those systems which may require a specialized sub-contractor, the sub-contractor providing and installing systems shall also be responsible for grounding and bonding per this specification.

1.22 COMPLETION

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.
- B. When all the work is complete Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.
- C. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

END OF SECTION 27 00 10

SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish and install all materials, equipment and labels required as shown on the Drawings, Schedules and as specified.
- B. It is the intent of the Specifications, Drawings and Schedules that all labels be legible and provided in locations which are readily visible.
- C. Only those items affected by the installation of the project shall be labeled unless otherwise indicated.

1.2 STANDARDS

- A. Unless otherwise noted, all labels at distribution frames shall follow the color-coding scheme identified in ANSI/TIA/EIA 606 "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings".

1.3 DRAWINGS AND SPECIFICATIONS

- A. The Contractor shall keep a detailed up-to-date record of the label information and placement of all labels installed as specified herein.

1.4 SUBMITTALS

- A. Submit product data for the following:
 - 1. Labeling machine.
 - 2. Labels

1.5 CLEANING

- A. The Contractor shall clean all surfaces prior to the attachment of labels. Follow the manufacturer's recommendations for cleaning.
- B. The Contractor shall follow the manufacturer's recommendations for affixing labels.

PART 2 - PRODUCTS

2.1 TERMINATION HARDWARE AND CABLE LABELS

- A. Acceptable Manufacturers:
 - 1. Brady
 - 2. Brother
 - 3. DYMO
 - 4. Approved Equal

PART 3 - EXECUTION

3.1 SPACES

- A. Item: Main Telecommunications Closet (MTR). The MTR for both copper and fiber terminations, has been pre-assigned and should be labeled by the contractor in a visible location as entering the space with minimum 2" high black on orange machine printed labels.

Example: MTR-A

- B. Item: Telecommunications Closet (TR). The TR has been pre-assigned and should be labeled by the contractor in a visible location as entering the space with minimum 2" high black on orange machine printed labels.

Example: TR-B

3.2 CABLING

3.2.1 Copper Cabling

- A. Item: Building Copper cable (BC). The BC is an interior multi-pair copper riser cable extending from the MTR to TR.
 - 1. Label Location:
 - a. On the cable at both ends, near the hardware on which the cable is terminated.
 - 2. Label Information:
 - a. The Cable identifier is the letters BC followed by the cable number (2 numeric characters) and the Cable Pair Count (4 numeric characters) and the identifying telecommunicate room letter. Identify both the beginning and end count. The Cable identifier is unique to the building. The Building copper cable identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading Building Copper.
 - 3. Method:
 - a. Black on white wire wrap machine printed label.
 - 4. Format:
 - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One-line centered formatted text. Use dash as delimiter.
 - 5. Example: BC01-0001-0100-A

- B. Item: Horizontal Copper Cable. The Horizontal Copper Cable extends from the MTR or TR to any field side location requiring voice or data service within the defined serving boundaries of the said MTR or TR.
 - 1. Label Location:
 - a. On the cable at both ends, near the hardware on which the cable is terminated.
 - 2. Label Information:
 - a. The Cable identifier is the letters (TR) followed by the serving TR identification letter and the 3 numeric characters field assigned by the Telecom Contractor during installation. The Cable identifier is unique to the TR. The Horizontal Copper Cable shall be recorded on the Communications Systems Identification Record document under the heading Jack ID. (see end of section)
 - 3. Method:
 - b. Black on white wire wrap machine printed label.
 - 4. Format:
 - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One-line centered formatted text. Use dash as delimiter.
 - 5. Example: TR-A-001

- C. Item: Patch Cables (data). The patch cables are used to connect data services to the user service locations and are plugged into the electronics or patch panels at the other end of the cable.
 - 1. Label Location:
 - a. On the end of the patch cable at the plug of both ends.
 - 2. Label Information:
 - a. Patch cable identifier (4 numeric characters). The patch cable identifier is sequential. The sequence is unique to the TR. The patch cable identifier shall begin with 0001 and end with the number corresponding to the quantity of jumpers installed in the closet. The patch cable identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading "Data Patch Cable Identifier" provided for each Telecommunication room. (see end of section)
 - 3. Method:
 - a. Black on white machine printed wire wrap labels.

4. Format:
 - a. The font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
 5. Example: 0001
- D. Item: Patch Cables (voice). The patch cables are used to connect voice services to the user service locations and are plugged into the electronics or patch panels at the other end of the cable.
1. Label Location:
 - a. On the end of the patch cable at the plug of both ends.
 2. Label Information:
 - a. Patch cable identifier (Alpha characters). The patch cable identifier is sequential. The sequence is unique to TR. The patch cable identifier shall begin with the letter A and end with the letter corresponding to the quantity of patch cables installed in the closet. When Z is reached. The sequence will start over again with double alpha characters. (AA) The patch cable identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading "Voice Patch Cable Identifier" provided for each Telecommunication room. (see end of section)
 3. Method:
 - a. Black on white machine printed wire wrap labels.
 4. Format:
 - a. The font shall be all Caps and as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
 5. Example: A to Z after Z follow with AA to ZZ.

3.2.2 Fiber Cabling

- A. Item: Building Fiber cable. The (BF) is an interior fiber riser cable extending from the MTR to the Telecommunications Closet (TR).
1. Label Location:
 - a. On the jacket or sheath of the cable at both ends (before the fanout or breakout point). Place the label near the cable entrance into the termination hardware and exterior to the termination hardware.
 2. Label Information:
 - a. The cable identifier is the letters BF followed by the cable number (2 numeric characters) and the Cable Strand Count (4 numeric characters) and the identifying telecommunication room letter. Both the beginning and end count. The cable identifier is unique to the building. The building fiber identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading Building Fiber. (see end of section)
 3. Method:
 - a. Black on white wire wrap machine printed label and large enough to wrap around itself to protect the print.
 4. Format:
 - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format. Use dash as delimiter.
 5. Example: BF01-0001-0012-A
- B. Item: House Fiber cable (HF). The (HF) is an interior fiber cable extending from the MTR or TR to any work area within the building that is not a communications room.
1. Label Location:
 - a. On the jacket or sheath of the cable at both ends (before the fanout or breakout point). Place the label near the cable entrance into the termination hardware and exterior to the termination hardware.

2. Label Information:
 - a. The cable identifier is the letters HF followed by the cable number (2 numeric characters) and the Cable Strand Count (4 numeric characters) and the identifying telecommunication room letter. The HF cable identifier is unique to the building. The HF identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading House Fiber. (see end of section)
3. Method:
 - a. Black on white wire wrap machine printed label and large enough to wrap around itself to protect the print.
4. Format:
 - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format. Center text. Use dash as delimiter.
5. Example: HF01-0001-0012-A

3.2 TERMINATION HARDWARE

3.3.1 Copper Termination Hardware

- A. Item: Outlet faceplate. The outlet faceplate is typically a 2-port or 4-port faceplate.
 1. Label Location:
 - a. On the top of the faceplate in the outlet location window and behind the clear plastic window.
 2. Label Information:
 - a. Outlet location number (8 alpha and numeric characters). The information shall match the outlet location number assigned by the contractor during installation. Outlet numbers are unique to the serving telecommunication room. Each outlet/jack number assigned by the Contractor and the room the jack is installed to shall be recorded on the Communications Systems Identification Record document under the heading Jack Identification and Jack Room Location.
 3. Method:
 - a. Manufacturer's white paper inserts. Print the information on an adhesive label and affix the label to the paper insert. Labels shall not be affixed to the clear plastic window. The orientation of the text on the label for the 2-port faceplates shall match the 4-port faceplates. Use only machine printed labels sized for purpose.
 4. Format:
 - a. Font should be sized to fill the area of the strip. The font should be Helvetica or equal and bold. One line format.
 5. Example: TR-X-XXX
- B. Item: Horizontal Copper Cable Patch Panels. The patch panel for horizontal copper cable is in the MTR or TR and installed in the equipment rack in pre-assigned rack units. The patch panel provides a connection point for voice and data service in the MTR or TR to any field side location within the defined serving boundaries of the said MTR or TR.
 1. Label Location:
 - a. In the manufactures designated port label location.
 2. Label Information:
 - a. Outlet location number (8 alpha and numeric characters). The information shall match the outlet location number assigned by the contractor during installation. Outlet numbers are unique to the serving telecommunication room. Each outlet/jack number assigned by the Contractor and the room the jack is installed to shall be recorded on the Communications Systems Identification Record document under the heading Jack Identification and Jack Room Location.
 3. Method:
 - a. Black on white machine printed manufacture patch panel labels.
 4. Format:
 - a. Font shall be sized to be readable, fitting all characters required within the manufacture provided area. The font should be Helvetica or equal and bold. One line format.
 5. Example: TR-A-001

- C. Item: Telco Patch Panels. The BC cables are terminated on a 25 or 50 port/pair voice Cat.3 RJ45 19in 1RU patch panel. If a 25 or 50 port/pair patch panel is not provided by the selected cable manufacturer from Sec. 27 1100-2.01B. A patch panel from any of the other approved manufacturers in Sec. 27 1100-2.01B can be submitted for approval by the Engineer.

1. Label Location A:
 - a. One single label on the face of the patch panel identifying the BC and serving TR.
2. Example: BC01-A
3. Label Location B:
 - a. At the provided patch panel port label location.
4. Label Information:
 - a. Copper Cable count (as applicable) per port.
5. Method:
 - a. Black on white machine printed adhesive Labels.
6. Format: Font should be sized to be readable and to fit all information required without overlap of text. The font should be Helvetica or equal. One line format.
7. Example: Port 1: 0001 Port 2: 0002
"Port 1:" is for example purpose only and is not to be included on label.

3.3.2 Fiber Termination Hardware

- A. Item: Fiber Housing enclosures including the following (FH).
1. CCH (Closet Connector Housing)
 2. WCH (Wall-mountable Closet Housing)
 3. Label Location:
 - a. On the outside of the enclosure and on the flat facing (i.e., front) surface in the top left corner.
 4. Label Information:
 - a. The Fiber enclosure identifier is the letters FH followed by the enclosure number (4 numeric characters). The Fiber enclosure identifier is unique to the Building. The fiber enclosure identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading Fiber housing.
 5. Method:
 - a. Machine printed 2.25" W x 1.25" H component Label.
 6. Format:
 - a. Font should be sized to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
 7. Example: FH-0001

3.3.3 Fiber Terminations

- A. Item: Building fiber terminations. The connector layout within each enclosure may vary. In general, the columns of fiber adapters are grouped in units of six duplex adapters per connector panels. Columns count from left to right. Terminations positions within a column count from top to bottom. The connector adapters are duplex LC. All connectors will be LC.
1. Label Location:
 - a. On the inside front panel of the enclosure in the location identified by the manufacturer for the label. Use the manufacturer's label placard that is enclosed with the hardware.
 2. Label Information:
 - a. The label information includes a Panel identifier, the Building Fiber cable identifier, and the fiber strand assignment. The Panel identifier (1 alpha character). The Panel identifier shall begin with the letter A and end alphabetically corresponding to the quantity of connector panels in the enclosure. All occupied panels within the enclosure shall be labeled. The Panel identifier is unique to the enclosure. The Panel identifier is assigned by the Contractor. The Building Fiber cable identifier is defined under the Item: Building Fiber cable (BF). The BF strand count is unique to the BF. The sequence begins with 0001.

3. Method:
 - a. Machine printed component Labels. Sized to fit the provided labeling card of the fiber housing manufacturer.
4. Format:
 - a. Font should be sized to fill the label space with the information without overlap of the next column. The font should be Helvetica or equal and bold. One line format.
5. Example:

A-BF01-0001	B-BF02-0001	C-BF03-0001
A-BF01-0002	B-BF02-0002	C-BF03-0002
A-BF01-0003	B-BF02-0003	C-BF03-0003
A-BF01-0004	B-BF02-0004	C-BF03-0004
A-BF01-0005	B-BF02-0005	C-BF03-0005
“ “ “ “ “ “		
A-BF01-0012	B-BF02-0012	C-BF03-0012

3.4 EQUIPMENT AND EQUIPMENT RACKS

- A. Item: Data Racks. The data racks are typically 19" free-standing or wall-mounted racks or cabinets.
 1. Label Location:
 - a. Top front and back cross bars of each data rack.
 2. Label Information:
 - a. The data rack identifier is the letters (DR) followed by the rack number (2 numeric characters). Start numbering from the front of the equipment rack, left to right. The equipment rack label information is shown on the drawing details. The equipment rack identifier is unique to the room.
 3. Method:
 - a. Machine printed 2.25" W x 1.25" H minimum component labels.
 4. Format:
 - a. All capital letters. The font should be sized to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
 5. Example: DR01

3.5 GROUNDING AND BONDING

- A. Item: Telecommunications Main Grounding Busbar (TMGB).
 1. Label Location:
 - a. On the left side of the busbar on the busbar wall standoff.
 2. Label Information:
 - a. The letters TMGB. The TMGB is unique to the building. The identifier information is identified on the grounding schematic detail of the drawings.
 3. Method:
 - a. Black on white machine printed 2.25" W x 1.25" H minimum component Label.
 - b. Format:
 - c. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
 4. Example: TMGB
- B. Item: Telecommunications Grounding Busbar (TGB).
 1. Label Location: On the left side of the busbar on the busbar wall standoff.
 2. Label Information:
 - a. The letters TGB followed by the sequence number (2 numeric characters). The sequence shall be unique to the building. The identifier information is identified on the grounding schematic detail on the drawings.
 3. Method:
 - a. Black on white machine printed 2.25" W x 1.25" H minimum component Label.

4. Format:
 - a. All capital letters. Font should be as large as possible to fill the label holder space with the information. The font should be Helvetica or equal and bold. One line format.
 5. Example: TGB-01
- C. Item: Telecommunications Bonding Backbone (TBB). The Telecommunications Bonding Backbone (TBB) bonds the TMGB to the TGB. There may be multiple TBB's. The quantity of TBB's depends on the methods used to interconnect the TGB's.
1. Label Location:
 - a. On the conductor at each end and at each break in the insulation (for connection to another conductor or a busbar). The label shall be placed near the end of the insulation.
 2. Label Information:
 - a. The letters BB followed by the sequence number (1 numeric character). The sequence number shall be unique to the building. The identifier information is identified on the grounding schematic details on the drawings.
 3. Method:
 - a. Black on white machine printed 2" W x .75" H wire wrap label.
 4. Format:
 - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
 5. Example: BB-1
- D. Item: Telecommunication Bonding Conductor (TBC). The TBC bonds the Intersystem Building Busbar to the TMGB. Typically, there is only one TBC.
1. Label Location:
 - a. On the conductor at each end. The label shall be placed near the end of the conductor at the connection to the Intersystem Building Busbar and the TMGB.
 2. Label Information:
 - a. The letters TBC followed by the sequence number (1 numeric character). The sequence number shall be unique to the building. The identifier information is identified on the grounding schematic detail on the drawings.
 3. Method:
 - a. Black on white machine printed 2" W x .75" H wire wrap label.
 4. Format:
 - b. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.

Example: TBC-1
- E. Item: Equipment Rack bonding conductor (RBC). The equipment rack bonding conductor (RBC) bonds the TMGB and TGB to other metallic items, including electronic equipment.
1. Label Location:
 - a. On the conductor at each end and at each break in the insulation (for connection to another conductor or a busbar). The label shall be placed near the end busbar or the break in the insulation whichever applies.
 2. Label Information:
 - a. The letters RBC followed by the sequence number (3 numerical characters). The sequence number shall be unique to the telecommunications closet. The contractor shall assign the numbers as necessary to accomplish the installation.
 3. Method:
 - a. Black on white machine printed wire wrap Label. .50" W x .375" H.
 4. Format:
 - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
 5. Example: RBC-001

SECTION 27 10 00
TELECOMMUNICATIONS GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 27 00 10 – Telecommunications General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this grounding and bonding system in compliance with the applicable standards, specifications and drawings. Contractor will provide and install all of the required material to form a complete and operational system whether specifically addressed in the technical specifications or not.
- B. All division 27 low voltage systems shall adhere to these grounding and bonding requirements.

1.3 SUBMITTALS

- A. Submittal data for equipment, cabling, and hardware shall consist of catalog cuts showing technical data necessary to evaluate the materials with specific item designated by arrow or by being highlighted.

1.4 WORK BY OTHERS

- A. The Intersystem Grounding Busbar located outside the main electrical service equipment will be installed as part of the main electrical gear and connected back to the various building grounding sources (ground rods, water pipe, building steel, etc.).

1.5 FIRESTOPPING

- A. Contractor shall be responsible for fire stopping all conduit sleeves (internally only) and cable tray where required to maintain integrity of fire and/or smoke walls. The Contractor shall review architectural drawings to determine which walls have a fire and/or smoke rating. Any rating other than “non-rated” shall constitute a wall that requires fire stopping in all penetrations/openings.

PART 2 - PRODUCTS

2.1 GROUNDING EQUIPMENT

- A. Telecommunications Main Grounding Busbar (TMGB): Panduit part number GB4B0624TPI-1.
- B. Telecommunications Grounding Busbar (TGB): Panduit part number GB2B0312TPI-1.
- C. Telecommunications Grounding and Bonding Conductor Label Kit: Panduit part number LTYK.
- D. Data Rack Grounding Busbar, 19”: Panduit part number RGRB19U.
- E. Server Cabinet Grounding Busbar, Cagenut Mounting, 19”: Panduit part number RGRB19CN.
- F. Electrostatic Discharge Port Kit: Panduit part number RGEDS2-1.

2.2 GROUNDING CABLING

- A. Cable used for Intersystem Grounding Busbar to Telecommunications Main Grounding Busbar (TMGB) shall be non-jacketed AWG #3/0 bare copper stranded grounding cable.
- B. Cable used for Telecommunications Main Grounding Busbar (TMGB) to Telecommunications Grounding Busbar (TGB) shall be non-jacketed AWG #3/0 bare copper stranded grounding cable.
- C. Cable used for Telecommunications Main Grounding Busbar (TMGB) or Telecommunications Grounding Busbar (TGB) to data racks/server cabinets inside the telecom room shall be AWG #6 copper stranded cable, green jacketed or bare copper.
- D. Cable used for Telecommunications Main Grounding Busbar (TMGB) or Telecommunications Grounding Busbar (TGB) to any wall mounted low voltage system in the telecom room that requires grounding shall be AWG #6 copper stranded cable, green or bare copper.
- E. Cable used for Telecommunications Main Grounding Busbar (TMGB) or Telecommunications Grounding Busbar (TGB) to the telecom room ladder rack system shall be AWG #6 copper stranded cable, green or bare copper.
- F. Cable used for Cable Tray and/or Wire Basket grounding outside the telecom room shall be #6 AWG stranded bare copper cable.

2.3 GROUNDING HARDWARE

- A. Two Hole Lug, Code Conductor, Long Barrel with Window, AWG #3/0 3/8" with 1" spacing. Panduit part number LCC3/0-38DW-X.
- B. Two Hole Lug, Code Conductor, Long Barrel with Window, AWG #6 with 5/8" spacing. Panduit part number LCC6-14AW-L.
- C. Paint Piercing Grounding Washer Kit with Antioxidant: Panduit parts.
- D. Bonding Screws, #12-24: Panduit part number RGTBSG-C.

PART 3 - EXECUTION

3.1 STAR TOPOLOGY

- A. The telecom grounding and bonding system shall be provided and installed in a star topology. Each building shall receive one Telecommunications Main Grounding Busbar (TMGB) in the designated telecom room or utility demarcation area (see below for location), and one Telecommunications Grounding Busbar (TGB) in each additional telecom room or identified specialty location (see below for locations). All TGB's shall receive a dedicated Telecommunications bonding backbone (TBB) conductor back to the TMGB. The TMGB shall receive a dedicated Telecommunication bonding conductor (TBC) conductor back to the building Intersystem Grounding Busbar (see work by Div.26). The building Intersystem Grounding Busbar is usually just outside the main electrical service gear (interior to the building, visible on the wall).

3.2 Intersystem Grounding Busbar location:

- A. Mechanical 02C

3.3 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB) LOCATION:

- A. Data / Server 02A
- B. If in a telecom room, the TMGB shall be mounted at an elevation approximately 6"-12" above the ladder rack in the room to allow easy access for grounding cables from the ladder rack, and to keep it up and out of the way for better technician safety.

3.4 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB) LOCATION:

- A. NA
- B. If in a telecom room, the TGB shall be mounted at an elevation approximately 6"-12" above the ladder rack in the room to allow easy access for grounding cables from the ladder rack, and to keep it up and out of the way for better technician safety.

3.5 TELECOMMUNICATIONS ROOM LADDER RACK

- A. All telecom room ladder rack shall be bonded together and to the telecommunications grounding busbar in that room using a dedicated Equipment bonding conductor (EBC).
- B. Bonding shall be accomplished per the following:
 - 1. Use the #6 AWG green cable listed in the cable paragraph.
 - 2. Use the #6 AWG two-hole lugs listed in the hardware paragraph.
 - 3. Use the bonding stud and bonding nuts listed in the hardware paragraph to secure the lug to the ladder rack.
 - 4. Drill holes in ladder rack to accommodate the two-hole lugs and bonding studs with bonding nuts.
 - 5. Install bonding conductors in a neat and orderly fashion so as not to droop or hang away from the material it is bonding.
 - 6. Use the #6 AWG two-hole lugs to bond to the busbar.

3.6 TELECOMMUNICATIONS ROOM RACKS AND CABINETS

- A. All telecom room racks and cabinets shall be individually bonded to the copper busbar in that room (the TMGB or TGB) using a dedicated Equipment bonding conductor (EBC).
- B. Grounding the rack or cabinet to the copper busbar shall be accomplished per the following:
 - 1. Use the #6 AWG green cable listed in the cable paragraph.
 - 2. Use the #6 AWG two-hole lugs listed in the hardware paragraph to connect to the telecom room grounding busbar.
 - 3. Use the #6 AWG two-hole lugs listed in the hardware paragraph to connect to the rack or cabinet grounding busbar.
 - 4. Use the paint piercing washers listed in the hardware paragraph.
 - 5. Install bonding conductors in a neat and orderly fashion so as not to droop or hang away from the material it is bonding.
 - 6. Use the #6 AWG two-hole lugs to bond to the busbar.

3.7 TELECOMMUNICATIONS CABLE TRAY AND/OR WIRE BASKET

- A. All installations of cable tray and/or wire basket runs shall be bonded to the nearest copper busbar in a telecom room (the TGB or TMGB) using a AWG #6 stranded bare copper grounding conductor. The break point shall be at the same boundary as the UTP boundary between telecom rooms. Do not bond the cable tray or wire basket together across these boundaries as this could cause a grounding loop.
- B. Bonding cable tray and/or wire basket shall be accomplished per the following:
 - 1. The bare copper bonding conductor shall be one continuous run from the telecom room grounding busbar to the end of the cable tray and/or wire basket longest run. Remember to not bond across the boundaries (see above).

2. Additional branches of cable tray and/or wire basket that branch off the initial "longest run" shall have their own installation of continuous bare copper bonding conductor from the main run to the end. This run shall be mechanically and permanently bonded to the "longest run" using permanent crimp on Panduit lugs and the proper Panduit hydraulic tool for the job. The end result of this is like a tree with a main trunk and branches off that main trunk (the branches connect at the main trunk and do not need to individually run to the telecom room).
3. Each individual piece or stick of cable tray and/or wire basket shall be mechanically bonded to the bare copper grounding conductor.
 - a) For cable tray, use a mechanical bonding lug with paint piercing washer and bolt with nylock nut through body of cable tray. The bare copper bonding cable shall slide into the "C" opening of the lug and be tightened using the lug stud.
 - b) For wire basket, use a mechanical screw type compression lug.

END OF SECTION 27 10 00

SECTION 27 11 00
TELECOMMUNICATIONS CABLING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 27 00 10 – Telecommunications General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

1.3 SUBMITTALS

- A. Manufacturer and Contractor Certifications are required submittals in the division 27 General Provisions specifications section. The Manufacturer Certification is based on the material information listed below in the Acceptable Manufacturers paragraph.
- B. Submittal data for cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.4 WORK BY OTHERS

- A. In general, the following is provided or is of note:
 - 1. Architect will specify each dedicated telecom room fully lined on all walls from floor to 8' AFF (+96") with 0.75" fire retardant 3/4" AC plywood (A side visible after installation), painted with three coats of fire retardant bright white paint. Each sheet of plywood shall have one fire rating stamp masked off such that after painting this stamp is visible to the Authority Having Jurisdiction (AHJ). The Division 27 Contractor shall review the architectural drawings and be prepared to mount ladder rack and other equipment to masonry, gypsum, or other wall types if the plywood was omitted from the architectural design.
 - 2. Electrical Contractor will provide field device back boxes and conduit paths for use by the Telecom or other division 27 Contractor.
 - 3. The project painter may not be aware that ANY paint overspray (or direct application) of paint of any type (latex, oil based and ALL other paint types) to the UTP (unshielded twisted pair, generally called data cabling) voids the manufacturer's warranty and violates this specification. Paint may not be chemically or physically removed in any way once applied to the data cabling. Any cabling with paint overspray shall be fully replaced (no splicing therefore the entire run).

1.5 FIRESTOPPING

- A. Contractor shall be responsible for fire stopping all conduit sleeves (internally only) and cable tray where required to maintain integrity of fire and/or smoke walls. The Contractor shall review architectural drawings to determine which walls have a fire and/or smoke rating. Any rating other than "non-rated" shall constitute a wall that requires fire stopping in all penetrations/openings.

PART 2 - PRODUCTS

2.1 COPPER UTP CABLE AND CONNECTIVITY PRODUCTS

- A. Cabling and connectivity products (devices, cover plates, patch panels, insulation displacement connectors, etc.) must be part of a matched solution, provided by manufacturers that have been tested together and provide a fully certified end to end system.
- B. Acceptable Manufacturers:
1. Belden Cat6 UTP connectivity (angled, modular patch panels) w/Mohawk 6LAN cable with 25-year Belden IBDN Component Warranty and Application Assurance Program provided by a Belden Certified System Vendor (CSV).
 2. CommScope Uniprise Cat6 UTP connectivity (angled, modular patch panels) w/ CommScope Uniprise Media 6 (6504 series) Cat6 cable, with Uniprise 20-year product and performance warranty.
 3. Leviton Cat6 Extreme UTP connectivity (angled, modular patch panels) w/ Berk-Tek LANmark-6 Cat6 cable with BLT limited lifetime warranty provided by Leviton Preferred Network Installers (PNI).
 4. Ortronics Tech Choice Cat6 UTP connectivity (angled, modular patch panels) w/ Superior Essex Series 77 Cat6 cable, with the 25 year "nCompass" system warranty provided by an Ortronics CIP (Certified Installer Plus).
 5. Panduit Netkey Cat6 UTP connectivity (angled, modular patch panels) w/ General GS6 Cat6 cable with PanGenPlus 20-year system warranty provided by a Panduit Certified Installer.

C. Cable Jacket Rating:

1. Non-Plenum

Note: If the above selection is not edited down to only one cable jacket type, the Contractor shall provide plenum rated cabling.

D. Additional Cabling and Connectivity Requirements:

1. Furnish and install cable between telecommunications room and field device locations as noted on the drawings.
2. Each field jack shall have a dedicated cable.
3. Provide cable terminations at telecommunications room.
4. Provide terminations at all field locations with an 8 pin, 8 conductor (RJ45 type) modular jack and flush wall plate per drawings.
5. Terminate using T568B wiring schematic unless noted otherwise.
6. Provide thermoplastic wall faceplates from the same connectivity manufacturer per location requirements for all field devices. Faceplate shall match electrical receptacle faceplates (if stainless steel, then match with stainless steel, if thermoplastic, then match with same color thermoplastic). Verify color/material before submittal time with Design Professional and include faceplate color/material choice in submittals.
7. Configure faceplates as required for individual field locations per drawings.
8. Blanks shall be installed in all empty jack locations.
9. Provide terminations onto insulation displacement connectors for high pair count copper cables.
10. All patch panels shall be high density 48 port in 2RU.
11. If multiple floors are being fed from one telecom room, the Contractor shall provide patch panels for each floor (do not continue from one floor to another on the same patch panel). Each floor's patch panels shall be separated in the rack such that each floor may be expanded by 20% by putting the new patch panels in the original line up).

2.2 TELECOM ROOM EQUIPMENT

A. Please see table below for hardware selection:

HARDWARE	PART #
Data Rack, Two Post. Mount to floor using minimum 3/8" bolt/lag/hardware.	CPI 55053-703
Vertical Cable Management CPI Evolution g3 Combination, black (front solid door and side fingers, rear open with fold down arms):	CPI Evolution DS g3 6", 35571-703
Horizontal Cable Management, 19" Rack Mounted. CPI Evolution, black. Provide "n+1" for patch panel, and also "n+1" for project furnished data switches. If no project furnished data switches, provide three (2) extra for Owner use.	CPI Evolution 2RU, 35441-701

- B. The table above is design basis information. Once the Contractor has selected a product line to bid from 2.01, COPPER UTP CABLE AND CONNECTIVITY PRODUCTS, paragraph B, and if the connectivity manufacturer listed in that selection also manufactures their own hardware equal to the CPI products listed, then the Contractor may use those products in place of the CPI products listed. If what is allowed in this paragraph is pursued, the Contractor assumes full liability for submitting and installing products which fully meet the criteria established by the CPI product, and also understands that if the engineer does not agree that the product meets the CPI design basis, the product line will revert back to mandatory installation of the CPI products listed, with any possible cost differences being fully the Contractors responsibility (including replacing installed hardware if this determination is made post-installation). Lastly, to be eligible to pursue this, the connectivity manufacturer shall offer an equivalent for each CPI part listed, and they all shall be used (no mixing manufacturers).
- C. Cooper B-Line products are also an acceptable alternative to the CPI items in the table above. The Contractor assumes full liability for submitting and installing products which fully meet the criteria established by the CPI product, and also understands that if the engineer does not agree that the product meets the CPI design basis, the product line will revert back to mandatory installation of the CPI products listed, with any possible cost differences being fully the Contractors responsibility (including replacing installed hardware if this determination is made post-installation).

2.3 WIRE BASKET HORIZONTAL CABLE MANAGEMENT

- A. Wire basket shall be provided and installed (generally outside of telecom rooms only) as shown on the plans.
- B. Acceptable Manufacturers are:
1. Wire Basket Tray (WBT) Shaped Wire Basket Tray
 2. Cooper B-Line, Flextray Cable Management
 3. Legrand Cablofil, Wire Mesh Cable Tray
 4. Approved equal.
- C. Additional Wire Basket Requirements:
1. All wire basket and hardware shall be galvanized (no other coatings) applied after product fabrication. This is to ensure a product that is made of an electrically conductive material for grounding purposes.
 2. Whenever possible the Contractor shall continue the basket around corners and changes in elevation by applying the factory instructions for cutting and bending the material rather than stopping the material, forcing the cable to jump from one installation to the other.
 3. The Contractor shall only cut the material with manufacturer approved cutters which leave a square edge, rather than bolt cutters which leave a sharp edge that can damage cables and severely injure installers or the Owner in the future.

4. Wire basket is shown in part diagrammatically on the plans. Conduit sleeves are shown passing through walls often with a stub symbol on each end (so the Electrical Contractor knows what to install) looking like they are 3' or 4' long, but in the field that sleeve will often not be any longer than the wall is thick (which is acceptable as long as it has bushings). The Contractor shall install the wire basket to the intended target shown on the plans (the destination of the cable that is, possibly the area below a floor box, wall sleeves, or other longer conduit pathway, etc.). The maximum air gap between wire basket and the cable destination horizontally shall be one foot (12"). The maximum air gap between wire basket and the cable destination vertically shall be two feet (24").

2.4 LIGHTNING PROTECTION

- A. Lightning protection shall be provided for all cabling that does not remain fully inside the building envelope.
- B. Acceptable Manufacturers are:
 1. L-Com inc.
 2. Approved Equal.
- C. Additional Lightning Protection Requirements:
 1. All cabling 25 pair or larger shall use an enclosed Building Entrance Terminal. This terminal shall be sized to accommodate all incoming cable pairs (full of 5 pin modules). Module selection shall be determined by the application chart found in manufacturer literature.
 2. For applications smaller than 25 pair, the proper manufacturer recommended solution is acceptable (enclosed or not).

2.5 FIRE ALARM PANEL CONNECTIONS

- A. Two fire alarm panel information drops shall be furnished and installed by Contractor for each fire alarm head end panel. These drops shall be provided when required, whether they are pictorially shown on the plans or not.
- B. Acceptable Manufacturers:
 1. UTP cabling shall be the same as the Contractor will be installing per paragraph 2.01.B of this specification.
 2. Terminate cabling on standard RJ45 modular Jacks and install in a 2 port surface mount housing from the cabling manufacturer noted per paragraph 2.01.B of the specification.

PART 3 - EXECUTION

3.1 UTP NO-PAINT WRITTEN NOTIFICATION REQUIREMENT

- A. Paint overspray of any quantity on voice/data UTP cabling (called UTP from here on) voids the manufacturer's extended warranty required by the specification. The Telecom Contractor shall notify the General Contractor in writing that the UTP cannot be painted (not even the slightest bit of overspray) and inform him or her that mechanical or chemical removal of paint is not allowed but rather full replacement of any cable that has received any amount of paint or paint overspray shall be fully replaced (no splicing allowed). This notification shall occur at least 30 days prior to any UTP being installed in the facility or brought on-site for storage.

3.2 INSTALLATION AND LABELING

- A. Install telecommunication systems cables and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
 1. In general, all interior cables are installed in conduit.
 2. D rings are allowed in telecommunications room as needed.

3. Contractor shall use hook and loop type fasteners on all UTP telecommunications cable. Tie wraps may be temporarily used loosely for dressing UTP cables during installation if they are removed before final inspection. Any tie wrap found in place around UTP cable tight enough that a 0.5" wooden dowel cannot be inserted into the bundle at the tie wrap location shall therefore obligate the Contractor to replace those potentially damaged UTP cables at the Design Professionals discretion, whether they pass electronic testing or not.
 4. Tie wraps may be used carefully on OSP and armored cabling at light tension levels which do not result in any visible cable jacket deformation.
 5. If unarmored fiber is specified without innerduct for any reason, tie wraps are forbidden on that cabling.
 6. Any and all tie wraps used in the project shall be trimmed flush at the locking device using a fully flush cutter tool for safety. Any tie wrap found with a sharp point shall be removed by the Contractor and replaced without additional compensation.
- B. Identify all fiber, copper, and coaxial cables that terminate in the telecommunication room as to field location.
1. See Spec. Section 27 05 53 Telecommunication Identification for Communications
- C. After completion, all cables shall be thoroughly tested in accordance with the division 27 Testing and Documentation section.
1. Contractor shall provide all instruments for testing the cables.
 2. Contractor shall demonstrate in the presence of Owner's representative that the telecommunications system is complete and operational.
 3. Contractor shall complete and submit the Certificate of System Demonstration.
- D. After completion, comprehensive As-Builts will be created and posted in each Telecom Room within 3 days.
1. Two hard copies shall be created for each Telecom Room detailing the entire structured cabling plant and labeling scheme after installation. One hard copy shall consist of (at a minimum) the Telecom plans marked with permanent ink to show the labeling used at each field location, and a table or spreadsheet (for example, an 8 ½" x 11" printed Excel file) that lists all the patch panel jacks in a column sequentially, followed by a cross reference column identifying the room name/number that the corresponding jack is in. This is the only part of the labeling process in which room name/numbers are acceptable. The second hard copy shall be identical to the first one. One copy shall be posted in each corresponding Telecom Room, and the other copy shall be submitted to the Design Professional for review according to the submittal process identified in the shop drawing paragraph of Specification Section 27 00 10. This second copy will then be forwarded to Owner.

END OF SECTION 27 11 00

SECTION 27 12 00
TELECOMMUNICATIONS TESTING AND DOCUMENTATION

PART 1 - GENERAL

1.1 GENERAL

- A. Refer to Division 00 – Procurement, Contracting and Warranty Requirements and Division 01 - General Requirements, which all apply to work under this section.

1.2 PURPOSE

- A. The purpose of the testing is to ensure proper installation of the telecommunications cabling system.

1.3 SUBMITTALS

- A. Submit product data under provisions of Division 1.
- B. Submit product data for the following:
 - 1. Hand-held testing equipment manufacturer, model, last calibration date/calibration due date and software version.
 - 2. Injector equipment manufacturer, model, and software version.

1.4 REFERENCES

- A. The following Performance Standards shall be followed. Unless otherwise stated, where Performance Standards conflict with manufacturer's recommendations, the more restrictive shall be applied:
 - 1. TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - 2. TIA-526-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - 3. TIA-568-C.0 Generic Telecommunications Cabling For Customer Premises
 - 4. TIA-568-C.1 Commercial Building Telecommunications Cabling Standard
 - 5. TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
 - 6. TIA-568-C.3 Optical Fiber Cabling Components Standard
 - 7. TIA-568-C.4 Broadband Coaxial Cabling and Components Standard

1.5 TEST EQUIPMENT

- A. Test Equipment: JDSU Certifier40G, Fluke DSX-5000, Fluke DTX-1800 or TIA & Connectivity Manufacturer approved Level IV (or better) Certifier.
- B. The software version for the testers shall be the latest version available.
- C. The tester must have been calibrated within the last 12 months with calibration date noted on all test results.

1.6 LINK DEFINITION FOR THE PROJECT

- A. A link consists of up to 90 meters (295 feet) of horizontal cabling, a connection at each end, up to 2 meters of test equipment lead from the main unit of the hand-held tester to the local connection, and up to 2 meters of test equipment lead from the remote unit to the remote connection. A total length of up to 94 meters (308 feet).
- B. The connection to the equipment at each end of the link is not included in the link definition.

1.7 CHANNEL DEFINITION FOR THE PROJECT

- A. A channel consists of up to 90 meters (295 feet) of horizontal cabling, a connection at each end, up to 7 meters for the cross-connect and equipment cable, and up to 3 meters for the work area equipment cable. A total length of up to 100 meters (328 feet).

- B. The connection to equipment at each end of the channel is not included in the channel definition.

PART 2 - COPPER CABLING ACCEPTANCE TESTING

2.1 ACCEPTANCE TESTS

- A. The following field acceptance tests shall be performed for twisted - pair cabling:
 - 1. Wire Map (continuity).
 - 2. Length.
 - 3. Attenuation.
 - 4. NEXT.
 - 5. ACR-F
 - 6. Delay and delay skew.
 - 7. Return loss.
 - 8. Power sum crosstalk (PSNEXT and PSACR-F).

2.2 TEST EQUIPMENT SET-UP AND TEST PARAMETERS

- A. Auto-test: Use the Auto-tests to perform the required tests. Customize the Auto-test as necessary to satisfy testing requirements and parameters.
- B. Cable Type: Select the cable type being tested. Cable Type may vary. Always change the NVP for the type of cable being tested.
- C. Frequency Range: The frequency range for category 6 tests shall be 1 MHz to 250 MHz.
- D. Cable Pairs: Test all cable pairs. Select all pairs for TEST and all pairs for Pass/Fail criteria for Auto-test.
- E. Length Units: Cable length test results shall be in feet.
- F. Date Style. The date style shall show month, day, and year. Date shall be the date the test is conducted.
- G. Language: The language shall be English.

2.3 TEST PROCEDURE

- A. Testing shall be performed with the tester at the distribution frame and the remote unit at the Work Area Outlet.
- B. A Channel OR Permanent Link certification test will be performed as outlined in the specific job description.
- C. Test leads and test hardware have limited life-cycles. Inspect and replace the test leads as necessary.
- D. Use only test leads specified by the test equipment manufacturer.
- E. Strictly follow the test equipment manufacturer's instructions for equipment setup, initialization, and calibration.

PART 3 - TESTING DOCUMENTATION

3.1 DOCUMENTATION

- A. The Test Documentation requirements are the minimum requirements. Other details of presentation and recording methods will be discussed with Owner and Design Professional. Gain approval from Owner and Design Professional of the test documentation format and content prior to full-scale testing. Coordinate with Owner and Design Professional to get representative sample of the documentation format and content for review.

- B. Provide Owner with a printed copy of ONLY the summary report of all tests, the electronic file of the test results for each test on CD or USB, and the electronic copy of the summary report on CD or USB. Do not print out each report.

3.2 TEST REPORT

- A. The following header fields on each test report shall contain the appropriate information. These are minimum requirements.
 - 1. Circuit ID
 - 2. Test Result
 - 3. Owner
 - 4. Test Equipment Serial Number
 - 5. Software Version
 - 6. Calibration Date
 - 7. Date
 - 8. Cable Type
 - 9. NVP
 - 10. Building
 - 11. Closet
- B. The information in each user definable header field on each test report shall contain the information as follows.
 - 1. Circuit ID: Indicate the outlet location number and jack number under test
 - 2. Owner: Indicate the owner of the test equipment
 - 3. Date: Indicate the date of the test
 - 4. Cable Type: Indicate the cable type being tested
 - 5. NVP: Indicate the field measured NVP
 - 6. Building: Indicate the building where the cable is being tested
 - 7. Closet: Indicate the closet identifier where the cable is terminated
- C. The minimum test result information on each report shall include the data for the tests identified in the Acceptance Tests paragraph of each applicable testing part.
- D. Contractor shall provide the test data in a complete and consistent format. Printed test results shall be printed from a laser printer.
- E. The contractor shall verify that a report for each jack in the Project is contained in the file list.
- F. Two weeks (14 days) prior to scheduled telecommunications systems start-up date Design Professional shall receive from Contractor complete printed cable performance test results via the submittal process (see 27 0010). Start-up shall not commence unless test results are submitted.

3.3 ELECTRONIC COPY

- A. The electronic copy of the test results shall be on CD or USB.
- B. The electronic copy shall be labeled. The label shall read:

Project Name
building name (BLDG. No. x)
"Copper/Fiber Test Results"
"CD No." X of X
date (month and year)

- C. The files shall not be altered from the original test equipment output.

END OF SECTION 27 12 00

SECTION 27 40 00
AUDIOVISUAL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 27 00 10 – Telecommunications General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of the Audiovisual Contractor furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this audiovisual system in compliance with the specifications and drawings. The Audiovisual Contractor shall provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.
- B. It is not acceptable for any portion of this scope of work (whether cable or material acquisition, or any labor to install said cable or materials) to be performed by the Electrical Contractor or any other contractor other than the acceptable bidder selected from the requirements in paragraph 1.06 *ACCEPTABLE AUDIOVISUAL CONTRACTORS* below who have demonstrated the necessary technical and professional capabilities for the work required.

1.3 SUBMITTALS

- A. Submittal data for audiovisual cabling and components shall consist of catalog product sheets showing technical data necessary to evaluate the materials and also one line diagrams showing the intended signal flow throughout.

1.4 EQUIPMENT OBSOLESCENCE AND MANUFACTURER REPLACEMENTS

- A. Electronic equipment of all types (audiovisual included) is a fast paced industry with ever changing technology. Products are often specified by manufacturer and model number but can become obsolete during extended construction timeframes. The Audiovisual Contractor shall be responsible for providing either the equipment specified or the manufacturer approved replacement for the specified item (despite potential price increases or decreases). Submittals for replacement items shall be submitted through channels as soon as possible after the item is discovered. The Audiovisual Contractor shall plan accordingly as cost adding change orders for equipment obsolescence items will not be approved.

1.5 WORK BY OTHERS

- A. Unless noted otherwise, the building's Electrical Contractor will provide field device backboxes, and conduit paths for use by Contractor. In general, the following is provided:
 - 1. Electrical Contractor will make 120VAC connections for the motorized screen and switch (if applicable).
 - 2. General Contractor will mount the screen housing (if recessed in ceiling).

1.6 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire walls. Contractor shall see architectural drawings for walls that require fire rating.

1.7 ACCEPTABLE AUDIOVISUAL CONTRACTORS

- A. The Contractor shall meet the minimum requirements identified herein.
- B. The Contractor's firm shall be an authorized sales and service center for all listed components, or for approved comparable product offerings in the specification.

- C. The Contractor's Audiovisual Technicians assigned to the systems shall be fully trained, qualified, and certified by the respective original equipment manufacturers on the engineering, installation, operation, and testing of these systems.
- D. The Contractor's Audiovisual Technicians assigned to the systems shall be fully trained, certified, and carry valid and current industry certifications regarding the engineering. At least one (1) CTS shall be assigned to implement and complete the installation and configuration of the system.
- E. The Contractor shall provide formal written evidence of current industry and manufacturer certifications for the installers dedicated to this project as part of their submittal.
- F. The Contractor looking for a bid from the contractors listed above shall contact them as soon as possible to ensure they are aware of the project and have adequate time to prepare a bid. Two weeks should be considered a minimum.

PART 2 - PRODUCTS

2.1 AUDIO SYSTEM

- A. Audio System shall be provided with all applicable accessories as a system.
- B. Audio System shall consist of mixer, DSP's, power amplifiers, loudspeakers, wireless microphones, audio feeds from program devices, and all associated connectivity.
- C. Acceptable Manufacturers:
 - 1. Provide per Audiovisual Schedule
- D. Additional Audio System Requirements:
 - 1. Configure gain structure and equalization in accordance with AVIXA A102.01:2017; Audio Coverage Uniformity in Listener Areas.
 - 2. Set microphone frequency to a band not in conflict with other equipment in the facility. Coordinate with Owner on frequencies used.

2.2 DISPLAYS

- A. Displays shall be provided per plans and specifications.
- B. Acceptable Manufacturers:
 - 1. Provide per Audiovisual Schedule
- C. Additional Display Requirements:
 - 1. Audio level shall be controlled by included handheld IR control.
 - 2. Disable extraneous video processing; GAME MODE is acceptable if included.
 - 3. Provide with Scheduled wall mount.

2.3 EQUIPMENT RACK

- A. Equipment Rack shall be provided per plans and specifications.
- B. Equipment Rack shall consist of the rack assembly, cooling, power, and accessory panels.
- C. Acceptable Manufacturers:
 - 1. Provide per Audiovisual Schedule

D. Additional Equipment Rack Requirements:

1. Coordinate with Division 26 Contractor the location of pull box and power receptacle.
2. Coordinate with Division 06 Contractor the location of the Equipment Rack within casework.

2.4 CABLING FOR AUDIO AND VIDEO

A. All cabling for audio and video devices shall be furnished and installed by the Audiovisual System Contractor as required for a complete and operational system. Special cable assemblies shall be furnished and installed as specified on the plans, but all bulk cabling (speaker wire, field terminated "back of rack" cabling, shielded microphone cable, etc.) shall be furnished as listed below.

B. Acceptable Manufacturers:

1. For pre-assembled cable assemblies or specialty cabling items, furnish as specified below.
 - a. Legrand/C2G
 - b. Liberty AV Solutions
 - c. Kramer
2. For all bulk cabling, furnish CMP-rated cabling.
 - a. Belden
 - b. Liberty AV Solutions
 - c. West Penn

C. Additional Cabling Requirements:

1. Cable A1: 22AWG, 2-conductor, shielded, stranded.
2. Cable A2: 22AWG, 2-conductor, shielded, stranded.
3. Cable S1: 16AWG, 2-conductor, unshielded, stranded.
4. Cable V1: HDMI ver. 2.0b or later, 4K 60Hz at 4:4:4 support, CL2, CMP
5. Cable V2: HDMI ver. 2.0b or later, 4k 60Hz at 4:4:4 support, CL2, CM or CMR

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install audiovisual systems cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.

1. Hook and loop type fasteners are preferred on all audiovisual cable. Tie wraps are acceptable if the Contractor uses them in a way that does not damage the cable (do not over-tighten), plus uses flush cut dikes (side cutters) to trim all tie wrap tails off flush with the connector body. Regular dikes or other cutters are not acceptable and pose a danger to all who may come in contact with the improperly trimmed tie wraps. Failure to follow this safety requirement (or the proper installation requirement regarding damage to cables) shall result in the Contractor removing all tie wraps and replacing them with hook and loop type fasteners. The Contractor shall be responsible for replacing any cable that does not perform properly and/or is damaged due to improper use of tie wraps.
2. Contractor shall use provided raceways or Contractor install J-hooks for all cabling. No fastening cabling to conduits, piping, equipment, or anything other than Contractor installed J-hooks.

B. Identify all audiovisual cables as to field location.

1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.

- C. After completion, all cables shall be thoroughly tested.
 - 1. Contractor shall provide all instruments for testing the cables.
 - 2. Contractor shall demonstrate in the presence of Owner's representative that the audiovisual system is complete and operational.
 - 3. Contractor shall complete and submit the Certificate of System Demonstration.

- D. After completion, comprehensive As-Builts will be created and provided to Owner within 3 days.
 - 1. Two hard copies shall be provided to Owner detailing the entire audiovisual system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

3.2 COMMISSIONING

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

END OF SECTION 27 40 00

SECTION 28 00 10
ELECTRONIC SAFETY AND SECURITY GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements, which all apply to work under this section.

1.2 DESCRIPTION OF WORK

- A. This section applies to all work under this division. This shall include, but not necessarily be limited to, the following:
1. Furnish, install, and terminate all system equipment and cabling as applicable and per drawings.
 2. Furnish and install any cabinets, racks and cable management as required and as indicated.
 3. Furnish any other material required to form a complete and operational system.
 4. Provide As-Built drawings per Division 0 and/or Division 1 specification.
 5. Provide Owner training and testing documentation.
 6. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
 7. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
1. National Electrical Code
 2. Local Electrical Code
 3. National Fire Protection Association
 4. National Electrical Manufacturers Association
 5. Standards of Institute of Electrical and Electronic Engineers
 6. Applicable Building Codes
 7. Occupational Safety and Health Act
 8. Wisconsin Administrative Codes
 9. ANSI TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 10. ANSI TIA-526-14-C Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 11. ANSI TIA-568-C.0 Generic Telecommunications Cabling For Customer Premises
 12. ANSI TIA-568-C.1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
 13. ANSI TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
 14. ANSI TIA-568-C.3 Optical Fiber Cabling Components Standard
 15. ANSI TIA-568-C.4 Broadband Coaxial Cabling and Components Standard
 16. ANSI TIA-569-D Telecommunications Pathways and Spaces
 17. ANSI TIA-570-C Residential Telecommunications Infrastructure Standard
 18. ANSI TIA-598-D Optical Fiber Cable Color Coding
 19. ANSI TIA-606-B Administration Standard for Commercial Telecommunications Infrastructure
 20. ANSI TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 21. ANSI TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
 22. National Fire Protection Agency (NFPA - 70), National Electrical Code (NEC)
- B. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.4 REQUIREMENTS & FEES OF REGULATORY AGENCIES

- A. Contractor shall comply with the rules and regulations of the local serving utility companies and shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Secure and pay for all permits, licenses, fees and inspections.

1.5 DRAWINGS

- A. Drawings for the work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.
- B. Contractor shall layout his own work and shall be responsible for determining the exact quantities and locations for equipment.
- C. Contractor shall take own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.
- D. Because of the scale of the drawings, certain basic items for a complete installation are not shown, but where such items are required by code or where they are required for proper installation and operation of the work, such items shall be furnished and installed.

1.6 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.
- B. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- C. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.7 SITE INSPECTION

- A. Contractor shall inspect the site prior to submitting bid for work to become familiar with the conditions of the site which will affect the work and shall verify points of connection with utilities and/or existing system wiring.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.8 COORDINATION AND COOPERATION

- A. It shall be the Contractor's responsibility to schedule and coordinate work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. The Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.

- C. Conflicts between the drawings and the specifications, or between the requirements set forth for the various divisions shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that the Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and the decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve the Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires the Contractor to work in areas previously finished by the Owner, the Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall be responsible for patching and refinishing of such areas which may be damaged in this respect.
- G. Where two or more specified items/systems in the specifications and/or the drawings are in conflict, that requiring the highest order of workmanship and the most financially expensive products shall take precedence. Such questions shall be referred to the Design Professional for final decision.

1.9 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same items, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.

1.10 SUBMITTALS

- A. Contractor shall furnish, to the Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. The Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.
- D. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.
- E. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- F. After award of contract, the contractor shall provide a completed submittal schedule including dates that the submittals will be to the Design Professional for review.

G. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
28 3100	Fire Alarm and Detection Systems	X	X		X	X		
28 50 00	Access Control		X			X		
28 60 00	Video Surveillance System		X			X		
28 70 00	Intrusion Detection System		X			X		
28 80 00	Distributed Antenna System		X			X		
Notes:								

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted to the Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.
- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three-ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
TELECOMMUNICATIONS SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME, ADDRESS AND PHONE NUMBER OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Each section shall contain the following information for equipment furnished under this contract:
1. Equipment and system warranties and guarantees.
 2. Installation instructions.
 3. Operating instructions.
 4. Maintenance instructions.
 5. Spare parts identification and ordering list.
 6. Local service organization, address, contact and phone number.
 7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.

1.12 TESTS AND DEMONSTRATIONS

- A. All systems shall be tested by the Contractor and placed in proper working order prior to demonstrating systems to Owner.

1.13 TRAINING AND DEMONSTRATIONS

- A. Prior to acceptance of the telecommunications installation, the Contractor shall provide to the Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct the Owner in the proper operation and maintenance of such systems.
 - 1. Provide adequate notice to the Owner as to when instruction will be conducted so appropriate personnel can be present.
 - 2. Prepare the instruction format for a minimum of four Owner Representatives.

- B. Equipment training:
 - 1. Manufacturer's representatives shall provide instruction on each major piece of equipment. The Contractor shall provide instruction on all other equipment.
 - 2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
 - 3. Training shall be performed by qualified factory trained technicians.
 - 4. The Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
 - 5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

- C. System training:
 - 1. Training sessions shall include hands-on demonstrations of system wide start-up, operation in all possible modes, shut-down and emergency procedures.

- D. The following are minimum requirements for Owner instruction:

Section	Description	Hrs. on Site	Hrs. off Site	Presented By	Others Present	Remarks
28 3100	Fire Alarm and Detection Systems	4	0	Manufacturer's Representative	Contractor	1
28 50 00	Access Control	4	0	Access Control Contractor	Owner	1
28 60 00	Video Surveillance	4	0	Video Surveillance Contractor	Owner	1
28 70 00	Intrusion Detection System	4	0	Intrusion Detection Contractor	Owner	1
28 80 00	Distributed Antenna System	2	0	DAS Contractor	Owner	1
Remarks:						
1. Perform complete system test at time of instruction.						

- E. The Contractor shall submit a certificate, signed by the Owner stating the date, time and persons instructed and that the instruction has been completed to the Owner's satisfaction. An example of a certificate form is as follows:

CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that the contractor has demonstrated the hereafter listed systems to the Owner's representatives in accordance with the Contract documents and that the instruction has been completed to the Owner's satisfaction.

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: _____

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

_____ Signature

_____ date

Owner's Representative:

_____ signature

_____ date

1.14 PERMITS, FEES, ETC.

- A. Secure all required permits and pay for all inspections required in connection with the telecommunication systems work. Contractor shall post all bonds and obtain all licenses required by the State, City, County, and Federal Agencies.

1.15 SUBSTITUTIONS

- A. To obtain approval to use unspecified equipment, Bidding Contractors (not equipment supplier, manufacturers, etc.) shall submit written requests to the Design Professional at least 10 days prior to bid due date. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent to include a cost comparison between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, the Design Professional will approve it in an addendum. The Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.16 APPROVED CONTRACTORS

- A. The Contractor shall be a manufacturer certified installer and service provider for the product submitted and installed. A copy of the Contractor's manufacturer certification must be submitted under this specification section for the Access Control Contractor and the Video Surveillance Contractor if applicable to the project. The Contractor is responsible for workmanship and installation practices in accordance with the manufacturer requirements and must be authorized to provide a Manufacturer's Product Warranty with his installation.
- B. The Contractor pulling the cabling (if different from the prime system Contractor) shall meet the BICSI or IBEW/NECA requirements found in the Division 27 General Provisions.
- C. Contractor shall be located within 125 miles of the construction site to establish a potential two-hour response time for ongoing customer needs after construction completion.

1.17 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plans are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to the Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the Contractor and/or the manufacturer.
- C. If the Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.18 QUALITY ASSURANCE

- A. The Contractor shall be a company specializing in telecommunication cable and/or accessories with a minimum of five years documented experience in installation of cable and/or accessories similar to those specified below.

1.19 WARRANTY

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
 - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
 - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
 - b. The entire HVAC system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 23 sections for systems, equipment, or material requiring extended warranties beyond one year.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

1.20 CHANGES IN THE WORK

- A. A Contract Change Order is a written order to the Contractor signed by the Owner and Contractor, issued after the execution of the Contract, authorizing a change in the Work or an adjustment in the Contract Sum or the Contract Time. The Contract Sum and the Contract Time may be changed only by Contract Change Order.
- B. The Owner, without invalidating the Contract, may order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, with the Contract Sum and the Contract Time being adjusted accordingly. All such changes in the Work shall be authorized by Contract Change Order and shall be performed under the applicable conditions of the Contract Documents.
- C. The cost or credit to the Owner resulting from a change in the Work shall be determined by mutual acceptance of a lump sum properly itemized and supported by sufficient substantial data to permit evaluation. Change Orders shall be submitted with each item listed individually with a material cost and labor unit extension. Overhead and profit, as mutually agreed upon between Owner and Contractor shall be added to material and labor cost figures.
- D. It shall be the responsibility of the Contractor before proceeding with any change to satisfy himself that the change has been properly authorized on behalf of the Owner.

1.21 COMPLETION

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by the Owner.
- B. When all the work is complete the Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.

- C. The Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

END OF SECTION 28 00 10

SECTION 28 05 00
COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 -GENERAL

1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements and Division 01 - General Requirements are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. This section applies to work under Division 28.
 - 1. Drawings are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.
 - 2. Contractor shall layout his own work and shall be responsible for determining the exact quantities and locations for equipment.
 - 3. Contractor shall take own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.
 - 4. Because of the scale of the drawings, certain basic items for a complete installation are not shown, but where such items are required by code or where they are required for proper installation and operation of the work, such items shall be furnished and installed.

1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
 - 1. National Electrical Code
 - 2. Local Electrical Code
 - 3. National Fire Protection Association
 - 4. National Electrical Manufacturers Association
 - 5. Standards of Institute of Electrical and Electronic Engineers
 - 6. Uniform Building Code
 - 7. Occupational Safety and Health Act
 - 8. Iowa Administrative Codes
- B. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.4 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same items, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.

1.5 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules, are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to the Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the Contractor and/or the manufacturer.
- C. If the Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

PART 2 - PRODUCTS

2.01 FIRESTOPPING

- A. Piping, sleeves and ducts passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe, sleeve, and/or duct shall be sealed with UL Listed intumescent fire barrier material equivalent to rating of wall/floor. Refer to section 07 8400 for firestopping materials and requirements.

PART 3 - EXECUTION

3.01 CLEANING

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by the Owner.
- B. When all the work is complete the Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.
- C. The Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

END OF SECTION 28 05 00

**SECTION 28 31 00
FIRE ALARM AND DETECTION SYSTEM**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

1.2 QUALITY ASSURANCE

- A. The system installation and wiring shall comply with applicable provisions of the current issue of NFPA-72, International Building Code, International Mechanical Code, Wisconsin Enrolled Commercial Building Code, Americans with Disabilities Act, and codes and regulations of local authorities having jurisdiction.
- B. NEC Compliance: Comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories.
- C. UL Compliance and Labeling: Provide fire alarm and detection system components which are UL-listed and labeled.

1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
1. National Fire Protection Association; NFPA 70, NFPA 72, NFPA 80, NFPA 20, NFPA 13
 2. National Electrical Manufacturers Association
 3. Standards of Institute of Electrical and Electronic Engineers
 4. International Building Code
 5. Occupational Safety and Health Act
 6. Wisconsin Enrolled Commercial Building Code
 7. NECA Standards
 8. Americans With Disabilities Act (ADA)
 9. ASME A17.1 State Elevator Code
 10. Regulations of local authorities having jurisdiction.

1.4 SUBMITTALS

- A. Submittal data for the fire alarm equipment shall consist of shop drawings outlined in NFPA 72 shop drawing requirements and include but not limited to: block diagrams of layout and operation of the system, full size drawings with device locations and addresses, battery power calculations, audible and visual device power supply calculations, voltage drop calculations, list of device identification and addresses that will be displayed on the control panel(s), quantities of equipment, catalog cuts showing technical data necessary to evaluate the equipment and other descriptive data necessary to describe fully the equipment proposed.
- B. In no instance shall the contract drawings be reproduced for shop drawing submittals.
- C. Contractor is responsible for any fees associated with the review and approval of the fire alarm drawings and product data by the Authority Having Jurisdiction (AHJ). Contractor is also responsible for completion of the required fire alarm system submittal form and submittal of the final fire alarm shop drawings to the AHJ.

1.5 RECORD DRAWING REQUIREMENTS

- A. Record drawings shall be provided prior to the time of scheduling of the final inspection. They shall include the location of the overcurrent protection that feeds any fire alarm related equipment and shall be clearly marked on the drawings. Include changes made during system testing and acceptance.
 - 1. The following should be included:
 - a. Alarm initiation devices with addresses.
 - b. Alarm signal devices with module locations/addresses and circuit numbers.
 - c. Door holders and smoke dampers with module location and addressed.
 - d. Air handling units with module and relay locations and addresses.
 - e. Junction pull boxes.
 - f. Layout of conduit with circuit identification.
 - g. 120 VAC power sources for control panels, door holders, and fire/smoke dampers.
 - h. Location of all end of line resistors.
 - i. Calculations for voltage drop on circuits, battery, and audio amplifier sizing.

1.6 SYSTEM OPERATION

- A. Control of System: By the Fire Alarm Control Panel.
- B. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
- C. Priority of Signals: Automatic alarm response functions resulting from an alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. An alarm signal is the highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when the lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received.
- D. Noninterference: A signal on one zone shall not prevent the receipt of signals from other zones.
- E. System Reset: All zones are manually resettable from the Fire Alarm Control Panel after initiating devices are restored to normal. Equipment that has been by-passed in software shall not change state of condition during a "reset".
 - 1. Fire Alarm Control Panel shall be reprogrammed so that it can be reset only when a security level access level of 3 or greater is used.
- F. Transmission to Remote Alarm Receiving Station: Automatically route alarm, supervisory, and trouble signals to a remote alarm station by means of a digital alarm communicator transmitter and telephone lines.
- G. System Alarm Capability during Circuit Fault Conditions: System wiring and circuit arrangement prevent alarm capability reduction when a single ground or open circuit occurs in an initiating device circuit, signal line circuit, or notification-appliance circuit.
- H. Loss of primary power at the Fire Alarm Control Panel initiates a trouble signal at the Fire Alarm Control Panel and the annunciator. An emergency power light is illuminated at both locations when the system is operating on the secondary power supply.
- I. Basic Alarm Performance Requirements: Unless otherwise indicated, operation of a manual station, automatic alarm operation of a smoke or heat detector, or operation of a sprinkler flow device initiates the following:
 - 1. Notification-appliance operation.
 - 2. Initiation of alarm system.

3. Identification at the Fire Alarm Control Panel and the remote annunciator of the device originating the alarm.
 4. Transmission of an alarm signal to the remote alarm receiving station.
 5. Recall of elevators if the alarm is initiated by a detector located in an associated machine room, hoistway, or elevator lobby.
 6. Shutdown of fans and other air-handling equipment serving the fire zone where alarm was initiated.
 7. Initiation of smoke control sequence(s).
 8. Closing of smoke dampers in air ducts of system serving the fire zone where alarm was initiated.
 9. Recording of the event in the system memory.
- J. Alarm Silencing, System Reset and Indication: Controlled by switches in the Fire Alarm Control Panel and the remote annunciator.
1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
 2. Subsequent alarm signals from other devices or fire zones reactivate notification appliances until silencing switch is operated again.
 3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.
- K. Operating a heat detector in the elevator shaft or elevator machine room shuts down elevator power by operating a shunt trip device in the circuit feeding the elevator.
1. A field-mounted relay actuated by the Fire Alarm Control Panel closes the shunt trip circuit and operates building notification appliances and annunciator.
- L. Operating a smoke detector in the elevator shaft, elevator machine room or elevator lobby initiates Phase I Emergency Recall Operation automatically recalling the elevator to the main level of egress or the alternate recall level if the main level elevator lobby smoke detector is in alarm.
- M. Operating the fireman's control key for the elevator shall initiate Phase II Operation and bypass all automatic controls.
- N. Smoke detection for zones or detectors with alarm verification initiates the following:
1. Audible and visible indication of an "alarm verification" signal at the Fire Alarm Control Panel.
 2. Activation of a listed and approved "alarm verification" sequence Fire Alarm Control Panel " and the detector
 3. General alarm if the alarm is verified.
 4. Cancellation of the Fire Alarm Control Panel indication and system reset if the alarm is not verified.
- O. Sprinkler valve-tamper switch operation initiates the following:
1. A supervisory, audible, and visible "valve-tamper" signal indication at Fire Alarm Control Panel and the annunciator.
 2. Transmission of supervisory signal to remote alarm receiving station.
- P. Remote Detector Sensitivity Adjustment: Manipulation of controls at the Fire Alarm Control Panel causes the selection of specific addressable smoke detectors for adjustment, display of their current status and sensitivity settings, and control of changes in those settings. Same controls can be used to program repetitive, scheduled, automated changes in sensitivity of specific detectors. Sensitivity adjustments and sensitivity-adjustment schedule changes are recorded in system memory and are printed out by the system printer.
- Q. Removal of an alarm-initiating device or a notification appliance initiates the following:
1. A "trouble" signal indication at the Fire Alarm Control Panel and the annunciator for the device or zone involved.
 2. Transmission of trouble signal to remote alarm receiving station.

- R. Fire Alarm Control Panel Alphanumeric Display: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating the report. Display monitoring actions, system and component status, system commands, programming information, and data from the system's historical memory.
 - 1. The upper line of the display shall indicate the zone in alarm according to the zone schedule on drawings.
 - 2. The lower line of the display shall indicate the address of the device in alarm.

- S. LED Lights:
 - 1. Only fire alarm zone lights and "device type" lights shall annunciate with a red LED. Device type, address and exact location shall annunciate on the digital readout.
 - 2. Any by-pass, disable, or trouble condition shall annunciate with an amber LED, a trouble sounder and annunciate on the digital readout. A "trouble pending" control module shall be included.

1.7 ACTIVE SYSTEMS

- A. Existing Fire Alarm Equipment: Re-use existing back boxes and raceways where feasible.

- B. Equipment Removal:
 - 1. Remove from site and legally dispose of existing material not designated for other disposition.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Contractor shall provide the following spare parts in quantities shown, with a minimum of 1/item:

Quantity	Type of Device Present
2	Smoke detectors and heat detectors
2	Smoke and heat detector bases
1	Monitor Modules
1	Control Modules
2	Horn/strobe Units wall and ceiling variants
2	Strobes wall and ceiling variants
1	Manual Pull Stations
5 units	Keys and Tools for access to locked and tamperproofed components

1.9 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- B. Special Warranty: A written warranty, signed by Contractor and manufacturer, agreeing to replace components that do not meet requirements or that fall within the specified warranty period.
 - 1. Warranty Period: One year from date of Final Acceptance. Full warranty applies throughout the warranty period.

PART 2 -PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer:
 - 1. Honeywell/FireLite: ES-50X
 - 2. The equipment supplier shall provide the services of a factory trained representative. They shall supervise the system installation and final connections to the equipment and provide testing to assure that the system is in proper operating condition.

2.2 FIRE ALARM AND DETECTION SYSTEMS

- A. General: Provide fire alarm and detection system products of types, sizes, and capacities indicated, which comply with manufacturer's standard design, materials, components; construct in accordance with published product information, and as required for complete installation. Provide fire alarm and detection systems for applications indicated, with the sequence of operations, components and function features indicated.
- B. Materials and Equipment:
 - 1. Wiring System Materials: Provide basic wiring materials which comply with 26 0500 – Common Works Results for Electrical, 26 0553 – Raceway and Boxes for Electrical Systems, and 26 0519 - Low-Voltage Electrical Power Conductors and Cables; types to be selected by Installer.
 - a. Junction and Pull Boxes:
 - 1) Junction and pull boxes shall be clearly marked. This shall be done by painting the covers red, and properly labeling them.
 - 2) All junction and pull boxes located at or above 8'0" from the floor shall be a minimum size of 4-11/16".
 - 3) No box extensions shall be permitted on new work.
 - 4) All junction boxes shall be readily accessible.
 - 5) No splicing in device mounting boxes.
- C. Manufacturer's Equipment: Provide manufacturer's standard construction equipment for material noted below:
 - 1. Central Fire Alarm Control Panel.
 - a. Cabinet: Front lockable steel enclosure with a 14 gauge door and 16 gauge cabinet body, minimum. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure. If more than one unit is required to form a complete control panel, fabricate with matching modular unit enclosure to accommodate components and to allow ample gutter space for field wiring and interconnecting panels.
 - 1) Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 1 inch high. Identify individual components and modules within cabinets with permanent labels.
 - 2) Mounting: Surface.
 - 3) Keys: Common to all system components.

- b. Storage:
 - 1) The system stores and logs alarm and trouble events. Each recorded event includes the time and date of the event's occurrence.
 - 2) The system has the capability of recalling alarms, detector verifications, trouble conditions, acknowledgments, and silencing and reset activities in chronological order for the purpose of recreating an event history.
 - 3) Memory: Battery protected random access memory.
 - 4) Alarm Log: 300 events. Trouble Log: 300 events.
 - 5) Available Reports:
 - a) Alarm, trouble and test conditions including the time and date of each occurrence.
 - b) Status of each device in the system including detector sensitivity and verification tally.
 - c) Detector trending.
- c. Alarm and Supervisory Systems: Separate and independent in the Fire Alarm Control Panel. Alarm-initiating zone boards consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.
 - 1) Initiating Device Capacity: Adequate for quantity of devices indicated on drawings plus 10 percent.
 - a) Quantity of Simultaneous Alarms: Unlimited.
 - 2) Maintenance Alert: Automatically warns of a contaminated detector prior to false alarm.
 - 3) One additional signal line circuit (SLC) for future.
- d. Control Modules: Include types and capacities required to perform all functions of fire alarm systems. Each circuit shall have 10 percent spare capacity.
- e. Indications: Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has a different sound.
- f. Resetting Controls: Prevent the resetting of alarm, supervisory, or trouble signals while the alarm or trouble condition still exists.
- g. Alphanumeric Display and System Controls: Arranged for interface between human operator at the Fire Alarm Control Panel and addressable system components, including annunciation, supervision, and control. Bypass switches shall provide specific alphanumeric display on the LCD annunciator.
 - 1) Display: A minimum of 80 characters; alarm, supervisory, and component status messages; and indicate control commands to be entered into the system for control of smoke detector sensitivity and other parameters.
 - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.
 - 3) Bypass Switches: Activation of a bypass switch allows system testing without operation of the bypassed circuit. A trouble condition is generated upon operation of a bypass switch. Provide bypass switches for the following:
 - a) Remote monitoring station notification.
 - b) Audio circuit.
 - c) Visual circuit.
 - d) Smoke dampers.
 - e) Pressurization fans.
 - f) Elevator recall.
 - g) Fire doors.
 - 4) Control Switches: Switches allow manual control or testing of the following:
 - a) Smoke removal system.
 - b) Stair pressurization system.
 - c) Alarm Test. Operation of switch simulates an alarm condition in the same manner as if a manual station was operated. Notification of the fire department or central monitoring station is bypassed.
- h. Programming:
 - 1) System Memory: Non-volatile, programmable.
 - 2) Loading or editing of special instructions and operating sequences allowed as required.

- 3) Capable of on-site programming to accommodate and facilitate expansion, building parameter changes, or changes as required by local codes.
- 4) Provisions for disabling and enabling all addressable devices, and all monitoring, signaling and control circuits individually for maintenance and testing purposes.
- 5) Provisions for distinctly different evacuation tone for disaster warning purposes.
- 6) Smoke sensor sensitivity:
 - a) Automatic sensitivity adjustment of each sensor based on time of day and day of week.
 - b) Multiple sensitivity settings per sensor.
 - c) Pre-alarm or two-stage function to provide an indication when a sensor reaches 50 percent of its alarm threshold.
- 7) Contractor shall provide a detailed device description label that includes Room Name, Room Number, and Location in Building for common room name (i.e. Mech Room by main storage).

i. Control Switches:

	<u>Access Level</u>
City disconnect with digital readout (for both alarms and troubles)	Level 3
Audio bypass with digital readout	Level 3
Visual circuit bypass with digital readout	Level 3
Smoke damper bypass with digital readout	Level 1
Elevator bypass	Level 1
Activation of elevator smoke damper	Level 1

- j. Provide air handler shutdown by specific unit or by fire zone (i.e. floor). Switch cannot be activated unless one or more of the following conditions occur:
 - 1) Fire Alarm Control Panel is in access level 3.
 - 2) Panel is in alarm condition.
- k. Fire alarm control panel power shall be supplied by dedicated circuit(s).

2. Manual Pull Stations

- a. Description: Fabricated of metal, and finished in red with molded, raised-letter operating instructions of contrasting color.
 - 1) Double-action mechanism requires two actions, such as a push and a pull, to initiate an alarm.
 - 2) Station Reset: Key or wrench operated; double pole, double throw; switch rated for the voltage and current at which it operates.
 - 3) Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
 - 4) When surface-mounting pull stations, fire alarm equipment provider shall provide back boxes to match pull stations.

3. Smoke Detectors

- a. General: Include the following features:
 - 1) Operating Voltage: 24-V dc, nominal.
 - 2) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 3) Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
 - 4) Sensitivity: Can be tested and adjusted in-place after installation.
 - 5) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
 - 6) Remote Controllability: Unless otherwise indicated, detectors are analog-addressable type, individually monitored at the Fire Alarm Control Panel for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the Fire Alarm Control Panel.

- b. Photoelectric Smoke Detectors: Include the following features:
 - 1) Sensor: LED or infrared light source with matching silicon-cell receiver.
 - 2) Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
 - 3) Magnetically actuated test switch.
 - 4) Integral Thermal Detector: Fixed-temperature type with 135 deg F setting.
- 4. Other Detectors
 - a. Heat Detector, Combination Type: Actuated by either a fixed temperature or rate of rise of temperature.
 - 1) Analog temperature measuring device with setpoint (rating) set by Fire Alarm Control Panel.
 - 2) Mounting: Plug-in base, interchangeable with smoke detector bases, where available.
 - 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
- 5. Notification Appliances
 - a. Description: Equip for mounting as indicated and have screw terminals for system connections.
 - 1) Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
 - b. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear or nominal white polycarbonate lens. Mount lens on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
 - 1) Rated Light Output: Field selectable 15 through 110 candela minimum per UL 1971 for ADA use unless otherwise indicated on drawing or required to meet NFPA 72 criteria.
 - 2) Strobe Leads: Factory connected to screw terminals.
 - 3) Synchronized operation.
 - 4) Mounting:
 - a) Ceiling: Flush with white baffle.
 - b) Wall: Surface with red or white housing.
 - c) Include skirt for surface mounted devices which do not conceal a standard 4-inch junction box.
 - c. Alarm Horns:
 - 1) Minimum sound pressure 87dB at 10'
 - 2) Separate in/out wiring for signal circuit
 - 3) Mounting:
 - a) Ceiling: Flush with white baffle.
 - b) Wall: Surface with red housing.
 - c) Include skirt for surface mounted devices which do not conceal a standard 4-inch junction box.
- 6. Remote Annunciator – Existing to remain and tied into new control panel.
- 7. Signal Circuit Remote Power Supply
 - a. General: Filtered, regulated, power limited with trouble indication; with emergency power supply.
 - b. Cabinet Lockable steel, surface-mounted enclosure, keyed to match, Fire Alarm Control Panel.
- 8. Battery Power Supply
 - a. General: Components include valve-regulated, recombinant lead acid battery; charger; and an automatic transfer switch.
 - 1) Battery Nominal Life Expectancy: 4 years as a minimum.
 - b. Battery Capacity: Comply with NFPA 72 for supplying a minimum of 24 hours of operation in normal condition, followed by no less than 15 minutes in full alarm for a system operating without a backup generator.

- c. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.
 - d. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.
9. Addressable Interface Devices
- a. Monitor Module: Microelectronic module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts; allows individual monitoring of non-addressable points.
 - b. Control Module: Microelectronic module listed for use in providing a multiplex system address to relays for system control functions.
 - 1) Relay: 24 VDC coil with red LED when in the "alarm" state; contacts rated 10A, 115 VAC, minimum; suitable for control function required.
10. Digital Alarm Communicator Transmitter
- a. Listed and labeled under UL 864 and NFPA 72.
 - b. Plain Old Telephone Service (POTS) Communicator:
 - 1) Unit receives an alarm, supervisory, or trouble signal from the Fire Alarm Control Panel panel, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising two lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.
 - c. Cellular/IP Communicator:
 - 1) The cellular communicator connects directly to the primary and secondary analog UL Listed Fire Alarm Control Panel telephone ports.
 - 2) The Communicator will communicate to GSM networks in the area including 2G, 3G and 4G. The multi-GSM platform technology automatically detects and chooses the best network in the area based on signal strength and immediately self-adjusts for operation.
 - 3) Supports both dynamic (DHCP) or Public and Private Static IP addressing.
 - 4) Communicates over any type of customer-provided Ethernet 10/100 Base network connection (LAN or WAN), DSL modem or cable modem.
 - 5) Data transmits over standard contact-ID protocol is secured with the industry's advanced encryption standard (AES 256 bit).
 - 6) Dual path communications: Uses Internet or GSM as primary.
 - 7) Provide with programming tools as required.
 - 8) Diagnostic LEDs: Signal strength and status indications.
 - 9) IP and GSM tested every day.
 - 10) All circuits shall be power-limited, per UL864 requirements.
11. Fire Alarm Documentation Cabinet
- a. Provide fire alarm documentation cabinet in accordance with NFPA-72 Cabinet to be labeled "SYSTEM RECORD DOCUMENTS". Space Age Systems SRD ACE-11 or equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Contractor/Installer shall meet with Owner prior to performing any work on existing/new system(s). Meeting shall determine existing building system functions and approach Contractor/Installer will take to remove the existing system. And, determine Contractor's/Installer's plan to install new system which includes raceway runs, typical wiring practices, and device and equipment installation, also to provide Contractor/Installer with Owner's expectations.

- B. The locations and spacing of alarm initiating devices and strobes indicated on the drawings are approximate. The equipment supplier shall verify device requirements and spacing and shall add devices as required to satisfy governing authorities. It shall be the responsibility of the equipment supplier or their representative to determine the type of detector required by local authorities for each type of installation.
- C. Install the fire alarm system in accordance with approved manufacturer's wiring diagrams. Furnish all conduit, wiring, outlet boxes, junction boxes, cabinets, and similar devices necessary for a complete installation. Boxes shall be installed in accessible spaces without requiring the removal of light fixtures or any other equipment.
- D. Coordinate system programming with the authority having jurisdiction.
- E. Provide 120 volt power to annunciator panels and remote signal circuit power supplies.
- F. Paint the fire alarm power supply disconnect red and label "Fire Alarm Circuit Control". Provide locking means.
- G. Coordinate the installation of equipment and devices that pertain to the work of other trades with the appropriate contractors.
- H. Provide switch and fuse stat's (type SOU) installed within the Fire Alarm Control Panel disconnect 120 VAC power and separately all battery power.
- I. Coordinate the installation of equipment and devices that pertain to the work of other trades with the appropriate contractors.
 - 1. Provide connections to 120V smoke dampers provided by the mechanical contractor. Install 120V indicator lights provided with the dampers and wire to position switches.
 - a. Provide dedicated 120 volt circuits for smoke dampers.
 - 2. Provide shut-down relays to initiate HVAC shut down. Locations indicated on the fire alarm drawings are diagrammatic. Coordinate relay installation and HVAC unit shut-down with temperature controls contractor.
 - 3. Provide monitoring of fire suppression system. Coordinate installation with the Fire Suppression System installer.
 - a. Activation of water flow shall initiate general alarm.
 - b. Activation of valve tamper switches shall initiate a supervisory alarm.
 - c. Provide monitoring of fire pump in accordance with NFPA 20.
 - d. Provide monitoring and control of elevator in accordance with ASME A17.1, International Building Code and State Elevator Code. Coordinate installation with the elevator installer.
 - e. Provide primary and secondary recall signals.
 - f. Monitor shunt-trip control power.
 - g. Provide shunt-trip signal in accordance with ASME A17.1. Provide timed delay of shunt-trip signal to allow elevator to be recalled. Coordinate length of time delay with elevator vendor.

3.2 DEVICE INSTALLATION

- A. Provide devices as indicated on drawings and as required to perform specified functions.
- B. Initiating Devices:
 - 1. Smoke Detectors:
 - a. Cover all smoke detection devices immediately after installation to maintain cleanliness.
 - b. Install within five feet of each door held open by the fire alarm system.
 - c. Where adjacent to an air shaft, supply diffuser or return grille, install smoke detector 36 inches minimum from the edge of the diffuser or grille.
 - d. Provide a smoke detector within 10 feet of each remote power supply panel.

2. Provide heat detectors in areas where smoke detectors would be subject to false alarm.
3. Program address for each device as directed by Owner or stated elsewhere in specification.
4. Program device output text by address and geographic location.
5. Provide an addressable interface module for each non-addressable device.
6. Provide an addressable interface module for each non-addressable initiating device.

C. Signaling Devices:

1. Where plans indicate a signaling device installed adjacent to a manual station, install the signaling device on the wall directly above the manual station.
2. Provide a minimum of two weatherproof audible signaling devices of the same type as other signaling devices provided with the system. The audible signaling devices will be located by the fire department connection to each building. Owner will determine the exact locations. Mount the devices on the exterior of the building. Provide a separate circuit for exterior audible signaling devices.
3. In sprinkled buildings, provide a 120 volt circuit to the fire sprinkler bell location. Provide manual bypass from the Fire Alarm Control Panel.
4. Set taps for toilet room speakers at 1/4 watt where toilet room is under 1000 square feet.
5. Signaling devices shall be completely deactivated by pressing "signal silence".
6. Audibles shall be placed so that they can be heard a minimum of 15 decibels above the ambient decibel level in all locations (refer to NFPA 72G and ISBC 17.705(12)).

D. Control Devices:

1. All devices controlled by the Fire Alarm Control Panel (i.e. dampers, doors, elevators, etc.) shall be operated by the use of "control modules" and not by relay type device on detector bases. No auxiliary equipment shall be directly connected to LMX control modules. Control modules shall activate a 24VDC relay with LED when in the "alarm".
2. Elevators: Verify recall requirements with local codes, authorities, and installers prior to system programming. Provide control modules and relays as required.
3. Provide control modules and relays as required to implement the required control sequences.
4. Provide control modules and relays for remote indication of alarm and trouble conditions.
5. Provide monitor module(s) where conventional non-addressable heat detectors and similar devices are installed.

E. Cabinets:

1. Mount Fire Alarm Control Panel and remote cabinets a maximum of 72 inches above finished floor to the top of the cabinet. Provide a 4-inch space between adjacent cabinets.

3.3 WIRING INSTALLATION

- A. Wiring Method: Use Class B wiring for communication between fire alarm panel equipment and Class B for field mounted devices. Install wiring in metal raceway according to Division 26, Section 26 0533 - Raceways and Boxes for Electrical Systems. Conceal raceway except in unfinished spaces and as indicated. Surface-mounted Wiremold shall be size 700 minimum.
- B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors. Do not install spare conductors in conduits or junction boxes.

- C. Cable Taps: All cables in the fire alarm control panel, junction boxes, and pull boxes shall be clearly marked in English (i.e. SLC 1, 3rd Floor Speakers, etc.). Label all junction box covers to indicate circuits and/or devices enclosed. Label inside cover of all junction boxes in finished areas. Label outside cover of all junction boxes in unfinished/concealed areas.
- D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red and provide circuit labels on inside of cover.
- E. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the Fire Alarm Control Panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.
- F. Install end-of-line resistors at the farthest device from panel or module in a separate junction box clearly marked "End-of-Line Resistor."
- G. Conductors (minimum size and color) and raceways shall be provided as listed below, unless otherwise recommended by the system manufacturer or required by the authority having jurisdiction:

1.	120VAC	12AWG		
2.	Initiating circuits	#18 tw/sh pair	White (+)	Black (-)
3.	Audible signaling circuits			
	a. Horns/bells	#14AWG	Red (+)	Black (-)
	b. Speakers	#14 tw/sh pair	Red (+)	Black (-)
4.	Module power	#14AWG	Violet (+)	Blue (-)
5.	Resettable module power	#14AWG	Yellow (+)	Gray(-)
6.	Visual signaling circuits	#14AWG	Red (+)	Black (-)
7.	Door holder/smoke dampers	#14AWG	Brown (+)	White (-)
8.	Control circuits	#14 AWG		
- H. Conduit fill and box fill never to exceed 50%.
- I. No spare conductors shall be installed in conduits or junction boxes.
- J. 3M #130C rubber tape (or approved equal) shall be used to insulate grounding shields.
- K. If surface Wiremold is specified, it shall be no smaller than 700 size.
- L. All junction and pull boxes located at or above 8'-0" from the floor shall be a minimum size of 4-11/16" square by 2-1/8" deep.
- M. No box extensions shall be permitted on new work.
- N. All fire alarm devices, junction and pull boxes shall be installed so they are accessible without removing light fixtures, equipment, conduits, junction boxes or other items.
- O. No splicing will be allowed in device mounting boxes.
- P. "End of Line Resistors" shall be located at the device that is farthest away from the panel or module.
- Q. All devices being controlled by the fire alarm control panel (i.e. dampers, doors, etc.) shall be operated by the use of control modules and not by relay type devices in detector bases. No auxiliary equipment shall be directly connected to an addressable control module. Each control module shall activate a 24 vdc relay with LED when in the "alarm" state.

- R. Back boxes shall be provided by equipment supplier for any surface-mounted pull stations or signaling devices.
- S. T-taps may be used for signaling line circuits if manufacturer's recommendations are followed.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 26, Section Identification for Electrical Systems.
- B. Install instructions frame in a location visible from the Fire Alarm Control Panel.
- C. Paint power-supply disconnect switch or breaker serving all fire alarm equipment red and label "FIRE ALARM". Provide handle lock to lock circuit breakers in the closed position.
- D. Affix the name and telephone number of the local service organization to the inside of the door of the Fire Alarm Control Panel and each remote cabinet.
- E. Label each control module to indicate the equipment controlled.
- F. Maintain wiring color codes throughout the system.
- G. All labels shall be on the inside of the cover.

3.5 GROUNDING

- A. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.6 ACCEPTANCE TESTING

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.
- B. Electrical Contractor shall be responsible for performing a "Pre-Test" of the Fire Alarm System and preparing/completing "Test Log".
 - 1. All equipment shall be installed prior to completing "Pre-Test".
 - 2. Scope of the Pre-Test is to:
 - a. "Align, adjust, and balance the system."
 - b. Confirm compliance with the drawings and specifications.
 - c. Install, test and check for operation of 100% of all fire alarm equipment and items being controlled by the fire alarm system.
 - 3. Manufacturer's representative is to be involved in the pre-test.
 - 4. Perform a thorough cleaning of the fire alarm system so each detector's chamber value reads less than 50%.
 - 5. At completion of the pre-test, the fire alarm system is to be complete and ready for owner acceptance.
 - 6. Complete a "Test Log", a written record of inspections, tests, and detailed test results.

- C. In preparation for the final test, Contractor shall:
1. Submit a "Test Log" and test forms from NFPA 72 and include a print out proving detector chamber values of less than 50% for all detectors.
 2. Provide a letter certifying pre-test compliance and a list of witnesses.
 3. Provide an up to date and complete printout of software at the time of final inspection and after any and all corrections or changes.
 4. Coordinate with Owner to record automatic messages for fire alarm and mass notification conditions.
- D. Contractor shall perform a Final "Minimum System Test" per NFPA 72.
1. Contractor shall test all equipment per minimum system testing requirements and maintain a "Test Log".
 2. Contractor to have sufficient personnel to conduct the test efficiently.
 3. Upon completion of the Final Test Contractor will submit the Test Log.
 4. Owner's representative has the authority to void the Final Test if it is proven during the Final Test that the Fire Alarm system installation is not complete.
 - a. Voiding the Final Test will require Contractor to schedule another Final Test.
 5. Upon approval of Final Test, successful owner training and submittal of completed "As-Built" drawings and O&M manuals, Owner will provide Contractor with acceptance of new Fire Alarm System.
 - a. Owner acceptance does not constitute "Project Closeout" or completion of "Final Punch List"
 - b. Owner acceptance only relieves Contractor of testing requirements, it does not relieve Contractor of other contract requirements.
 - c. Final Testing does not constitute Owner training.
 - d. Owner acceptance provides approval to activate the new Fire Alarm System as the primary system.
 6. Contractor shall perform final test in the presence of manufacturer's representative, Owner's representatives, and necessary local code authorities.
- E. Minimum System Tests' test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:
1. Verify the absence of unwanted voltages between circuit conductors and ground.
 2. Test all conductors for short circuits using an insulation-testing device.
 3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohm meter. Record the circuit resistance of each circuit on record drawings.
 4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
 5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
 6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
 7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
 8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.
 9. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets Specifications and complies with applicable standards.
 10. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log on the satisfactory completion of test

- F. The manufacturer's authorized representative shall perform a 100% quality inspection of the final installation and in the presence of Contractor, Owner's Representative and local code and fire authorities, shall perform a complete finished test of all aspects of the system. A system certification verifying the proper system operation shall be required prior to acceptance.
- G. Audible sound level measurements shall be conducted throughout the entire building, and all spaces with the evacuation system off and sounding.

3.7 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer. Provide detector cleaning report proving a maximum chamber value of 50% for all detectors.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 2 hours training.
 - 2. Provide a minimum of 8 hours of software program training.
 - 3. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
 - 4. Schedule training with Owner, with at least seven days advance notice.

3.9 MAINTENANCE

- A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.
- B. Provide a maintenance contract from the local service organization beginning on the date of Substantial Completion and remaining in force throughout the warranty period. Include required NFPA testing at times scheduled by Owner.
- C. Provide Owner with a proposal from the local service organization for a one-year maintenance contract beginning at the end of the warranty period.

END OF SECTION 28 31 00

**SECTION 28 50 00
ACCESS CONTROL SYSTEM**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this access control in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system.

1.3 SUBMITTALS

- A. Submittal data for access control cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.4 WORK BY OTHERS

- A. Unless noted otherwise, the building’s Electrical Contractor will provide field device backboxes as needed, and conduit paths for use by Access Control Contractor. In general, the following is provided:
 - 1. Available space on Telecom Room plywood wall to surface mount head end equipment as required with telecommunications room ground bus bar available for grounding.

1.5 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire and/or smoke walls. Contractor shall see architectural drawings for walls that require fire rating.

1.6 ACCEPTABLE ACCESS CONTROL CONTRACTORS

- A. The following contractors are pre-approved to bid this job:
 - 1. Access Control Contractor shall be a manufacturer authorized Dealer, verifiable by the manufacturer’s representative. The Access Control Contractor shall also provide documentation upon request proving that he or she was an established manufacturer authorized dealer in good standing for a minimum of six continuous months before the project bid date. Bidding the project without certifications and attempting to acquire certifications after the bid is not acceptable.
 - 2. Contractor shall be located within 125 miles of the construction site to establish a potential two-hour response time for ongoing customer needs after construction completion.

PART 2 - PRODUCTS

2.1 ACCESS CONTROL CABLING AND COMPONENTS

- A. Acceptable Access Control System Manufacturers:
 - 1. Dane County has an existing access control system that will be extended to the Sheriff building
 - a. Continental Access System. No other substitutes.

B. Acceptable Access Control System Components:

1. Card Readers
 - a. HID: Signo
2. Access Control Cable
 - a. CSC WESSCO
 - b. Belden
 - c. Approved equal
3. Access Control Request to Exit
 - a. See Div.8 Door Hardware
4. Access Control Power Supply and Battery Backup
 - a. Same as Access Control System
 - b. Altronix
 - c. LifeSafety Power
5. Access Control Door Controller
 - a. Proprietary Continental Access Control System controllers. No Substitutes.

C. Additional Access Control Requirements:

1. The Access Control Contractor shall install and configure all local access control panels in the identified telecommunication rooms on the construction plans. Unless noted otherwise.
2. The Access Control Contractor shall program all security system databases hardware configurations.
3. The Access Control Contractor shall test and certify all access control communication and operation in accordance with the specifications and manufactures recommendations.
4. The Access Control Contractor shall provide and install all cabling necessary for a complete and operational system taking into account all access control system devices called out on the plans (door contacts of all types, card readers, request to exit devices either internal to door hardware or surface mounted, and electrified door hardware of all types).
 - a. Access control cabling shall be home-run to the main system hardware, no splicing.
5. Any door identified on the plans that has any of the system components {door contacts (sometimes called position switches) of all types, card readers, request to exit devices, electrified door hardware of all types} shall be considered an access control system door.
6. Any door that is considered an access control system door shall have door contacts that can ensure the door is in the closed position and that the door is latched unless specifically noted otherwise. Both sides of a contact shall have a dedicated alarm point in the system.
7. If an electric strike is being provided with a latch bolt monitoring contact internal to the strike, a door slab contact shall still be provided to monitor the position of the slab. It shall be the Access Control Contractors responsibility to:
 - a. Verify that a suitable latch bolt monitoring contact is being specified in the door hardware or point out that what is specified is not compatible with the access control product being provided or the system requirements placed upon the Contractor.
 - b. Provide and install a door slab contact which, when these two are used together, accomplish the requirements of knowing that the door slab is physically closed, and the door hardware is engaged therefore ensuring a secured doorway.
8. The Access Control Contractor shall provide door controllers for all access control doors on the project that require a controller.
9. The Access Control Contractor shall provide and install all devices not specifically identified on the plans which are required for a complete and operational system for all access control system doors.
10. The Access Control Contractor shall provide and install one client software package on an Owner provided computer.
11. The Access Control Contractor shall provide training to all Client operators and or managers identified by the Client.
12. The Access Control Contractor shall furnish 50 credential cards/Fob per the owners direction.

13. ADA door operation: Doors that are part of the access control system and have ADA electric openers shall be subject to the following hardware/software requirements.
 - a. The Access Control Contractor shall provide and install the necessary physical equipment and/or programming or other soft services necessary to meet these requirements.
 - b. The card reader shall be in close proximity to the ADA button (whether on the building wall or on a bollard or equivalent).
 - c. During times when the system is scheduled to have the door of interest unlocked, pressing the ADA button (no card presentation required) shall physically open the door (and retract the latch as necessary). The access control system shall only unlock door trims during the unlocked door schedule (the latch shall remain engaged so the door cannot be opened by the wind or by people without using the door hardware). The Access Control Contractor shall coordinate with door hardware provided.
 - d. During times when the system is scheduled to have the door of interest locked, pressing the ADA button without a valid card presentation shall not activate any electric door hardware or electric opening devices.
 - e. During times when the system is scheduled to have the door of interest locked, pressing the ADA button after a valid card presentation shall activate any electric door hardware necessary to unlatch the door and activate the electric opening device(s).
 - 1) The valid card presentation shall only allow activation of these electrical systems for a limited amount of time after the card presentation.
 - 2) At no time shall a valid card presentation automatically activate the electric door opening device.
 - 3) Pressing the ADA button to have the door electrically open shall always be required, subject to the requirements listed above.
14. The Access Control head end (all cabinets if multiple) shall be furnished and installed with a minimum 7ah of battery backup serving no more than 8 doors each (i.e. if one panel serves 16 doors, then two 7ah batteries are required minimum). A battery backed power supply of the same manufacturer as the access control system shall be used if available, otherwise see this spec. 2.01 B.8 for an acceptable manufacturer to use.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install systems cables and auxiliary materials as indicated in accordance with access control manufacturer's written instructions, and recognized industry practices.
 1. Contractor shall use hook and loop type fasteners on all security cable. Tie wraps shall not be used.
- B. Identify all cables as to field location.
 1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated, or machine printable with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.
- C. After completion, all cables shall be thoroughly tested.
 1. Contractor shall provide all instruments for testing the cables.
 2. Contractor shall demonstrate in the presence of Owner's representative that the access control is complete and operational.
 3. Contractor shall complete and submit the Certificate of System Demonstration.
- D. After completion, comprehensive As-Builts will be created and provided to Owner within 14 days.
 1. Two hard copies shall be provided to Owner detailing the entire access control after installation. Each field position shall be labeled, and cross referenced to the appropriate head end position for ease of troubleshooting.

3.2 COMMISSIONING

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

END OF SECTION 28 50 00

SECTION 28 60 00
VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this surveillance system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

1.3 SUBMITTALS

- A. Submittals for all Manufacturer and Contractor certifications (noted below) shall be submitted first.
- B. Submittal data for surveillance cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.4 WORK BY OTHERS

- A. Unless noted otherwise, the building's Electrical Contractor will provide field device backboxes as needed, and conduit paths for use by surveillance Video Surveillance Contractor. In general, the following is provided:
 - 1. Grounded 19" data rack in Telecom Room by Telecom Contractor to mount head end equipment to.
 - 2. Available space on Telecom Room wall for power supply.

1.5 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire and/or smoke walls. Contractor shall see architectural drawings for walls that require fire rating.

1.6 ACCEPTABLE VIDEO SURVEILLANCE CONTRACTORS

- A. The following contractors are pre-approved to bid this job:
 - 1. Video Surveillance Contractor shall be a certified dealer of the Acceptable Manufacturer in this spec, section 2.01, A. Shall be in good standing for a minimum of six continuous months before the project bid date. This shall include factory trained and certified technicians in house for the installation of this project (six months experience applies here also). The dated dealer certification document and the dated technician training certificate are each required submittal items.
 - 2. Video Surveillance Contractor shall be a certified camera dealer of the Acceptable Manufacturer in this spec, section 2.01, C. Shall be in good standing for a minimum of six continuous months before the project bid date. This shall include factory trained and certified technicians in house for the installation of this project (six months experience applies here also). The dated dealer document and the dated technician training certificate are each required submittal items.
 - 3. The four or more submittal items (if multiple technicians) noted above are all criteria which determine if the Contractor is authorized to enter the project and begin work. No project work shall be authorized until these submittals are reviewed with a favorable response. Product data submittals are a separate submittal package and shall only be reviewed after the above items are resolved.
 - 4. Contractor shall be located within 125 miles of the construction site to establish a potential two-hour response time for ongoing customer needs after construction completion.

PART 2 - PRODUCTS

2.01 VIDEO SURVEILLANCE CABLING AND COMPONENTS

- A. Acceptable Video Management System Manufacturers:
 - 1. Avigilon Control Center
 - a. Software Version: ACC7 Enterprise
- B. Acceptable Video Management Storage Servers:
 - 1. Shall be Avigilon Compatible and Avigilon approved.
- C. Acceptable Video Surveillance Camera Manufacturers:
 - 1. Avigilon Network Cameras
 - a. Interior Camera Model: 4.0c-H5a-D1-IR
 - b. Exterior Entrance Model: 4.0c-H5a-D1-IR
 - c. Multi View Camera Models
 - 1) 180°: A24C-H4A-3MH-180 + H4AMH-AD-IRIL
 - 2) 270°: 24C-H4A-3MH-270 + H4AMH-AD-IRIL
 - 3) 360° : 32C-H4A-4MH-360 +H4AMH-AD-IRIL
- D. Additional Video Surveillance Requirements:
 - 1. All power and video cables shall be homerun, no splicing.
 - 2. The Contractor shall provide new local video storage server/servers for this project.
 - 3. Total required video storage is calculated on:
 - a. Minimum video compression: H.265
 - b. Maximum resolution for selected cameras: 4MP - 4K / or 8MP
 - c. Minimum Frames Per Second: 30 FPS
 - d. Percentage of motion:
 - 1) Exterior: 75%
 - 2) Interior: 50%
 - e. Hours of active video:
 - 3) Exterior: 18 hours
 - 4) Interior: 12 hours
 - f. Duration of video storage: 45 days minimum. Coordinate with Dane County for longer storage requirements for different departments.
 - g. Required storage space for future growth: 20%
 - 4. The Contractor shall furnish and install the required amount of video storage based off the criteria for calculations stated in the spec, section 2.01. D.3.a – g.
 - 5. Contractor shall provide licensing for 3 client workstations.
 - 6. Contractor shall coordinate with the Client regarding establishing access to the client workstations for individual users.
 - 7. The Contractor shall program all camera names into the system per the Client's direction.
 - 8. The Contractor shall coordinate with Client's network administrator in the integration of cameras and VMS into the Client's network. Including, but not limited to, the following areas:
 - a. IP addressing
 - b. Hostnames (as necessary)
 - c. Port settings to allow video traffic to traverse firewalls.
 - d. PoE requirements
 - e. Video bandwidth requirements
 - f. VLAN integration (as necessary)
 - g. VPN integration (as necessary)
 - 9. The Contractor shall furnish camera licenses for all cameras provided on the project, and program all the associated camera license keys into the software to make the cameras operational.

10. The Contractor shall provide Avigilon software and license updates to all cameras, VMS client software, and VMS server software for the maximum number of years offered by the manufacturer.
11. The field of views indicated (FOV) on the construction plans are for general aiming direction only. The contractor shall coordinate a time with the Client after the cameras have been brought online to aim and set the final FOV for each camera. During the warranty period the Client may request one follow up visit to make any necessary FOV adjustments.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install surveillance systems cables and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
 1. Contractor shall use hook and loop type fasteners on all security cable. Tie wraps shall not be used.
- B. Identify all cables as to field location.
 1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.
- C. After completion, all cables shall be thoroughly tested.
 1. Contractor shall provide all instruments for testing the cables.
 2. Contractor shall demonstrate in the presence of a Client representative that the surveillance system is complete and operational.
 3. Contractor shall complete and submit the Certificate of System Demonstration.
- D. After completion, comprehensive As-Builts will be created and provided to the Client within 14 days.
 1. Two hard copies shall be provided to the Client detailing the entire security system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

3.2 COMMISSIONING

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

END OF SECTION 28 60 00

SECTION 28 80 00
DISTRIBUTED ANTENNA SYSTEM (DAS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of the Distributed Antenna System (DAS) Contractor furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of the DAS in compliance with the specifications and drawings. The DAS Contractor shall provide and install all of the required material to form a complete and operational system whether specifically addressed in the technical specifications or not.
- B. It is not acceptable for any technical portion of this scope of work (procuring materials, terminating cables, installing antennae or electronics, etc.) to be performed by the Electrical Contractor or any other contractor other than the acceptable bidder selected from the requirements in paragraph 1.06 *ACCEPTABLE DAS CONTRACTORS* below who have demonstrated the necessary technical and professional capabilities for the work required.

1.3 SUBMITTALS

- A. Submittal data for DAS cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.4 WORK BY OTHERS

- A. Unless noted otherwise, the building's Electrical Contractor will provide conduit paths for use by Contractor.

1.5 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire walls. Contractor shall see architectural drawings for walls that require fire rating.

1.6 ACCEPTABLE DAS CONTRACTORS

- A. The contractor shall be knowledgeable in testing and installation of these systems with at least 5 years of experience.
- B. The contractor looking for a bid from the contractors listed above shall contact them as soon as possible to ensure they are aware of the project and have adequate time to prepare a bid. Two weeks should be considered a minimum.

PART 2 - PRODUCTS

2.1 DISTRIBUTED ANTENNA SYSTEM

- A. Distributed Antenna System items shall be provided with all applicable accessories as a complete and operational system.
- B. Acceptable Manufacturers:
 - 1. Honeywell Gamewell FCI
 - 2. SureCall Guardian
 - 3. Approved equal.

C. Additional Emergency Responder Antenna System Requirements:

1. System may utilize telecommunications pathway shown on the plans to traverse areas.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install DAS systems cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
1. Contractor shall use provided conduits or DAS Contractor install J-hooks for all cabling. No fastening cabling to conduits, piping, equipment, or anything other than DAS Contractor installed J-hooks.
 2. Identify all DAS cables as to field location.
- B. After completion, comprehensive As-Builts will be created and provided to the Engineer for review.

3.02 COMMISSIONING

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

END OF SECTION 28 80 00

SECTION 31 05 00
COMMON WORK RESULTS FOR EARTHWORK

PART 1 GENERAL

1.1 SCOPE

- A. This section provides information common to two or more technical site work specification sections or items that are of a general nature, and not included in other sections. This section applies to ALL site work, as applicable. Included are the following topics:

PART 1 GENERAL

Scope
Related Work
Referenced Organizations
Referenced Documents
Quality Assurance
Safety
Permits
Construction Limits
Work by Others
Submittals
Off-Site Storage
Codes
Certifications and Inspections

PART 2 MATERIALS

Barricades, Signs, and Warning Devices
Temporary Plastic Barrier Fencing

PART 3 EXECUTION

Maintenance of Site Access/Egress
Continuity of Existing Traffic/Parking and Traffic Control
Protection and Continuity of Existing Utilities
Protection of Existing Work and Facilities
Stormwater/Excavation Water Management

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
1. Section 31 20 00 - Earthmoving
 2. Section 31 22 16.15 - Subgrade Preparation
 3. Section 32 91 19 - Topsoil-Select Fill Materials and Application

1.3 REFERENCED ORGANIZATIONS

- A. Applicable provisions of Division 1 shall govern all work under this section.

- B. Abbreviations of organizations referenced in these specifications are as follows:

AASHTO	American Association of State Highway and Transportation Officials
ACPA	American Concrete Pipe Association
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
FHA	Federal Highway Administration
EPA	Environmental Protection Agency
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association

NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
STI	Steel Tank Institute
UL	Underwriters Laboratories Inc.
WDNR	State of Wisconsin Department of Natural Resources
WISDOT	State of Wisconsin Department of Transportation

1.4 REFERENCED DOCUMENTS

- A. Where reference is made to the "Construction Standards", it shall be construed to mean the City of Stoughton's Construction Standards, as they may pertain, except the method of measurement and basis of payment shall not apply.
- B. Where reference is made to the "Standard Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- C. Where reference is made to the "State Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- D. Where reference is made to the "Geotechnical Report", it shall be construed to mean the geotechnical report provided in Section 02 32 00.

1.5 QUALITY ASSURANCE

- A. Provide materials and products as required by individual specification sections. Refer to General Conditions of the Contract regarding substitutions.
- B. Provide quality assurance testing and reporting as required by individual specification sections.

1.6 SAFETY

- A. Contractor is solely responsible for worksite safety.
- B. Perform all work in accordance with applicable OSHA, state and local safety standards.
- C. Contact Diggers Hotline at 1-800-242-8511 in accordance with statutory requirements. Request that non-member utilities and private utilities be located by the appropriate parties.

1.7 PERMITS

- A. Unless otherwise noted in the Contract Documents, Owner shall be responsible for obtaining and paying for all permits necessary to complete the work.

1.8 CONSTRUCTION LIMITS

- A. Construction Limits are defined by lines denoted as Construction Fencing/Limits of Disturbance as indicated on the Drawings. In the absence of such a designation on the Drawings, confine work to the minimum area reasonably necessary to undertake the work as determined by the City's Construction Representative. In no case shall construction activities extend beyond property lines or construction easements.
- B. The Contractor shall restore all disturbed areas in accordance with the Drawings and Specifications. If Drawings and Specifications do not address restoration of specific areas, these areas will be restored to pre-construction conditions as approved by the City's Construction Representative.
- C. Coordinate work under this project with work by City's Construction Representative and other contractors providing separate work on the site related to other contracts.

1.9 SUBMITTALS

- A. Refer also to Section GC - General Conditions of the Contract and Division 1.
- B. Submit manufacturer's shop drawings, product data, samples, substitutions and Operation and Maintenance (O&M) data for approval as required by individual specification sections.

- C. Submittals shall be provided to the Owner's Construction Representative for review and approval, unless otherwise directed. Submittals shall be sent electronically by email in *.pdf format unless otherwise directed.

1.10 OFF-SITE STORAGE

- A. Refer to Division 1.
- B. In general, the payments for materials stored off site will only be considered in instances where there is limited space available for storage on the site. Prior approval by the Owner's Construction Representative, together with the execution of a Storage Agreement will be required.

1.11 CODES

- A. Comply with the requirements of all applicable, local, state, and federal codes.

1.12 CERTIFICATIONS AND INSPECTIONS

- A. Refer to Section GC - General Conditions.
- B. Obtain and pay for all required sampling, testing, inspections, and certifications except those expressly listed as provided by the Owner or City in the Contract Documents. Deliver originals of certificates and documents to the City's Construction Representative within three days; provide copies to the Owner's Construction Representative. Include copies of the certifications and documents in the O&M Manual.

PART 2 MATERIALS

2.1 BARRICADES, SIGNS, AND WARNING DEVICES

- A. Traffic barricades, traffic signs, and warning devices shall meet the requirements of current applicable OSHA standards and MUTCD.

2.2 TEMPORARY PLASTIC BARRIER FENCING

- A. UV stabilized high-density polyethylene barrier fence free of holes tears and other defects. Provide 5-foot tall fence in diamond or rectangular pattern. Fencing shall be "safety orange" color, unless otherwise noted.
- B. Posts for temporary plastic barrier fencing shall be 5 feet tall, minimum 12-gauge, painted metal posts.

PART 3 EXECUTION

3.1 MAINTENANCE OF SITE ACCESS/EGRESS

- A. Unless otherwise shown or directed, maintain existing access and egress to the facility throughout construction. Contact the City of Stoughton and Owner prior to any construction activities to obtain directives for preferred access to the site. Maintain ANSI A117 compliant access to the high school site for disabled persons, delivery access, emergency vehicle access, and emergency egress. Do not interrupt access and egress without prior written approval from the Owner's Construction Representative.

3.2 CONTINUITY OF EXISTING TRAFFIC/PARKING AND TRAFFIC CONTROL

- A. Refer also to Section GR - General Requirements.
- B. Do not interrupt or change existing traffic, delivery, or parking without prior written approval from the City or Owner's Construction Representative. When interruption is required, coordinate schedule with the City and Owner's Construction Representative to minimize disruptions. When working in public right-of-way, obtain all necessary approvals and permits from the City if not provided by the Owner.
- C. When Contractor's activities impede or obstruct traffic flow, Contractor shall provide traffic control devices, signs, and flaggers in accordance with other Contract Documents and current applicable OSHA standards and MUTCD. Contractor shall be responsible for all costs associated with temporary traffic control. All barricades, signs, and warning devices shall be included under the traffic control bid item.
- D. Access to the future high school construction site must be maintained at all times. Two-way traffic must be maintained on all existing roadways at all times. Flagging will be permitted, as necessary, for work during daylight hours if approved by the City's Construction Representative.

3.3 PROTECTION AND CONTINUITY OF EXISTING UTILITIES

- A. Verify the locations of any water, drainage, gas, sewer, electric, drainage, gas, sewer, electric, telephone/communication, fuel, steam lines or other utilities and site features which may be encountered in any excavations or other sitework. All lines shall be properly underpinned and supported to avoid disruption of service.
- B. Do not interrupt or change existing utilities without prior written approval from the City's Construction Representative, affected utilities, and users. Notify all users impacted by outages a minimum of 48 hours in advance of outage. Notification shall be provided in writing and describe the nature and duration of outages and provide the name and number of Contractor's foreman or other contact.
- C. Any service connections encountered which are to be removed shall be cut off at the limits of the excavation and capped in accordance with the requirements of applicable codes and any specifications governing such removals.

3.4 PROTECTION OF EXISTING WORK AND FACILITIES

- A. Verify the locations of, and protect, any signs, paved surfaces, buildings, structures, landscaping, streetlights, utilities, and all other such facilities that may be encountered or interfered with during the progress of the work. Take measures necessary to safeguard all existing work and facilities that are outside the limits of the work or items that are within the construction limits but are intended to remain. Report any damage to existing facilities to the City's Construction Representative immediately. Correct and pay for all damages.

3.5 STORMWATER/EXCAVATION WATER MANAGEMENT

- A. Control grading around structures, pitch ground to prevent water running into excavated areas.
- B. Pits, trenches within building line, and other excavations shall be maintained and free of water.
- C. Provide trenching, pumping, other facilities required.
- D. Notify Owner's Construction Representative in the event that springs or running water are encountered in excavation; provide discharge by trenches, drains, pumping to point outside of excavation. Provide information to Owner's Construction Representative of points and areas that water will be discharged. At the Owner and City's Construction Representative's option, the Contractor shall drain the spring to the storm sewer system by the use of field tile.
- E. Establish and maintain an onsite Erosion Control Maintenance Log. The log shall document erosion control installation locations and date of establishment, rainfall event dates and amounts, erosion control failure locations, corrective measures taken and weekly inspection documentation. This log shall be available onsite during the entire construction process and available to the Owner, Owner's Construction Representative, Governing Municipality, and authorized WDNR staff.
- F. Be responsible for control measures to prevent damage from flooding, erosion, and sedimentation to on-site and off-site areas.

END OF SECTION

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. Section 02 20 00 - General Sitework Requirements
- B. Section 02 32 00 - Geotechnical Investigation
- C. Section 02 41 13 - Demolition
- D. Section 31 25 00 - Erosion Control

1.2 REFERENCE STANDARDS

- A. Where reference is made to the "Construction Standards", it shall be construed to mean the City of Stoughton's Standard Specifications for Public Works Improvements.
- B. Where reference is made to the "Standard Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- C. Where reference is made to the "State Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- D. Where reference is made to the "Geotechnical Report", it shall be construed to mean the Geotechnical Report provided in Section 02 32 00 - Geotechnical Investigation.

1.3 DEFINITIONS

- A. Clearing:
 - 1. Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including down timber, snags, brush, and rubbish occurring in the areas to be cleared.
- B. Grubbing:
 - 1. Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas.

1.4 SUBMITTALS

- A. The following shall be submitted:
 - 1. Written permission to dispose of such products on private property shall be filed with the City's Construction Representative.
 - 2. Submit documentation from the disposal facility to verify that it is licensed to accept the material.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 CLEARING

- A. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation as may be indicated or directed to be left standing.
- B. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 1½ inches or more in diameter and shall be trimmed of all branches below the heights indicated or directed.
 - 1. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches.
 - 2. Cuts more than 1½ inches in diameter shall be painted with an approved tree-wound paint.

3. Trees and vegetation to be left standing shall be protected from damage incidental to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require.
- C. Clearing shall also include the removal and disposal of structures that obstruct, encroach upon, or otherwise obstruct the work.
- D. Disposal of Elm and Ash trees, roots, or branches shall be in accordance with local and state regulations.

3.2 GRUBBING

- A. Remove material to be grubbed, together with logs and other organic or metallic debris not suitable for roadway construction in accordance with Section 201.3 of the State Specifications, except the minimum depths for removal shall be as follows:
 1. In cut areas, 18 inches below final subgrade.
 2. In embankments areas, 18 inches below the existing grade.
- B. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform to the proposed surface of the ground.
- C. Burning or burying as a means of disposal is prohibited.

3.3 TREE REMOVAL

- A. Where indicated or directed, individual trees and stumps that are designated shall be removed from areas outside those areas designated for clearing and grubbing.
- B. This work shall include the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING.
- C. Dispose of materials as specified in paragraph CLEAN UP.

3.4 TOPSOIL

- A. Topsoil: Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material. Refer to Section 32 91 19 - Topsoil-Select Fill Materials and Application for further information.
 1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.
 2. Stockpile topsoil in storage piles in areas indicated or directed. Construct storage piles to provide free drainage of surface water.

3.5 CLEAN UP

- A. Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations, shall be disposed of outside the limits of the project at the Contractor's responsibility, except when otherwise approved in writing
- B. All waste and debris shall be disposed of in compliance with state and local regulations within five days of being cut or removed.
- C. Disposal of Elm trees shall be in accordance with local regulations.
- D. Submit the location of any disposal facility located outside the limits of the project to the City's Construction Representative prior to removal from the project site.
- E. Submit documentation from the disposal facility to verify that it is licensed to accept the material.
- F. No material shall be removed from the project site without prior approval from the City's Construction Representative.
- G. Burning or burying as a means of disposal is prohibited.

END OF SECTION

SECTION 31 13 16
TREE PROTECTION

PART 1 GENERAL

1.1 SCOPE

- A. These specifications include the protection and trimming of existing trees that interfere with, or are affected by execution of the Work, whether temporary or permanent construction related sections.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section:
 - 1. Section 02 20 00 – General Sitework Requirements
 - 2. Section 31 10 00 – Site Clearing
 - 3. Section 31 20 00 – Earthmoving
 - 4. Section 31 25 00 – Erosion Control
 - 5. Section 32 91 19 – Topsoil-Select Fill Materials and Application

1.3 DEFINITIONS

- A. Tree Protection Zone: Area surrounding individual trees or groups of trees to remain during construction, and defined by the area encompassing 1.5 times the tree caliper at 4.5 feet above the ground or the perimeter drip line unless otherwise indicated by arborist.

1.4 REFERENCE STANDARDS

- A. *American Standards for Nursery Stock, ANSI Z60.1*, current edition. American Association of Nurserymen, Inc.
- B. *Standardized Plant Names, Second Edition (1942)*. American Joint Committee on Horticulture Nomenclature, Horace McFarland Company, Harrisburg, PA.
- C. *American National Standard for Tree Care Operations - Tree, Shrub and Other Woody Plant Maintenance-Standard Practices, ANSI A300*, current edition.

1.5 QUALITY ASSURANCE

- A. An experienced tree service firm that has successfully completed tree protection similar to that required for this Project.
- B. Pre-installation Conference: Conduct conference at Project site to comply with requirements and to identify boundary of tree protection fencing.

1.6 PLANTING SCHEDULE

- A. All plants shall be guaranteed to be in healthy and flourishing condition for one full year after installation and acceptance by the Owner.
- B. Plants not thriving shall be replaced at no cost to the Owner. The Contractor may suggest substitutions for replacement plants.
- C. Replacement plants shall be guaranteed for one year after installation.
- D. At any time during the guarantee period, the Contractor shall remove or replace, without cost to the Owner and within a specified planting period, all plants not in a healthy and flourish conditions as determined by the Owner.

1.7 MAINTENANCE

- A. The Contractor shall maintain plantings and lawn for at least a period of 30 days, or until final acceptance from the Owner. The Contactor is responsible for adequately watering plants and lawn during this 30-day period.
- B. Fertilizing: Any and all chemical applications are to be performed in accordance with current federal, state, and local laws, through EPA-registered materials and application techniques, and performed under the supervision of a licensed certified applicator. Apply fertilizer to planted areas at the specified rate, and as per manufacturer's recommendations.

- C. Watering: All plant materials installed under the contract shall be watered within the first 24 hours of initial planting and not less than twice weekly until final acceptance by Owner. Water used shall be of sufficient quality for irrigation and free of materials harmful to plant growth.
- D. Pesticide: Any use of pesticides during the contracted maintenance period, as determined by the Owner, shall utilize the minimum amount of approved pesticide needed to control pests on plant materials installed under the contract. Pesticide applications are to be performed in accordance with current federal, state and local laws, through EPA-registered materials and application techniques, and performed under the supervision of a licensed certified applicator. Apply at the specified rate, and as per manufacturer's recommendations.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Mulch: Shredded hardwood bark mulch, free of material detrimental to healthy plant growth. Mulch shall be finely shredded, weed free, and dye-free.
- B. Topsoil: Refer to Topsoil-Select Fill Materials and Application section.

PART 3 EXECUTION

3.1 PREPARATION

- A. Temporary Fencing: Install temporary fencing around tree protection zones to protect trees identified on plan that have been indicated as existing trees to remain. Temporary fencing shall be installed around dripline as much as possible. Maintain temporary fence and remove when construction is complete.
- B. Protect the root systems of existing trees to remain from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
- C. Mulch areas inside tree protection zones and within drip line of trees to remain and other areas indicated.
- D. Apply 2-inch average thickness of mulch. Do not place mulch within 6 inches of tree trunks.
- E. Do not store construction materials, debris, or excavated material inside protection zones. Do not permit vehicles or foot traffic within tree protection zones; prevent soil compaction over root systems. Do not allow fill on trees roots inside the tree protection zone. Note: As little as 2 inches can have deleterious long-term effects on tree health. If fill or grade changes must occur, a serious look at whether or not the tree should be left must occur.
- F. Maintain tree protection zones free of weeds and trash.
- G. Do not allow fires within tree protection zone.

3.2 EXCAVATION

- A. Install shoring or other protective support systems to minimize sloping or benching of excavations.
- B. Do not excavate within tree protection zones unless necessary to install stormwater management facilities. If excavation is required, temporary fencing shall be adjusted to the furthest extent of grading away from the trunk.
- C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Cut roots in the area to be excavated with a saw to ensure a clean cut. Torn or ripped roots must be trimmed.
- D. Redirect roots in backfill areas where possible. Note: If encountering large, main lateral roots, an assessment of future tree stability must be made. Expose roots beyond excavation limits as required to bed and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction.
- E. Do not allow exposed roots to dry out before placing permanent backfill. Provide a temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
- F. Where utility trenches are required within tree protection zones, tunnel under or around roots by drilling auger boring, pipe jacking, or digging by hand.
- G. Root Pruning: Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots with sharp pruning instruments, do not break or chop.

3.3 REGRADING

- A. Grade Lowering: Where new finish grade is indicated below existing grade around trees, slope grade away beyond tree protection zones. Maintain existing grades within tree protection zones.
- B. Root Pruning: Prune tree roots exposed during grade lowering. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots with sharp pruning instruments; do not break or chop.
- C. Minor Fill: Where existing grade is 1 inch or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

3.4 DISPOSAL OF WASTE MATERIALS

- A. Burning is not permitted.
- B. Disposal: Remove excess excavated material and displaced trees from Owner's property.

END OF SECTION

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SECTION 31 20 00
EARTHMOVING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Stripping of topsoil and stockpiling.
 - 2. Excavation, preparation, backfilling, and compaction of subgrades per the Geotechnical Report.
 - 3. Cutting, filling, grading, and compaction for drives, walks, roads, and parking subgrade.
 - 4. Cutting, filling, grading, and compaction for landscaping area subgrade ready for topsoil.

1.2 RELATED SECTIONS include the following:

- A. Section 02 20 00 - General Sitework Requirements
- B. Section 31 10 00 - Site Clearing
- C. Section 31 25 00 - Erosion Control

1.3 STANDARD SPECIFICATIONS

- A. Where reference is made to the "Construction Standards", it shall be construed to mean the City of Stoughton's Construction Standards, as they may pertain, except the method of measurement and basis of payment shall not apply.
- B. Where reference is made to the "Standard Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- C. Where reference is made to the "State Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- D. Where reference is made to the "Geotechnical Report", it shall be construed to mean the geotechnical report in Section 02 32 00.
- E. All construction of public facilities and/or work within public lands or rights of way shall conform to the requirements and conditions of the Standard Specifications stated above with the most stringent applying.
- F. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.
 - 1. ASTM International (ASTM):

ASTM D422	Particle Size Analysis of Soil
ASTM D698	Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft/lbf/ft ³ (600 kN.m/m ³))
ASTM D1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2,700 Kn.m/m ³))
ASTM D2487	Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	Description and Identification of Soils (Visual-Manual Procedures)
ASTM D4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D6938	In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
 - 2. American Association of State Highway and Transportation Officials (AASHTO):

AASHTO T 88	Particle Size Analysis of Soils
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 - 3. National Fire Protection Association (NFPA):

NFPA 70	National Electrical Code
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4. American Water Works Association (AWWA):
- | | |
|-----------|---|
| AWWA C200 | Standard for Steel Water Pipe - 6 In. (150 mm) and Larger |
| AWWA C206 | Field Welding of Steel Water Pipe |

1.4 SUBMITTALS

- A. Submit documentation of materials meeting the required specifications.
- B. Testing:
1. The City shall provide testing for work performed for public improvements.
 2. The Contractor shall provide quality control testing as defined in the Contract Documents.
 3. The Contractor shall coordinate work and testing requirements with the Owner's Construction Representative and City's testing agency.

1.5 DEFINITIONS

- A. Backfill: Soil materials used to fill an excavation.
- B. Base Course: Course placed between the sub-grade and the hot-mix asphalt, concrete pavement, walks, or curbs.
- C. Breaker Run Stone: Meet the requirements defined in Wisconsin Department of Transportation (WisDOT) Section 311.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Excavation: Removal of material encountered above the subgrade elevations and to lines and dimensions indicated.
1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Owner's Construction Representative. Authorized additional excavation and replacement material will be paid for according to Contract provisions.
 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction of Owner's Construction Representative. Unauthorized excavation, as well as remedial work directed by the Owner's Construction Representative, shall be without additional compensation.
- F. Fill: Soil materials used to raise existing grades.
- G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- H. Topsoil: Excavated on-site material, free of large tree roots, rocks, subsoil, debris, and weeds.

1.6 CONTOURS (GRADE ELEVATIONS)

- A. Contours indicated on drawings are the finished grade elevations. Contractor shall review all grade elevations before commencing to ensure that proper slopes for drainage, slope for drives, walks, paving, etc., are maintained. If Contractor believes a deficiency is apparent, they shall notify the City or Owner's Construction Representative for clarification.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

- A. General: All materials shall conform to requirements of the Geotechnical Report.
- B. Materials:
1. Fill and Backfill. Satisfactory materials excavated from the site.
 2. Imported Fill Material: Satisfactory material provided from off-site borrow areas when sufficient satisfactory materials are not available from required excavations.
 3. Trench Backfill: ASTM D2321 and the Standard Specifications, unless otherwise specified or shown on the Drawings.
 4. Subgrade Sub-base Material: As required by the Geotechnical Report and/or Section 31 22 16.15.
 5. Building Sub-base Material: Sub-base for building and appurtenances slabs on ground is specified in Section 03 30 00 or the Geotechnical Report as applicable.
 6. Bedding: Aggregate type as indicated on the plans or naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100% passing a 1-inch sieve and not more than 8% passing a No. 200 sieve.

7. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100% passing a 1½-inch sieve and 0% to 5% passing a No. 8 sieve.
 8. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100% passing a 1-inch sieve and 0% to 5% passing a No. 4 sieve.
 9. Topsoil: Topsoil shall consist of stripping material excavated from the site. Topsoil shall consist of organic surficial soil found in depth of not more than 6 inches. Topsoil shall be as further defined in Section 32 91 19 - Topsoil-Select Fill Materials and Application.
- C. Where conflicts between this specification, the Drawings and the Geotechnical Report exist, requirements of the Geotechnical Report shall govern.
- D. Source Quality Control:
1. Laboratory testing of off-site materials proposed for use in the project shall be provided by the Contractor's testing consultant. Test results shall be provided to the Owner's Construction Representative for approval before incorporation into the work.
 2. The following tests shall be performed on each type of imported soil material used as compacted fill:
 - a. Moisture and Density Relationship: ASTM D698 or ASTM D1557
 - b. Mechanical Analysis: AASHTO T88 or ASTM D422
 - c. Plasticity Index: ASTM D4318

PART 3 EXECUTION

3.1 GENERAL

- A. General: All work shall be executed and conform to requirements of the Geotechnical Report.
1. Where conflicts between this specification and the Geotechnical Report exist, requirements of the Geotechnical Report shall govern.
 2. For any material provided by the Owner, the Contractor shall provide a minimum of five days' notice for the material and shall include the quantity of material and delivery location requested for each day. Delivered material shall be available Monday-Friday 7:00 a.m. to 3:30 p.m. unless otherwise agreed upon by both the Owner and Contractor."

3.2 PREPARATION

- A. Subgrades, fill material, and grading for pavement, ramps, sidewalks, and structures shall conform to the recommendations in the Geotechnical Report.
- B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- C. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- D. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 CLEARING AND GRUBBING

- A. Limits of clearing and grubbing shall be areas which are affected by excavation and grading.
- B. Refer to Section 31 10 00 - Site Clearing.
- C. Remove trees, stumps, roots, brush, other vegetation, debris, existing foundations, pavements, fences, and other items which interfere with new construction.
- D. Remove stumps, logs, roots, and other organic material including existing structure occurring outside the structure excavation to depths below the following:
 1. Walks: 18 inches
 2. Roads and Drives: 18 inches
 3. Parking Areas: 36 inches
 4. Lawn Areas: 12 inches
 5. Concrete Pads: 24 inches
 6. Depressions within areas shall be filled and compacted as specified under Controlled Backfill.

- E. Removal of existing trees which are to remain will not be permitted. Notify Owner's Construction Representative if existing trees create a difficulty when grades are raised or lowered in excess of 6 inches.

3.4 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. All dewatering activities must meet all the requirements set forth in the WDNR Construction Site Erosion & Sediment Control Technical Standard 1061. The Contractor shall obtain any necessary permits for dewatering.
- C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation:
 - 1. Reroute surface water runoff away from excavated areas.
 - a. Do not allow water to accumulate in excavations.
 - b. Do not use excavated trenches as temporary drainage ditches.
 - 2. Install a dewatering system to keep subgrades dry and convey groundwater away from excavations. Maintain until dewatering is no longer required.
- D. Provide dewatering systems as required for excavations:
 - 1. Design and provide dewatering system using accepted and professional methods consistent with current industry practice to eliminate water entering the excavation under hydrostatic head from the bottom or sides. Design system to prevent differential hydrostatic head, which would result in floating out soil particles in a manner, termed as a "quick" or "boiling" condition. System shall not be dependent solely upon sumps or pumping water from within the excavation where differential head would result in a quick condition, which would continue to worsen the integrity of the excavation's stability.
 - 2. Provide dewatering system of sufficient size and capacity to prevent ground and surface water flow into the excavation and to allow Work to be installed in a dry condition.
 - 3. Control, by acceptable means, all water regardless of source. The Contractor shall be responsible for disposal of the water.
 - 4. Control groundwater in a manner that preserves strength of foundation soils, does not cause instability or raveling of excavation slopes, and does not result in damage to existing structures. Where necessary, lower water level in advance of excavation utilizing wells, well points, jet educators, or similar positive methods. The water level as measured by piezometers shall be maintained a minimum of 3 feet below prevailing excavation level.
 - 5. Commence dewatering prior to any appearance of water in excavation and continue until Work is complete to the extent that no damage results from hydrostatic pressure, flotation, or other causes.
 - 6. Open pumping with sumps and ditches will be allowed provided it does not result in boils, loss of fines, softening of the ground, or instability of slopes.
 - 7. Install wells or well points, if required, with suitable screens and filters so that continuous pumping of fines does not occur. Arrange discharge to facilitate collection of samples by the Owner or municipal agencies. During normal pumping and upon development of wells, levels of fine sand or silt in the discharge water shall meet WDNR discharge standards.
 - 8. Control grading around excavations to prevent surface water from flowing into excavation areas.
 - 9. Designate and obtain the services of a qualified dewatering specialist to provide dewatering plan as may be necessary to complete the Work.
 - 10. Contractor shall be responsible for the accuracy of the drawings, design data, and operational records required.
 - 11. Contractor shall be responsible for the design, installation, operation, maintenance, and any failure of any component of the system.
- E. Maintaining Excavation in Dewatering Condition:
 - 1. Dewatering shall be a continuous operation. Interruptions due to power outages or any other reason will not be permitted.
 - 2. Continuously maintain excavation in a dry condition with positive dewatering methods during preparation of subgrade, installation of pipe, and construction of structures until the critical period of construction or backfill is completed to prevent damage of subgrade support, piping, structure, side slopes, or adjacent facilities from flotation or other hydrostatic pressure imbalance.
 - 3. Provide standby equipment on site, installed, wired, and available for immediate operation if required to maintain dewatering on a continuous basis in the event any part of the system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform

such work as may be required to restore damaged structures and foundation soils at no additional cost to the Owner.

4. System maintenance shall include but not be limited to 24-hour supervision by personnel skilled in the operation, maintenance, and replacement of system components and any other work required to maintain excavation in dewatered condition.

3.5 EXPLOSIVES

- A. Blasting of materials classified as rock shall be permitted only when authorized by the Owner's Construction Representative and municipality. Contractor shall meet all federal, state, and local requirements
- B. Blasting shall be done with explosives of quantity and power, and fired in such sequence and locations as to not injure personnel, damage or crack rock against which concrete is to be placed, damage property, or damage existing work or other portions of new work. Contractor shall be responsible for damage caused by blasting operations.
- C. The Contractor shall submit a Blasting Plan, prepared and sealed by a registered professional engineer that includes calculations for overpressure and debris hazard. Blasting mats shall be provided and non-electric blasting caps shall be used. The Contractor shall obtain written approval prior to performing any blasting and shall notify the Owner's Construction Representative a minimum of 24 hours prior to blasting. The plan shall contain provisions for storing, handling and transporting explosives as well as for the blasting operations.

3.6 STRIPPING OF SITE

- A. Strip the site in conformance with the requirements of the Geotechnical Report referenced in Section 02 32 00.
- B. Strip those portions of the site which will occupy walks, roads, drives, parking areas and where grade changes are to be made, by a minimum of depth of topsoil indicated by the soils report plus additional soil as required to reach soil free of roots or organic debris subject to rotting and settling.
- C. Stockpile reusable topsoil for use in finish grading and restoration. Reusable topsoil shall be fertile, friable agricultural soil capable of sustaining vigorous plant growth and suitable for growth of grass, neither excessively alkaline or acidic, free from subsoil, clay lumps, gravel, brush, objectionable weeds, litter, stones larger than 1 inch in diameter, and other material. Do not permit surplus topsoil to leave the project site until the finish grading is nearing completion or unless otherwise approved in writing by the Owner's Construction Representative.
- D. Do not excavate, grade, or work topsoil in frozen or muddy conditions.

3.7 ROCK IN EXCAVATIONS

- A. When rock as defined above is encountered before the proper subgrade is reached, work shall proceed as follows:
 1. The excavation shall stop at this point and it shall be determined if such material is classified as rock.
 2. Material classified as rock shall be removed to the lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms.
 - b. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - c. 6 inches beneath the bottom of concrete slabs on grade.

3.8 UTILITY ROCK EXCAVATIONS

- A. When rock as defined above is encountered when excavating for water main or storm sewer, work shall proceed as follows:
 1. The excavation shall stop at this point and it shall be determined if such material is classified as rock.
 2. Material classified as rock shall be removed to 6 inches below the proposed utility location to permit installation of the utility without exceeding the following dimensions:
 - a. 8 feet in width centered on the proposed utility.
 - b. 6 inches beneath the bottom of the proposed water main or storm sewer.
 - c. Utility rock excavations shall be completed in accordance with Section 608 of the State Specifications.

3.9 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavations shall be in conformance with the requirements of the Geotechnical Report referenced in Section 02 32 00.
- B. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

3.10 SUBGRADE INSPECTION

- A. Notify Owner's Construction Representative when excavations have reached subgrade.
- B. If Owner's Construction Representative determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll shall be completed in accordance with Geotechnical Report referenced in Section 02 32 00 and in accordance with Section 31 22 16.15.
- D. Authorized additional excavation and replacement material will be paid for according to the Contract provisions.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Owner's Construction Representative, without additional compensation from the Owner.

3.11 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust. Provide necessary erosion control devices as shown on the Erosion Control Plan.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.12 BACKFILL

- A. Backfill shall be in conformance with the requirements of the Geotechnical Report referenced in Section 02 32 00.
- B. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Removing trash and debris.
 - 2. Removing deleterious materials.

3.13 FILL

- A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.
- B. Plow, scarify, bench, or break up sloped surfaces steeper than one vertical to four horizontal so fill material will bond with existing material.
- C. Place and compact fill material in layers to required elevations per the Geotechnical Report.
- D. Fill areas to contours and elevations shown on the Drawings with materials deemed satisfactory.
- E. Place fills in continuous lifts specified herein.
- F. Fill within proposed building subgrade, paving subgrade, and outparcel subgrades shall not contain rock or stone greater than 6 inches in any dimension.
- G. Unless otherwise specified for rock fill, rock or stone less than 12 inches in largest dimension may be used in fill below structures, paving, outparcels, and graded areas, up to 24 inches below surface of proposed subgrade of hard surface paved areas or 24 inches below finish grade of landscape and turf graded areas when mixed with satisfactory material. Rock or stone less than 4 inches in largest dimension may be used in fill within the upper 24 inches of proposed subgrade or finish grade of graded areas when mixed with satisfactory material.
- H. Rocks larger than 12 inches in diameter shall be separated and stockpiled at an onsite location determined by the Owner's Construction Representative.
- I. Fill materials used in preparation of subgrade shall be placed in lifts or layers not to exceed 12 inches.

3.14 MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2% of optimum moisture content.
 - 1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2% and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF BACKFILLS AND FILLS

- A. Place backfill and fill materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact as follows:

<u>Location</u>	<u>Percent of Maximum Laboratory Density</u>	
	<u>ASTM D698</u>	<u>ASTM D1557</u>
Subgrade and fill below foundations, slab-on-grade, and upper 12 inches of area to be paved	98	95
Subgrade and fill in all other areas	95	92

- D. Maintain moisture content of not less than 1% below and not more than 2% above optimum moisture content of fill materials to attain required compaction density.
- E. Exercise proper caution when compacting immediately over top of pipes or conduits. Water jetting or flooding is not permitted as method of compaction.
- F. Corrective Measures for Non-Complying Compaction: Remove and re-compact deficient areas until proper compaction is obtained.

3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - 1. Lawn or Unpaved Areas: Plus or minus (±) 1 inch (25 mm).
 - 2. Walks: Plus or minus (±) 1 inch (25 mm).
 - 3. Pavements: Plus or minus (±) 1/2 inch (13 mm).

3.17 FINISH GRADING

- A. Grade areas where finish grade elevations or contours are indicated on the Drawings, other than paved areas, outparcels, and buildings, including excavated areas, filled and transition areas, and landscaped areas. Graded areas shall be uniform and smooth, free from rock, debris, or irregular surface changes. Ground surfaces shall vary uniformly between indicated elevations. Grade finished ditches to allow for proper drainage without ponding and in manner that will minimize erosion potential. For topsoil, sodding, and seeding requirements refer to Sections 32 92 00 and Section 32 92 19.
- B. Correct settled and eroded areas within one year after date of completion at no additional expense to the City. Bring grades to proper elevation.

3.18 MAINTENANCE OF SUBGRADE

- A. Verify finished subgrades to ensure proper elevation and conditions prior to construction above subgrade.
- B. Protect subgrade from excessive wheel loading during construction, including concrete trucks, dump trucks, and other construction equipment. If rutting or damage to the subgrade does occur, regrade and compact to project specified tolerances.
- C. Construct temporary ditches and perform such grading as necessary to maintain positive drainage away from subgrade at all times. Contractor shall be responsible for maintaining grades and subgrades throughout construction from frost, moisture and excessive wheel loading. Contractor shall be responsible for choosing means, methods and best management practices to protect the subgrade.

3.19 BORROW AND SPOIL SITES

- A. Comply with WPDES and local erosion control permitting requirements for any and all on-site and off-site, disturbed spoil and borrow areas. Upon completion of spoil or borrow operations, clean up spoil or borrow areas in a neat and reasonable manner to the satisfaction of the Developer or off-site property owner, if applicable.
- B. Topsoil stripping and re-spread will be paid for at the quantity and unit price noted on the Bid Form. Excavation shall be paid as part of the Lump Sum price for Excavation Common as noted on the Bid Form. Seeding and mulching shall also be paid at the unit prices noted in the Bid Form.

3.20 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Owner's Construction Representative; reshape and re-compact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

3.22 FIELD QUALITY CONTROL

- A. Field quality control shall be the responsibility of the Owner's Construction Representative. Except for specified mandatory testing, field quality control testing and inspection shall be at the discretion of the Contractor as necessary to assure compliance with Contract requirements.
- B. The Owner's testing agency will perform retesting and re-inspection as necessary until corrections are fully completed by the Contractor at the Contractor's expense.

END OF SECTION

**SECTION 31 22 16.15
SUBGRADE PREPARATION**

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section shall consist of providing all work, materials, labor, equipment, and supervision necessary to complete roadway and parking lot grading, as required in these specifications, on the Drawings and as otherwise deemed necessary to complete the work.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section:
1. Section 01 00 00 - General Requirements
 2. Section 02 32 00 - Geotechnical Investigation
 3. Section 31 25 00 - Erosion Control
 4. Section 31 23 16.13 - Trenching
 5. Section 31 20 00 - Earthmoving
 6. Section 31 32 00 - Soil Stabilization

1.3 QUALITY ASSURANCE

- A. The Contractor shall retain the services of a geotechnical consulting engineer to conduct sampling testing and analysis as required by this section and elsewhere in the Contract Documents. The geotechnical consulting engineer shall meet the requirements of ASTM E329-00b.

Material	Test Required	Test/Sample Frequency
Granular Fill	D422-63(1998) - Standard Test Method for Particle Size Analysis of Soils	1 test/500 cy placed
Granular Fill	ASTM D1557 - Optimum Moisture-Maximum Density Determination (Modified Proctor)	1 test per type of material

Table 31 22 16.15 - 1

1.4 REFERENCES

- A. Where reference is made to the "Construction Standards", it shall be construed to mean the City of Stoughton's Construction Standards, except the method of measurement and basis of payment shall not apply.
- B. Where reference is made to the "Standard Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- C. Where reference is made to the "State Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- D. Where reference is made to the "Geotechnical Report", it shall be construed to mean the Geotechnical Report in Section 02 32 00.
- E. ASTM International (ASTM):
 1. ASTM D698 – Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbs/ft³ (600 kN-m/m³)).
 2. ASTM D1557 – Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbs/ft³ (2,700 kN-m/m³)).
 3. ASTM D6938 – In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.5 PERMITS/FEES

- A. Contractor shall be solely responsible for obtaining all permits necessary to complete the work that are not provided by the Owner. Contractor shall pay all fees associated with obtaining permits. These include, but are not limited to, permits for work within public right-of-way, and building permits.
- B. The Owner will obtain and provide the WDNR WRAPP permit, City Erosion Control and Stormwater permits, and Wisconsin Department of Safety and Professional Services Exterior Plumbing permit.

1.6 PROVISIONS FOR FUTURE WORK

- A. None.

1.7 SURVEY AND STAKING

- A. Owner will provide benchmarks and control points for the project as defined in Section 01 00 00 - General Requirements.
- B. Contractor shall be responsible for transferring benchmarks, control points, lines, and grades as necessary to complete his work.

PART 2 MATERIALS

2.1 AGGREGATE MATERIALS - GENERAL

- A. Alternate crushed aggregate material blends that are locally available will be considered on a project by project basis for crushed aggregate base courses, and will be subject to the City's approval. The Owner's Construction Representative will require the Contractor to furnish a gradation report on the materials.

2.2 SPECIAL FILL

- A. In certain cases, special fill materials may be required for specific purposes, such as stabilizing subgrades, backfilling, undercut excavations or filling behind retaining walls. Fill materials shall meet the requirements of the following sections of the State Specifications: Section 209 for Granular Backfill, Section 210 for Structure Backfill, Section 305 for Dense Graded Base Course, Section 312 for Select Crushed Material, and Section 311 for Breaker Run of the State Specifications.

2.3 GEOTEXTILE FABRIC

- A. See Section 31 32 00 - Soil Stabilization.

PART 3 EXECUTION

3.1 PREPARATION

- A. Review plans and prepare work plan and schedule. Coordinate any necessary interruptions in site access with Owner's Construction Representative, in accordance with other specification sections.
- B. Contact Diggers Hotline. Locate and protect utilities, structures, pavement, trees, landscaping, benchmarks, and other features in the work area.
- C. Layout work. Establish and transfer line and grade as necessary to complete the work.
- D. Remove topsoil from work area. Sawcut and remove pavement from work area.
- E. Grade roadways and parking areas to drain water away.

3.2 PREPARE FOUNDATION FOR ASPHALTIC PAVEMENT

- A. Provide all labor, materials, and equipment necessary to prepare the foundation for to a condition suitable for constructing and supporting asphaltic pavement in accordance with these Specifications and Section 211 of the State Specifications.

3.3 EXCAVATION

- A. Excavate to elevations and dimensions as shown on the Drawings and as necessary to complete construction. Excavations shall be sufficiently deep to provide for all proposed base course and pavement.

- B. Notify the Owner’s Construction Representative if correction of unauthorized excavation or over-excavation is necessary. Said excavations will be corrected based on recommendations of the Owner’s Construction Representative or Owner’s Geotechnical Consultant. Contractor will be responsible for all costs associated with correcting these excavations, including fees charged by City and/or Owner’s Geotechnical Consultant.
- C. Segregate the various materials excavated. Reserve material meeting the requirements of backfill for the location. Excavated material that does not meet the requirements of backfill, and excess excavated material, shall be removed from the site and disposed by the contractor, unless directed otherwise by other specification sections or the Owner’s Construction Representative.
- D. Locate spoil piles in accordance with OSHA requirements, and so that it does not interfere with public travel, adjacent landowners or other construction activities.

3.4 FILL AND COMPACTION

- A. Excavation shall be reasonably free of water prior to beginning filling. Do not place material on frozen surfaces or use frozen material.
- B. Fill areas using the material specified on Table 31 22 16.15 - 2, or as shown on the Drawings.
- C. Place and compact material to minimize settlement and avoid damage to structures, pipes, utility lines and other features. Hand-place and compact material as necessary.
- D. Place backfill simultaneously on both sides of structures.
- E. Moisture condition backfill material as necessary to achieve density required for given use.
- F. Compact fill material as required by Table 31 22 16.15 - 2 for the given use. Compaction requirements based on Modified Proctor Dry Density (ASTM D1557).
- G. It is the responsibility of the Contractor to provide all necessary compaction equipment and other grading equipment that may be required to obtain the specified density. Vibratory plate or tamping type walk behind compactors will be required whenever backfill is placed adjacent to structures, pipes, utility lines confined spaces (i.e., backfilling undercut areas) and other features.

Area	Percent Compaction (1)	
	Clay/Silt	Sand/Gravel
<u>Within 10 feet of building lines</u>		
Footing bearing soils	95	95
Under floors, steps and walks		
• Lightly loaded floor slab	95	95
• Heavily loaded floor slabs and thicker fill zones	95	95
<u>Beyond 10 feet of building lines</u>		
Under walks and pavements - Granular Fill		
• Less than 2 feet below subgrade	95	95
• Greater than 2 feet below subgrade	92	92

Table 31 22 16.15 - 2

- H. Where additional filling or excavation is necessary, or placement of base course will be delayed, roll surface of proposed roadway with a smooth drum roller to provide relatively impervious surface and promote drainage. Roll with a smooth single drum vibratory roller having a minimum operating static weight of 12,000 pounds and a minimum centrifugal force of 22,000 pounds to provide relatively impervious surface and promote drainage. In the event the material is deficient in moisture content for readily obtaining the necessary density, it shall be moistened to the degree necessary by means of approved equipment. The compaction operation shall continue until the Engineer observes no visible displacement of material laterally or longitudinally under the compaction equipment or hauling equipment.

3.5 SUBGRADE APPROVAL/PROOF-ROLLING

- A. Prior to undercutting or excavating below subgrade (EBS) or placing any base course, contact the Owner’s Construction Representative to schedule inspection of subgrade and proof-rolling. Provide minimum of 24 hours confirmed notice. All proof-rolling shall be completed in the presence of the Owner’s Construction Representative or Owner’s Geotechnical Consultant.

- B. To complete proof-rolling, entire roadway subgrade shall be provided with a relatively smooth surface, suitable for observing soil reaction during proof-rolling.
- C. Contractor shall schedule and provide a fully loaded tri-axle dump truck for proof-rolling. Loaded truck shall have a minimum gross operating weight of 30 tons. Test shall be conducted with “tag” or “pusher” axles retracted from the ground.
- D. Test rolling shall be accomplished in a series of traverses parallel to the centerline of the street or parking area. The truck shall traverse the length of the street or parking area once for each 12 feet of width. Additional passes along the traverse shall be completed as directed by the Owner’s Construction Representative, to further define unsatisfactory subgrade.
- E. Soft areas, yielding areas, cracked areas or areas where rolling or wave action is observed shall be considered indicative of an unsatisfactory subgrade. Such areas shall be undercut as outlined in subsequent subsections of this specification.
- F. Once the subgrade has been proof-rolled and approved, protect the soils from becoming saturated, frozen, or adversely altered.

3.6 UNDERCUTTING/EXCAVATION BELOW SUBGRADE (EBS)

- A. Undercutting/EBS shall be completed only when directed by the Owner’s Construction Representative. The Contractor shall not be compensated for any unauthorized undercutting/EBS. Measure and document undercut areas and depths in consultation with Owner’s Construction Representative.
- B. Payment for undercutting/EBS shall be made on a unit price (cubic yard) basis measured in place at the rate as defined in the Contract. Payment will be made only for the measured quantity of undercutting/EBS directed by the Owner’s Construction Representative to be performed. The unit price shall include all costs for labor and materials necessary to remove and replace undercut areas including providing backfill materials and disposal of excavated materials off site.
- C. Excavate undercut areas to the depth specified using equipment with smooth cutting edge. Excavated undercut material that does not meet the specifications for fill needed elsewhere on site shall be removed from the site and legally disposed.
- D. Undercut areas shall be backfilled with 3-inch dense graded base course, as directed by the Owner’s Construction Representative in maximum of 6-inch thick lifts (compacted) or as directed by the Owner’s Construction Representative. Three-inch dense graded base course shall be compacted in thin lifts with a vibratory compactor until no further consolidation is evident.

3.7 GEOTEXTILE FABRIC

- A. When required by the Owner’s Construction Representative geotextile fabric shall be installed over the subgrade layer and prior to installing base aggregates. The Owner’s Construction Representative shall determine if geotextile fabric installation is required at the time of subgrade proof-rolling.

END OF SECTION

SECTION 31 23 16.13

TRENCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Excavation of trenches, pipe bedding, backfilling, and compaction for storm sewer, culverts, and water service.

1.2 RELATED SECTIONS

- A. Section 02 20 00 – General Sitework Requirements
- B. Section 02 32 00 – Geotechnical Investigation
- C. Section 31 20 00 – Earthmoving
- D. Section 33 10 00 – Water System Construction
- E. Section 33 40 00 – Storm Sewer Construction

1.3 REFERENCES

- A. ASTM C33-586 Specification for Concrete Aggregate
- B. ASTM C136-84a Method for Sieve Analysis of Fine and Coarse Aggregate
- C. ASTM D698-78 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-lb (2.49-kg) Rammer and 12-in. (304.8 mm) Drop
- D. ASTM D1557-78 Test Methods for Moisture-Density Relations of Soil-Aggregate Mixtures Using 10-lb. (4.54- kg) Rammer and 18-in. (457-mm) Drop
- E. ASTM D2487-85 Classification of Soils for Engineering Purposes
- F. ASTM D2922-81 Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- G. ASTM D3017-78 Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- H. Where reference is made to the “Construction Standards”, it shall be construed to mean the City of Stoughton’s Construction Standards, except the method of measurement and basis of payment shall not apply.
- I. Where reference is made to the “Standard Specifications”, it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- J. Where reference is made to the “State Specifications”, it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- K. Where reference is made to the “Geotechnical Report”, it shall be construed to mean the geotechnical report in Section 02 32 00.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 00 00.
- B. Field Testing Reports:
 - 1. Density and Moisture Tests: Submit within 14 days of test date.

PART 2 PRODUCTS

2.1 GENERAL

- A. Conform to requirements of Standard Specifications:
 - 1. Where conflicts between this specification, the Standard Specifications, and the Construction Standards exist, the most stringent requirements shall apply.

2.2 BEDDING AND COVER MATERIALS

- A. Water Mains:
 - 1. Bedding and cover material shall conform to the Construction Standards and Standard Specifications.

2.3 BASE MATERIAL

- A. Crushed Stone: Hard, durable particles of crushed stone or gravel substantially free from shale or lumps of clay or loam. When crushed stone base is required under sewer, water main, or structures, gradation shall meet the requirements of Type 1. When crushed stone for trench bottom stabilization is required to affect soil stability or drainage, it shall meet the gradation requirements of Type 2.

Type 1: 1½-Inch Crushed Stone

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
2 Inch	100
1½ Inch	90-100
1 Inch	20-55
¾ Inch	0-15
½ Inch	0-5

Type 2: 2-Inch Crushed Stone

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
2½ Inch	100
2 Inch	90-100
1½ Inch	35-70
1 Inch	0-15
½ Inch	0-5

2.4 BACKFILL

- A. Granular Backfill: Durable particles ranging from fine to coarse in a substantially uniform combination. Sufficient fine material shall be present to fill all the voids of the coarse material. Some fine clay or loam particles are desirable, but clay or loam lumps shall not be present. Conform to the following gradation:

Granular Backfill

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
3 Inch	100
2 Inch	95-100
No. 4	35-60
Finer than No. 200	5-15

- B. Excavated Material: Natural soils classified in ASTM D2487 as Gravels (GW, GP GM and GC), Sands (SW, SP, SM and SC), and Silts and Clays (ML and CL). Silts and Clays classified as OL, MH, CH, OH, and PT are not acceptable unless specifically allowed by Engineer. Soil material shall be free from vegetable or other organic matter, trash, debris, stones larger than three inches and frozen material.
- C. Use of excavated material for backfill of public utilities shall be subject to approval of the City’s Construction Representative and City’s Geotechnical Consultant prior to its use.

PART 3 EXECUTION

3.1 GENERAL

- A. Conform to requirements of Standard Specifications.
 - 1. Where conflicts between this specification, the Standard Specifications, and the Construction Standards exist, the most stringent requirements shall apply.

3.2 EXAMINATION

- A. Verify fill materials to be used are acceptable.

3.3 PREPARATION

- A. Identify required lines, levels, contours and datum.
- B. Maintain and protect existing utilities remaining, which pass through work area.
- C. Protect plant life, lawns, and other features remaining as a portion of the final landscaping.
- D. Protect bench marks, existing structures, shore protection structures and base materials, sidewalks, paving and curbs from excavation equipment and vehicular traffic.
- E. Protect above and below grade utilities which are to remain.
- F. Strip topsoil and stockpile on-site for re-use.
- G. When excavating across or within existing pavement, saw cut in neat straight lines.

3.4 DEWATERING

- A. Do not allow water to accumulate in the trench.
- B. Provide all dewatering equipment needed to accomplish the Work. Unless indicated otherwise, no additional compensation will be made for dewatering.
- C. No additional compensation will be made for crushed stone used for trench drainage.
- D. Dispose of water in a suitable manner without damage to property.
- E. Install, operate and abandon dewatering equipment in accordance with applicable state and local codes.
- F. Contact the Wisconsin DNR for a permit if the quantity of water to be pumped from dewatering equipment is in excess of 70 GPM.

Wisconsin Department of Natural Resources
Private Water Supply Section
P.O. Box 7921
Madison, WI 53707-7921

3.5 EXCAVATION

- A. Excavate subsoil to required depth and grade.
- B. Cut trenches sufficiently wide to enable installation of the utilities and allow inspection. Normal trench width below the top of the pipe shall be the nominal pipe diameter plus 24 inches. Do not undercut trench walls.
- C. Trench walls above the top of the pipe shall be as dictated by soil type and safety requirements. Provide shoring and bracing as required to maintain safe working conditions.
- D. Stockpile excavated material in area designated on-site.

3.6 BEDDING

- A. Place bedding in trench before installing pipe.
- B. Support pipe during placement and compaction of bedding.
- C. Provide a minimum of 4 inches of bedding material under the pipe barrel and under the bell.
- D. Lightly consolidate the material so that it fills and supports the haunch area and encases the pipe to the limits shown on the Drawings.
- E. If excavation is carried deeper than six inches below the pipe barrel, backfill the excess depth with 1½-inch crushed stone meeting the requirements of paragraph 2.3, A. of this section.
- F. After the pipe has been laid and jointed, place bedding materials by hand or equally careful means around the sides of the pipe and up to a level 12 inches above the pipe. Lightly consolidate the material.

3.7 BACKFILLING

- A. Backfill trenches to contours and elevations with unfrozen materials.
- B. Do not backfill over wet, frozen, or spongy subgrade surfaces.
- C. Granular Backfill: Place and compact materials in continuous layers not exceeding 12 inches compacted depth.
- D. Natural Soil Backfill: Place and compact material in continuous layers not exceeding 8 inches compacted depth.

- E. Maintain optimum moisture content of backfill materials to attain required compaction density.
- F. Utilize surplus backfill materials on project or remove surplus backfill material from site.
- G. Leave fill material stockpile areas completely free of excess fill materials.
- H. At all manholes, 3/4-inch crusher run stone shall be installed from the top of the cone to the top of the casting.

3.8 TOLERANCES

- A. Top Surface of Backfilling: Under Paved Areas
- B. Plus or minus (\pm) .05 feet from required elevations
- C. Top Surface of General Backfilling: Plus or minus (\pm) 0.2 feet from required elevations

3.9 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 01 00 00 by either the Owner's testing agency.
- B. Density/moisture relationship will be determined in accordance with ASTM D1557 (Modified Proctor).
- C. Compaction testing will be performed by Owner's testing agency and will be in accordance with ASTM D2922 and ASTM D3017.
- D. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest at no cost to the Owner. Additional testing of the removed and replaced work will be at the expense of the Contractor.
- E. Frequency of Tests:
 - 1. For trenches under paved areas - one test per 100 linear feet of trench.
 - 2. For trenches under unpaved areas - one test per 250 linear feet of trench.

3.10 COMPACTION SCHEDULE

- A. For paved areas compact to at least 95% of optimum density in accordance with ASTM D1557.
- B. For unpaved areas compact to at least 92% of optimum density in accordance with ASTM D1557.

END OF SECTION

SECTION 31 25 00
EROSION CONTROL

PART 1 GENERAL

1.1 SUMMARY

- A. Related sections:
 - 1. Section 31 20 00 - Earthmoving
 - 2. Section 31 32 00 - Soil Stabilization
 - 3. Section 32 92 19 - Seeding and Sodding

1.2 REFERENCE STANDARDS

- A. Where reference is made to the "Construction Standards", it shall be construed to mean the City of Stoughton's Construction Standards, except the method of measurement and basis of payment shall not apply.
- B. Where reference is made to the "Standard Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- C. Where reference is made to the "State Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- D. Where reference is made to the "Geotechnical Report", it shall be construed to mean the geotechnical report in Section 02 32 00.

1.3 SUBMITTALS

- A. Provide a detailed Erosion Control and Sequencing Plan for approval by the Owner's Construction Representative, if differing from the approved sequencing and erosion control plans issued as part of the Contract Documents.
- B. Provide manufacturer's data and WisDOT Product Acceptability List verification for silt fence, temporary ditch checks and erosion mat for review and approval by Owner's Construction Representative prior to procurement.
- C. Identify seed supplier and provide seed source, purity and germination specifications, for all seed mixes specified for installation in this section, to Owner's Construction Representative for approval prior to procurement.
- D. Provide manufacturer's data for fertilizer for review and approval by Owner's Construction Representative prior to procurement.

1.4 QUALITY ASSURANCE

- A. Contractor shall ensure that the General Provisions and Special Conditions of the following permits issued for the project shall be complied with at all times:
 - 1. City of Stoughton Stormwater Management and Erosion Control Permit.
 - 2. WDNR General Permit to discharge under the Wisconsin Pollutant Discharge Elimination System, for land disturbing construction activities.
- B. Inspect erosion control materials and supplies after delivery to verify that no damage has occurred.
- C. The status of erosion control measures will be an item of discussion in every weekly construction meeting. All corrective actions required during construction meetings shall be accomplished within three working days of the meeting date.
- D. Contractor shall provide weekly written reports on the erosion control system for the previous week to the Owner's Construction Representative for the duration of construction in a format approved by the Engineer. These reports shall be provided at each weekly construction meeting and shall be reported to the City of Stoughton's erosion control reporting representative (electronic PDF preferred). The weekly erosion control report shall describe:
 - 1. The extent of erosion control system installed.
 - 2. The condition of erosion control measures for that week, based on field observations.
 - 3. Any accidental release of sediment.

4. A summary of daily rainfall/snowmelt data for the week.
5. Any specific corrective action taken.
6. Corrective action that needs to be taken.
7. The person that conducted the observations shall sign the report.

1.5 WARRANTY

- A. Work conducted under this section shall be subject to the one-year warranty provisions described in the General Conditions of contract.

1.6 SEQUENCING AND SCHEDULING

- A. The sequencing of project construction activities will be generally as described in the plans and Contract Documents. The specific sequence for construction within a particular area shall be agreed upon with Owner's Construction Representative prior to construction within that area.
- B. All erosion control measures shall be completely installed for each construction area and approved by Owner's Construction Representative before any other construction activity takes place.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Silt Fence:
 1. Silt fence shall be as specified in the WDNR Construction Site Erosion & Sediment Control Technical Standard 1056.
- B. Erosion Mat - Class I - Type B and Class II Type B:
 1. Erosion control mat shall be to the requirements of WDNR Construction Site Erosion & Sediment Control Technical Standard 1052.
 2. WisDOT Erosion Mat Class 1 Type B erosion mat meeting the requirements of Section 628.2.2 of the State Specifications shall be used for all seeded areas within the public right-of-way unless noted otherwise on the plans.
- C. Seeding Temporary:
 1. Temporary seed shall be 100% Annual Ryegrass, with purity and germination requirements as specified in Section 630.2.1.5.1.2 of the State Specifications or as indicated in the WDNR Construction Site Erosion & Sediment Control Technical Standard 1059. Temporary seeding will be incidental to the grading items in the contract.
- D. Mulch:
 1. Mulch proposed for use shall be clean straw, with no weed material or seeds, and shall be approval Engineer before use.
 2. Mulch shall meet the standards set forth within the WDNR Construction Site Erosion & Sediment Control Technical Standard 1058.
- E. Tracking Pads:
 1. Stone for use in temporary access pads shall range in size from 3 inches to 6 inches in diameter.
 2. Pad shall be a minimum of 50 feet long.
 3. Pad shall meet the requirements of WDNR Construction Site Erosion & Sediment Control Technical Standard 1057.
- F. Fertilizer - Type A:
 1. Fertilizer shall be as specified in Section 629.2.1.2 of the State Specifications for Fertilizer, Type A.
- G. Riprap:
 1. Provide riprap as specified in Section 606.2.1 of the State Specifications for the size and type indicated on the construction drawings or bid form. If the size is not specified, medium riprap shall be used.
- H. Temporary Ditch Checks:
 1. Provide temporary ditch checks of material found on WisDOT's PAL list.
 2. Submit a written copy of the proposed material and manufacturer's specification for installing the product on slopes channels, and next to live traffic lanes as applicable to the project to the Owner's Construction Representative for approval prior to installation.

3. Erosion Bales shall not be used on this project as a sole means of perimeter erosion control. Erosion bales may be used to reinforce or support other primary means of perimeter erosion control, like silt fence..
- I. Inlet Protection - Type D:
 1. Use a Type FF geotextile fabric conforming to Section 645.2.2.1 of the State Specifications, except use a woven polypropylene fabric. Furnish Type FF geotextiles, or bags manufactured from Type FF geotextiles, from the WisDOT's PAL list.
- J. Rock Check Dams:
 1. Provide rock check dams in accordance with the standard detail drawings at locations identified in the plans and as directed by the Owner's Construction Representative.

PART 3 EXECUTION

3.1 GENERAL

- A. Establish all heights and grades to properly execute work from benchmark established by others.
- B. Contractor shall provide all surveys to accurately locate the construction on the site.
- C. Provide temporary erosion control measures in accordance with the Contractor's approved erosion control and sequencing plan. These measures may include temporary sedimentation basins, diversion berms and swales and other measures constructed in accordance with the WDNR Technical Standards.

3.2 EROSION CONTROL STRUCTURES

- A. Runoff diversion berms shall be constructed of clean topsoil, 2 feet high, with 3H:1V side slopes, and seeded and mulched immediately after installation.
- B. Silt fence shall be placed according to the WDNR Construction Site Erosion & Sediment Control Technical Standard 1056.

3.3 SEEDING TEMPORARY AND MULCHING

- A. Temporary seeding shall be conducted as described in Section 630.3.3 of the State Specification, with sowing using either Method A or Method B. Temporary seeding areas shall receive fertilizer at the rate of 10 lbs./1,000 sq. ft.
- B. Temporary seed shall receive mulch at the rate of 2,500 lbs./acre, and shall be crimped into the soil using WisDOT Procedure specified in Section 627.3.2.3 of the State Specifications.
- C. Disturbed areas within the construction site shall be graded, prepared for seeding, and seeded to conform to the following requirement for the maximum duration of bare-ground conditions:
 1. Areas within 100 feet of and draining directly to wetlands or watercourses, with slopes less than 5%: seven days
 2. Areas within 100 feet of and draining directly to wetlands or water courses, with slopes between 5% and 25%: three days
 3. Areas in the interior of the site that do not drain directly to wetlands and water courses: 30 days.

3.4 EROSION MAT CLASS I TYPE B and CLASS II TYPE B

- A. Erosion control mat shall be applied according to WDNR Technical Standards 1052 or 1053 as applicable and manufacturer's requirements.

3.5 TRACKING PAD

- A. Install tracking pads at the locations as shown in the plans or as directed by the Owner's Construction Representative.
- B. Tracking Pads shall be installed and maintained in accordance with Section 628.3.16 of the State Specification.
- C. Tracking Pads shall be maintained throughout construction and removed once construction is completed or the adjacent work area is stabilized.

3.6 FERTILIZER TYPE A

- A. Fertilizer applied to temporary seeding areas shall be applied as specified in Section 629.2.1.2 of the State Specification at locations where temporary seeding is required.

3.7 RIPRAP

- A. Place riprap of the specified size at locations as shown in the construction drawings.
- B. Place riprap in accordance with Section 606.3 of the State Specifications.
- C. Riprap at outfall locations shall be placed immediately after or concurrent with the placement of the apron endwall. Riprap at the outfalls is intended to be left in place as a permanent erosion control measure.

3.8 TEMPORARY DITCH CHECKS

- A. Place and maintain temporary ditch checks at the locations shown on the construction drawing and as directed by the Owner's Construction Representative
- B. Place and maintain temporary ditch checks in accordance the manufacturer's instructions and Section 628.3.14 of the State Specifications, except erosion bales are not to be used as temporary ditch checks on this project.
- C. Remove ditch checks after the slope ditches are stabilized in accordance with Section 628.3.14 of the State Specifications.

3.9 INLET PROTECTION TYPE D

- A. Furnish install and maintain inlet protection in accordance with Section 628.3.13 of the State Specifications.
- B. Inlet protection shall be maintained throughout construction, and removed once the area adjacent to the inlet has been stabilized and as directed by the Owner's Construction Representative.

3.10 MAINTENANCE AND CLEANUP

- A. The erosion control system shall be maintained throughout the duration of the construction project, in accordance with the procedures identified in Section 628.3.4.2 of the State Specifications.
- B. The erosion control system shall be inspected immediately after each rainfall of more than 0.5 inch, and daily during prolonged rainfall. All inspections shall be reported to the Owner's Construction Representative in the weekly erosion control system report.
- C. Accumulated sediment within the erosion control system shall be removed before one-half of the storage capacity of the erosion control measure is used, or as specified by the Owner's Construction Representative.
- D. Accumulated sediment in riprap shall be removed as directed by the Owner's Construction Representative during the project, and as a final condition of acceptance if deficiencies are noted at final walk through.

3.11 ROCK CHECK DAMS

- A. Place and maintain rock check dams at the locations shown on the construction drawing and as directed by the Owner's Construction Representative
- B. Remove sediment deposits when the build-up reaches approximately one-third of the height of the rock check dam, and as directed by the Owner's Construction Representative. Contractor may also remove and replace the stone check with sediment and replace with new stone at their discretion. Each location will be paid for initial placement only maintenance is incidental to this item.
- C. Remove rock check dams after the slopes and ditches are stable and turf develops enough to make future erosion unlikely. The Owner's Construction Representative will determine when the contractor meets this criteria.

END OF SECTION

SECTION 31 32 00
SOIL STABILIZATION

PART 1 GENERAL

1.1 SUMMAR

- A. Section includes:
 - 1. Geotextile fabric and geogrid for stabilization of subgrade.
- B. Related requirements:
 - 1. Section 31 20 00 - Earthmoving

1.2 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.
- B. Where reference is made to the "State Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

1.3 SUBMITTALS

- A. Submit manufacturer's specifications for geotextile fabric and geotextile grid.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Provide products from one of the following manufacturers as specified in the Materials paragraph below:
 - 1. TenCate Geosynthetics North America (Mirafi), Pendergrass, GA - (706) 693-2226, www.tencate.com
 - 2. Hanes Geo Components (WEBTEC), Winston Salem, NC - (336) 747-1600, www.hanesgeo.com
 - 3. Tensar International Corp., Atlanta, GA - (888) 828-5126, www.tensarcorp.com
 - 4. Thrace-LINQ Inc., Summerville, SC - (843) 873-5800, www.thraceling.com
 - 5. DuPont (Tygar), Summerville, SC - (843) 832-6860, www.typargeo.com
 - 6. Synteen Technical Fabrics, Lancaster, SC - (800) 796-8336, www.synteen.com

2.2 MATERIALS

- A. Aggregate:
 - 1. Coarse Aggregate: Crushed carbonate, crushed gravel, crushed air-cooled slag, granulated slag, a mixture of crushed and granulated slag, or other types of suitable material meeting the gradation requirements of Section 305 of "State of Wisconsin Standard Specifications for Highway and Structure Construction", latest edition.
 - 2. Fine Aggregate: Sand - Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter meeting the gradation requirements of Section 305 of "State of Wisconsin Standard Specifications for Highway and Structure Construction", latest edition.
 - 3. Subsoil: Existing to be re-used.

2.3 ACCESSORIES

- A. Geotextile Fabric for Stabilization - provide one of the following:
 - 1. Mirafi HP 370 or HP 570, by TenCate
 - 2. SF40 or SF65, by DuPont
 - 3. GTF-200 or 300, by Thrace-LINQ
 - 4. TerraTex HD, by Hanes
- B. Geogrid for Stabilization - provide one of the following:
 - 1. Biaxial Geogrid Type 1 (formerly BX 1100), by Tensar
 - 2. Biaxial Geogrid Type 2 (formerly BX 1200), by Tensar
 - 3. Mirafi BXG 11, by TenCate

4. Mirafi BXG 12, by TenCate
5. SF 11, by Synteen
6. SF 12, by Synteen

PART 3 EXECUTION

3.1 PREPARATION

- A. Start stabilization only when weather and soil conditions are favorable for successful application of proposed material.
- B. Proof-roll subgrade to identify areas in need of stabilization.

3.2 EQUIPMENT

- A. Perform operations using suitable, well maintained equipment capable of excavating subsoil, mixing and placing materials, wetting, consolidating, and compacting of material.

3.3 EXCAVATION

- A. Excavate subsoil to depth sufficient to accommodate soil stabilization.
- B. Remove lumped subsoil, boulders, and rock that interfere with achieving uniform subsoil conditions.
- C. Notify Owner's Construction Representative in writing of unexpected subsurface conditions. Discontinue affected work in area until notified to resume work.
- D. Remove excess excavated material from site.

3.4 GEOTEXTILE FABRIC AND/OR GEOGRID

- A. Place geotextile fabric and/or geogrid over subsoil surface, lap edges and ends in accordance with manufacturer's recommendations in those areas that are shown on Construction Drawings or in those areas that need additional stabilization prior to placement of base course. Place geotextile fabric and/or geogrid in accordance with manufacturer's recommendations.

3.5 FIELD QUALITY CONTROL

- A. Field quality control shall be the responsibility of the Contractor in accordance. Except for specified mandatory testing, field quality control testing and inspection shall be at the discretion of the Contractor as necessary to assure compliance with Contract requirements. The Owner's Construction Representative specified below shall not be considered a substitute for the Contractor's responsibility to perform similar routine, necessary, and customary testing and inspection of the methods and frequency suitable for the type of work involved.

3.6 TESTING

- A. Field Density: Field in-place density shall be determined as specified in Section 31 20 00.

END OF SECTION

SECTION 32 05 00
COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS

PART 1 GENERAL

1.1 SCOPE

- A. This section provides information common to two or more technical sitework specification sections or items that are of a general nature, and not included in other sections.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section:
1. Section 02 41 13 - Demolition
 2. Section 31 23 16 13 - Trenching
 3. Section 31 25 00 - Erosion Control
 4. Section 32 91 13 - Soil Preparation

1.3 REFERENCED ORGANIZATIONS

- A. Abbreviations of organizations referenced in these specifications are as follows:
- | | |
|--------|--|
| AASHTO | American Association of State Highway and Transportation Officials |
| ACPA | American Concrete Pipe Association |
| ANSI | American National Standards Institute |
| ASCE | American Society of Civil Engineers |
| ASME | American Society of Mechanical Engineers |
| ASTM | American Society for Testing and Materials |
| AWWA | American Water Works Association |
| AWS | American Welding Society |
| FHA | Federal Highway Administration |
| EPA | Environmental Protection Agency |
| NEC | National Electric Code |
| NEMA | National Electrical Manufacturers Association |
| NFPA | National Fire Protection Association |
| NSF | National Sanitation Foundation |
| OSHA | Occupational Safety and Health Administration |
| STI | Steel Tank Institute |
| UL | Underwriters Laboratories Inc. |
| WDNR | State of Wisconsin Department of Natural Resources |
| WISDOT | State of Wisconsin Department of Transportation |

1.4 REFERENCED DOCUMENTS

- A. Where reference is made to the "Construction Specifications", it shall be construed to mean the pertinent section of the City of Stoughton Standard Construction Specifications, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- B. Where reference is made to the "Standard Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- C. Where reference is made to the "State Specifications", it shall be construed to mean the pertinent section of the WisDOT Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- D. Where reference is made to the "Geotechnical Report", it shall be construed to mean the geotechnical report in Section 02 32 00.

1.5 QUALITY ASSURANCE

- A. Provide materials and products as required by individual specification sections. Refer to Section GC - General Conditions of the Contract regarding substitutions.
- B. Provide quality assurance testing and reporting as required by individual specification sections.

1.6 SAFETY

- A. Contractor is solely responsible for worksite safety.
- B. Perform all work in accordance with applicable OSHA, state, and local safety standards.
- C. Contact Diggers Hotline at 1-800-242-8511 in accordance with statutory requirements. Request that non-member utilities and private utilities be located by the appropriate parties.

1.7 PERMITS

- A. Unless otherwise noted in the Contract Documents, Contractor shall be responsible for obtaining and paying for all permits necessary to complete the work.

1.8 CONSTRUCTION LIMITS

- A. Construction Limits are indicated on the drawings. In the absence of such a designation on the drawings, confine work to the minimum area reasonably necessary to undertake the work as determined by the Owner's Construction Representative. In no case shall construction activities extend beyond state property lines or construction easements.
- B. The Contractor shall restore all disturbed areas in accordance with the drawings and specifications. If plans and specifications do not address restoration of specific areas, these areas will be restored to pre-construction conditions as approved by the Owner's Construction Representative.

1.9 SUBMITTALS

- A. Refer also to Section GC - General Conditions of the Contract and Division 1.
- B. Submit manufacturer's shop drawings, product data, samples, substitutions, and operation and maintenance (O&M) data for approval as required by individual specification sections.
- C. Submittals shall be provided to the Owner's Construction Representative for review and approval, unless otherwise directed. Submittals shall be submitted electronically by email in *.pdf format unless otherwise directed.

1.10 OFF-SITE STORAGE

- A. Refer to Division 1.
- B. In general, the payments for materials stored off site will only be considered in instances where there is limited space available for storage on the site. Prior approval by the Owner's Construction Representative, together with the execution of a Storage Agreement, will be required.

1.11 CODES

- A. Comply with the requirements of all applicable, local, state, and federal codes.

1.12 CERTIFICATIONS AND INSPECTIONS

- A. Refer to Section GC - General Conditions.
- B. Obtain and pay for all required sampling, testing, inspections, and certifications except those expressly listed as provided by the A/E or other third-party in the Contract Documents. Deliver originals of certificates and documents to the Owner's Construction Representative within three (3) days; provide copies to the City Engineer. Include copies of the certifications and documents in the O&M Manual.

PART 2 MATERIALS

2.1 BARRICADES, SIGNS, AND WARNING DEVICES

- A. Traffic barricades, traffic signs, and warning devices shall meet the requirements of applicable OSHA standards and the FHA Manual of Uniform Traffic Control Devices (MUTCD).

2.2 TEMPORARY PLASTIC BARRIER FENCING

- A. UV stabilized high-density polyethylene barrier fence free of holes tears and other defects. Provide 4-foot tall fence in diamond or rectangular pattern. Fencing shall be "safety orange" color, unless otherwise noted.
- B. Posts for temporary plastic barrier fencing shall be 5-foot tall, minimum 12-gauge, painted metal posts.

PART 3 EXECUTION

3.1 MAINTENANCE OF SITE AND BUILDING ACCESS/EGRESS

- A. Unless otherwise shown or directed, maintain existing access and egress to the facility throughout construction. Maintain ANSI A117 compliant access for disabled persons, delivery access, emergency vehicle access, and emergency egress. Do not interrupt access and egress without prior written approval from the Owner's Construction Representative.

3.2 CONTINUITY OF EXISTING TRAFFIC/PARKING AND TRAFFIC CONTROL

- A. Refer also to Section GR - General Requirements.
- B. Do not interrupt or change existing traffic, delivery, or parking outside the requirements of the staging plan without prior written approval from the Owner's Construction Representative. When interruption is required, coordinate schedule with the Owner agency to minimize disruptions. When working in public right-of-way, obtain all necessary approvals and permits from applicable municipalities and WISDOT.
- C. When Contractor's activities impede or obstruct traffic flow, Contractor shall provide traffic control devices, signs and flaggers in accordance with other Contract Documents and the current version of the MUTCD, or as shown on the Drawings.

3.3 PROTECTION AND CONTINUITY OF EXISTING UTILITIES

- A. Verify the locations of any water, drainage, gas, sewer, electric, drainage, gas, sewer, electric, telephone/communication, fuel, steam lines or other utilities and site features which may be encountered in any excavations or other sitework. All lines shall be properly underpinned and supported to avoid disruption of service.
- B. Do not interrupt or change existing utilities without prior written approval from the Owner's Construction Representative, affected utilities and users. Notify all users impacted by outages a minimum of 48 hours in advance of outage. Notification shall be provided in writing and describe the nature and duration of outages and provide the name and number of Contractor's foreman or other contact.
- C. Any service connections encountered which are to be removed shall be cut off at the limits of the excavation and capped in accordance with the requirements of applicable codes and any specifications governing such removals.

3.4 PROTECTION OF EXISTING WORK AND FACILITIES

- A. Verify the locations of, and protect, any signs, paved surfaces, buildings, structures, landscaping, streetlights, utilities, and all other such facilities that may be encountered or interfered with during the progress of the work. Take measures necessary to safeguard all existing work and facilities that are outside the limits of the work or items that are within the construction limits but are intended to remain. Report any damage to existing facilities to the Owner's Construction Representative immediately. Correct and pay for all damages.

3.5 STORMWATER/EXCAVATION WATER MANAGEMENT

- A. Control grading around structures, pitch ground to prevent water running into excavated areas.
- B. Pits and other excavations shall be maintained free of water.
- C. Provide trenching, pumping, other facilities required.
- D. Notify Architect/Engineer if springs or running water are encountered in excavation; provide discharge by trenches, drains, pumping to point outside of excavation. Provide information to Architect/Engineer of points and areas that

water will be discharged. At the Engineer's option, the Contractor shall drain the spring to the storm sewer system by the use of field tile.

- E. Be responsible for control measures to prevent damage from flooding, erosion, and sedimentation to on-site and off-site areas.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes provisions for providing aggregate base course as the foundation for hot-mixed asphalt paving, concrete curb and gutter, and concrete sidewalk.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 - Specification Sections, apply to this Section.
- B. Related Sections - The following sections contain requirements that relate to this Section:
 - 1. Section 02 20 00 – General Sitework Requirements
 - 2. Section 03 30 00 – Cast-In-Place Concrete
 - 3. Section 31 20 00 – Earthmoving
 - 4. Section 31 22 00 – Soil Stabilization
 - 5. Section 32 12 16.13 – Plant-Mix Asphalt

1.3 REFERENCES

- A. Where reference is made to the “Construction Specifications”, it shall be construed to mean the pertinent section of the City of Stoughton Standard Construction Specifications, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- B. Where reference is made to the “Standard Specifications”, it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- C. Where reference is made to the “State Specifications”, it shall be construed to mean the pertinent section of the WisDOT Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- D. Where reference is made to the “Geotechnical Report”, it shall be construed to mean the geotechnical report in Section 02 32 00.
- E. ASTM:
 - 1. ASTM D1557-78: Test Methods for Moisture-Density relation of Soil and Soil-Aggregate Mixtures Using 10 lbs. (4.54-kg) Rammer and 18-in. (457 mm) Drop.
 - 2. ASTM D698: Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbs/ft³ (600 kN-m/m³)).
 - 3. ASTM D1557: Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbs/ft³ (2,700 kN-m/m³)).
 - 4. ASTM D6938: In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:
 - 1. Submit 50-pound samples of each type of aggregate to testing laboratory for materials not obtained from on-site stockpiles and for blended aggregate.
 - 2. Weight slips of each load showing the net weight of the aggregate.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Provide materials meeting the requirements of the Geotechnical Report and WisDOT Sections 301, 305, and 306 and as shown in the Drawings.
 - 1. Reclaimed or recycled asphalt products will not be an acceptable alternative or equal to 1¼ Dense Grade Base material.
- B. Hot-Mix Sand Asphalt Bases: Asphalt Institute Type VI, VII, or VIII Mixes for Hot-Mix Sand Asphalt Bases. Hot-mix base shall be used only under asphaltic concrete surfaces.

PART 3 EXECUTION

3.1 PREPARATION

- A. Prepare the subgrade in accordance with the Geotechnical Report and Section 31 20 00 - Earthmoving as necessary for undercut.

3.2 EQUIPMENT

- A. Meet requirements of WisDOT Section 301.3.1.

3.3 SPREADING AND SHAPING

- A. Meet requirements of WisDOT Section 305.3.4.
- B. Construct to thickness indicated on Construction Drawings. The minimum base thickness as shown on drawings shall be achieved throughout all pavement areas.
 - 1. Aggregate Base: Apply in lifts or layers not exceeding 8 inches, measured loose.
 - 2. Sand Base: Apply in lifts or layers not exceeding 6 inches, measured loose.
 - 3. Hot-Mix Sand Asphalt Bases: Apply in lifts or layers not exceeding 3 inches, measured loose.

3.4 COMPACTION

- A. Meet requirements of WisDOT Section 305.3.2.2, except as modified below.
 - 1. Compact base material to not less than 98 percent of optimum density as determined by ASTM D698 or 95 percent of optimum density, as determined by ASTM D1557 unless otherwise indicated on the Drawings.

3.5 TOLERANCES

- A. Smoothness: Maximum variation of 3/8 inch when measured with a 10-foot straight edge.
- B. Compacted thickness: within 1/4 inch.

3.6 FIELD QUALITY CONTROL

- A. Field inspection and testing will be done by the City/County in public right-of-way or the Owner's Construction Representative
- B. Repair or remove and replace unacceptable base course as directed by the Owner's Construction Representative.

END OF SECTION

SECTION 32 12 16.13
PLANT-MIX ASPHALT PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hot-mix asphalt paving, hot-mix asphalt patching, and pavement-marking paint.

1.2 RELATED SECTIONS

- A. Section 02 20 00 – General Sitework Requirements
- B. Section 31 20 00 – Earthmoving
- C. Section 32 11 23 – Aggregate Base Course

1.3 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM D1188 Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
 - 2. ASTM D2041 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
 - 3. ASTM D2950 Density of Bituminous Concrete in Place by the Nuclear Methods
 - 4. ASTM D2726 Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixture
 - 5. ASTM D5444 Mechanical Size Analysis of Extracted Aggregate
- B. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M017 Mineral Filler for Bituminous Paving Mixtures
 - 2. AASHTO M140 Emulsified Asphalt
 - 3. AASHTO M208 Cationic Emulsified Asphalt
 - 4. AASHTO M320 Performance-Graded Asphalt Binder
 - 5. AASHTO M323 Superpave Volumetric Mix Design
 - 6. AASHTO T164 Quantitative Extraction of Asphalt Binder from Hot-Mix Asphalt (HMA)
 - 7. AASHTO T166 Bulk Specific Gravity of Compacted Hot-Mix Asphalt Mixtures Using Saturated Surface-Dry Specimens
 - 8. AASHTO T209 Theoretical Maximum Specific Gravity and Density of Hot-Mix Asphalt (HMA)
 - 9. AASHTO T245 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
 - 10. AASHTO T275 Bulk Specific Gravity of Compacted Hot-Mix Asphalt Mixtures Using Paraffin-Coated Specimens
 - 11. AASHTO T308 Asphalt Content of Hot-Mix Asphalt (HMA) by the Ignition Method
 - 12. AASHTOT312 Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
 - 13. AASHTO T331 Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
- C. National Asphalt Pavement Association (NAPA):
 - 1. IS 123 - Recycling Hot-Mix Asphalt Pavements
 - 2. IS 128 - HMA Pavement Mix Type Selection Guide

1.4 STANDARD SPECIFICATIONS

- A. Where reference is made to the “Standard Specifications”, it shall be construed to mean the pertinent section of the Wisconsin Department of Transportation (WisDOT) Standard Specifications for Road and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- B. Where reference is made to the “Geotechnical Report”, it shall be construed to mean the geotechnical report in Section 02 32 00.
- C. All construction of public facilities and/or work within public lands or rights of way shall conform to the requirements and conditions of the City of Stoughton Standard Specifications for Public Works Construction.

1.5 SUBMITTALS

- A. Job-Mix Designs for each job mix proposed for the work.
- B. Material Certificates, signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

1.6 DEFINITIONS

- A. Plant-Mix Asphalt Paving Terminology: Refer to ASTM D8 for definitions of terms.

1.7 SYSTEM DESCRIPTION

- A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of WisDOT.

1.8 QUALITY ASSURANCE

- A. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot-Mix Asphalt Pavements," unless more stringent requirements are indicated.
- B. Pre installation Meeting: Convene a pre installation meeting at the site at least two (2) weeks prior to commencing work of this Section. Require attendance of parties directly affecting work of this Section, including, but not limited to, Developer, Developer's Engineer, and inspector, Contractor, paving sub-contractor, and job foreman.
 - 1. Contact Developer' Engineer and the City/County three (3) weeks prior to pre-installation conference to confirm schedule.
 - 2. Record discussions of meeting and decisions and agreements (or disagreements) reached, and furnish copy of record to each party attending. Review foreseeable methods and procedures related to paving work, including the following:
 - a. Review preparation and installation procedures and coordinating and scheduling required with related work.
 - b. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
 - c. Tour, inspect and discuss condition of subgrade, drainage structures, and other preparatory work.
 - d. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
 - e. Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - f. Review paving requirements (drawings, specifications, and other contract documents).
 - g. Review required submittals, both completed and yet to be completed.
 - h. Review required inspections, testing procedures.
 - i. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.
 - j. Review safety precautions relating to placement of paving.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing Manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by Manufacturer. Protect stored materials from direct sunlight.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp.
- B. Paving under conditions when surface temperatures approximately 3 feet above grade are at or below 40 degrees F (40°F) shall be in accordance with Cold Weather Paving provisions in the State Specifications; specifically Section 450.
- C. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 degrees F (40°F) for oil-based materials, 50 degrees F (50°F) for water-based materials, and not exceeding 95 degrees F (95°F). Paint color shall be as specified on the Drawings.

PART 2 PRODUCTS

2.1 GENERAL

- A. All materials and methods for on-site pavement shall conform to WisDOT Standard Specifications. Where conflicts between this specification and the WisDOT Standard Specifications exist, requirements of the WisDOT shall govern.
- B. All materials and methods for public roadways shall conform to City of Stoughton Standard Specifications for Public Works Construction.

2.2 MATERIALS AND MIXES

- A. Provide asphaltic pavement per WisDOT Standard Specifications Sections 460.2 and 460.3 and the Pavement Design section of the Geotechnical Report but excluding limitations in Section 460.3.2 restricting layer thickness by aggregate size.
- B. Pavement thickness: See pavement sections in Drawings:
 - 1. Bituminous Concrete: Refer to Section 460-3
 - 2. Base Course: Refer to Section 301.3.4.2 - Standard Compaction
- C. Mixture Type: See Drawing sections, Table 460-2 of the WisDOT Standard Specifications.
- D. Bituminous Material: Per WisDOT Standard Specifications, of suitable grade and consistency for application.
- E. Tack Coat: Per WisDOT Standard Specifications, of suitable grade and consistency for application.
- F. Water: Potable.

2.3 MARKING MATERIALS

- A. Type S or Type N traffic paint in accordance with AASHTO Designation M248. Regular set drying time.
- B. Waterborne Paint: Paints shall conform to FS TT-P-1952.
- C. Solvent Borne Paint: Paint shall conform to FS A-A-2886 or AASHTO M248. Paint shall be non-bleeding, quick drying, and alkyd petroleum base paint suitable for traffic bearing surface and be mixed in accordance with manufacturer's instructions before application for colors White, Yellow, Blue, and Red.
- D. Epoxy marking from the WisDOT approved products list and in accordance with Section 646.2.4.
- E. Glass Beads: AASHTO M 247, Type 1 or FS TT-B-1325, Type 1, Gradation A.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.
- B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction per Geotechnical Report.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

- A. Hot-Mix Asphalt Pavement: Sawcut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
 - 1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
- B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Place hot-mix asphalt binder course in number of lifts and thicknesses indicated.
 - 2. Spread mix at minimum temperature of 250 degrees F (250°F).
 - 3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
 - 4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless in-fill edge strips of a lesser width are required.
 - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt binder course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches. Coat longitudinal joints that are not completed before the previously laid mixture has cooled to a temperature below 140 degrees F (140°F), with liquid asphalt just before paving is continued.
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches. If placing of material is discontinued or if material in place becomes cold, make a joint running perpendicular to the direction traveled by the paver. Before placement continues, trim the edge of the previously placed pavement to a straight line perpendicular to the paver and cut back to expose an even vertical surface for the full thickness of the course. When placement continues, position the paver on the transverse joint so that sufficient hot mixture will be spread in order to create a joint after rolling that conforms to the required smoothness. If the temperature of the previously placed pavement material drops below 140 degrees F (140°F) before paving is resumed, give the exposed vertical face a thin coat of liquid asphalt just before paving is continued.
 - 4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements".
 - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 - 6. Compact asphalt at joints to a density within 2% of specified course density.
- B. Construction joints shall have same texture, density, and smoothness as other sections of asphalt concrete course.

3.6 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 degrees F (185°F).
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 96% of reference laboratory density according to AASHTO T 245, but not less than 94% nor greater than 100%.
 - 2. Average Density: 92% of reference maximum theoretical density according to ASTM D2041, but not less than 92% nor greater than 97%.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked. Any masked or marred finish surfaces shall be repaired or smoothed.
- G. Compaction at Unsupported Edges of Pavements: Start the first roller pass 12 to 15 inches from the unsupported edge. Allow the uncompacted asphalt to act as a dike to hold the mat in place. The final pass over the uncompacted dike should not slough off if the roller is supported on the compacted mat.
- H. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- I. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- J. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCE

- A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Binder Course: Plus or minus (\pm) 1/4 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Binder Course: 1/4 inch
 - 2. Surface Course: 1/8 inch
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: The Owner's Construction Representative will engage a testing agency to perform field tests and inspections and to prepare test reports.
 - 1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.
- B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C. Thickness:
 - 1. In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D3549.
 - 2. Lot 2: The CTL will measure thickness of each core sample taken. At each core location, the thickness of the course shall meet or exceed the thickness shown. If the thickness of a lower course of asphalt is less than the thickness shown, it shall be identified as a deviation and recorded. The Contractor shall either remove and replace the deficient pavement or increase the thickness of the upper course so that the total thickness of the pavement meets or exceeds the design thickness, provided that the specified compaction of the lower lift is achieved.
- D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances. In areas of obvious depressions or bumps, suspect areas of each lift shall be checked with a 10'-0" straightedge both parallel with, and at right angles to, centerline of the paved area. The variation of the surface between two (2) contact points shall not exceed 1/4 inch.
- E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.9 SPLIT PAVING

- A. Where specified, paving of the binder course and surface course are to be performed in same construction seasons.
- B. If paving of binder and surface course are done in successive construction season, the Contractor shall be responsible for damage to the binder course and curbs until the surface course is placed and accepted by the Owner as appropriate.

3.10 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
- B. Do not allow excavated materials to accumulate on-site.

3.11 MARKING APPLICATION - PAINT

- A. Pavement markings shall be placed at locations and to dimensions shown on Drawings.
- B. Applied lines shall have a uniform cross section.
- C. Lines shall have sharp cut-off defined edges on both side and ends.
- D. Pavement markings applied to new asphaltic pavement surfaces shall be applied to surface course within seven (7) days of placement.
- E. Pavement markings applied to new concrete surfaces shall be applied prior to allowance of any traffic on surface.
- F. Agitate paint for 5-10 minutes prior to application to ensure even distribution of paint pigment.
- G. Paint shall be applied in accordance with manufacturer's recommendations and apply two coats of same color of paint as specified without addition of thinner, with maximum of 100 square feet per gallon or as required to provide a minimum wet film thickness of 15 mils and dry film thickness of 7½ mils per coat.
- H. Dispense paint at ambient degrees Fahrenheit to wet-film thickness of 15 mils.
- I. Apply markings to indicated dimensions at indicated locations.
- J. Prevent splattering and over spray when applying markings.
- K. Apply glass beads at pedestrian crosswalk striping and at lane striping and arrows at driveways connecting to public streets. Broadcast glass beads uniformly into wet markings at a rate of 6 lbs./gal.
- L. Unless material is track free at end of paint application convoy, use traffic cones to protect markings from traffic until track free. When vehicle crosses a marking and tracks it or when splattering or over spray occurs, eradicate affected marking and resultant tracking and apply new markings.
- M. Collect and legally dispose of residues from painting operations.

3.12 MARKING APPLICATION - EPOXY

- A. Application shall be in accordance with Section 646.3.3.2 of the State Specifications.

END OF SECTION

SECTION 32 16 00
CONCRETE CURB AND SIDEWALKS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Portland cement concrete curbs, gutters, and sidewalks, except sidewalks adjacent to building.
- B. Related requirements:
 - 1. Section 31 20 00 - Earthmoving
 - 2. Section 31 22 16.15 - Subgrade Preparation

1.2 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.
- B. American Concrete Institute (ACI):
 - 1. ACI 305R - Hot Weather Concreting
 - 2. ACI 306R - Cold Weather Concreting
 - 3. ACI 306.1 - Cold Weather Concreting
 - 4. ACI 308 - Curing Concrete
- C. ASTM International (ASTM):
 - 1. ASTM A185 - Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
 - 2. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement
 - 3. ASTM C31 - Making and Curing Concrete Test Specimens in the Field
 - 4. ASTM C39 - Comprehensive Strength of Cylindrical Concrete Specimens
 - 5. ASTM C42 - Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 - 6. ASTM C94 - Ready-Mixed Concrete
 - 7. ASTM C138 - Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
 - 8. ASTM C143 - Slump of Hydraulic Cement Concrete
 - 9. ASTM C231 - Air-Content of Freshly Mixed Concrete by the Pressure Method
 - 10. ASTM C172 - Sampling Freshly Mixed Concrete
 - 11. ASTM C173 - Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
 - 12. ASTM C260 - Air-Entraining Admixtures for Concrete
 - 13. ASTM C309 -Liquid Membrane-Forming Compounds for Curing Concrete
 - 14. ASTM C618 - Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete
 - 15. ASTM C989 - Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
 - 16. ASTM C1064 - Temperature of Freshly Mixed Portland Concrete Cement
 - 17. ASTM C1218 -Water-Soluble Chloride in Mortar and Concrete
 - 18. ASTM D98 - Calcium Chloride
 - 19. ASTM D994 - Preformed Expansion Joint Filler for Concrete (Bituminous)
 - 20. ASTM D1190 - Concrete Joint Sealer, Hot Poured, Elastic Type
 - 21. ASTM D1751 - Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
 - 22. ASTM D2628 - Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
- D. Federal Specifications (FS):
 - 1. FS HH-F-341 - Fillers, Expansion Joint: Bituminous (Asphalt and Tar)
- E. Wisconsin Department of Transportation (WisDOT):
 - 1. State of Wisconsin Standard Specifications for Highway and Structure Construction, latest edition.

1.3 SUBMITTALS

- A. Mix Design:
 - 1. Fill out and submit attached Concrete Mix Design Submittal Form.
 - 2. Submit three (3) copies of each proposed mix.

3. Submit separate mix design for concrete to be placed by pumping in addition to the mix design for concrete to be placed directly from the truck chute.
4. Include applicable information shown on the Mix Design Submittal Form and the following:
 - a. Proportions of cementitious materials, fine and coarse aggregate, and water.
 - b. Water-cementitious material ratio, 28-day compressive design strength, slump, and air content.
 - c. Type of cement, fly ash, slag and aggregate.
 - d. Aggregate gradation.
 - e. Type and dosage of admixtures.
 - f. Special requirements for pumping.
 - g. Range of ambient temperature and humidity for which design is valid.
 - h. Special characteristics of mix which require precautions in mixing, placing, or finishing techniques to achieve finished product specified.
 - i. Materials and methods for curing concrete.
- B. Submit certified laboratory test data or manufacturer's certificates and data for the items listed below certifying that materials are in conformance requirements specified herein. Submit to the Engineering Consultant of Record and the Construction Testing Laboratory for review and approval and within seven calendar days after receipt of Notice to Proceed.
 1. Concrete mix design(s)
 2. Type and source of Portland cement, fly ash, and slag
 3. Aggregate gradations
 4. Preformed expansion joint filler
 5. Field molded/poured sealant
 6. Dowel bars
 7. Expansion sleeves
 8. Tie bars
 9. Reinforcing steel bars
 10. Welded wire fabric
 11. Air entraining admixtures
 12. Water-reducing, set-retarding and set-accelerating admixtures (if used)
- C. Test Reports: Submit field quality control test reports.

1.4 PROJECT CONDITIONS

- A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Forms shall be of wood or metal and shall be straight and of sufficient strength to resist springing, tipping or other displacement during the process of depositing and consolidating the concrete. If of wood, forms shall be surfaced plank of at least 2-inch nominal thickness stock except for sharply curved sections; and if of metal, they shall be of approved section. The forms shall be of the full depth of the required curb or gutter, driveway or sidewalk sections and shall be designed to permit secure fastening. Face boards, if used, shall be so constructed and shaped that their lower edge conforms to the lines and radius indicated by the cross section for the pertinent structure as shown on the plans. Flexible or curved forms of proper radius shall be used for curves of 100-foot radius or less. All forms shall be cleaned thoroughly and oiled before the concrete is placed against them.
- B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A185 and AASHTO M31 Grade 60. Furnish in flat sheets.
- C. Reinforcing Steel: Deformed steel bars, ASTM A615, Grade 60.
- D. Epoxy Coating: ASTM A775 where noted in the Drawings.
- E. Portland Cement: Shall conform to ASTM C150, Type I unless Type III is specified.
- F. Exterior Pavement Joint Materials:
 1. Preformed Expansion Joint Filler shall be 3/4 inch in thickness and shall conform to AASHTO M-213.
 2. Joint Back-up Material: Polyethylene foam, 100% closed cell.

- 3. Sealant:
 - a. Dow 888, by Dow Corning
 - b. 301 NS by Pecora
 - c. Spectrum 800 or 900 by Tremco
- G. Aggregate: ASTM C33.
- H. Water: Clean and potable.
- I. Dowel Bars: ASTM A615, Grade 60, and plain steel bars.
- J. Air Entrainment:
 - 1. Air entrained concrete shall be used for all concrete construction. Slip formed concrete pavement shall contain 7.0% air, $\pm 1.5\%$. Other concrete shall contain 6.0% air, $\pm 1.5\%$.
 - 2. ASTM C260:
 - a. Air-Mix or AEA-92, by Euclid Chemical Corp.
 - b. MB-VR MB-AE 90, or Micro-Air, by BASF
 - c. Daravair or Darex Series, by W.R. Grace
 - d. Equivalent approved products
- K. Liquid Membrane Curing and Sealing Compound: ASTM C1315, Type I, Class A or B, 25% minimum solids content, clear non-yellowing with no styrene-butadiene. Specifications for Liquid Membrane-Forming Compounds for Curing Concrete, AASHTO M-148, Type 2 shall also apply if more stringent.
 - 1. Water Based, VOC less than 350 g/l:
 - a. Super Aqua Cure, by Euclid Chemical Corp.
 - b. Kure 1315 by BASF
 - 2. Solvent Based:
 - a. Super Rez-Seal, by Euclid Chemical Corp.
 - b. Kure-N-Seal 30 by BASF
- L. Polyethylene Sheeting: Polyethylene sheeting for curing concrete shall conform to the requirements for white opaque polyethylene film of the Specification for Sheet Materials for Curing Concrete, AASHTO M-171.

2.2 CONCRETE MIXING

- A. Mix concrete and deliver in accordance with ASTM C94. Design mix shall produce normal weight concrete consisting of Portland cement, supplementary cementitious materials, aggregates, admixtures and water to produce the following:
 - 1. Compressive Strength: 3,500 psi minimum at 28 days unless otherwise indicated on the Drawings.
 - 2. Slump Range: 2 to 4 inches for hand placed concrete, 1¼ to 3 inches for machine placed (slip-form) concrete.
- B. Supplementary Cementitious Materials (SCM):
 - 1. Concrete mix shall contain SCM at the amounts specified unless other amounts are approved by the Owner's Civil Engineer. Either fly ash or ground granulated blast furnace slag (GGBFS) may be used for the SCM, but shall not be used together to form a ternary mix. Use of fly ash or GGBFS in the concrete mix is mandatory.
 - 2. Fly Ash:
 - a. Substitute fly ash for Portland cement at 15 percent (15%) of the total cementitious content. ASTM C618, Class C.
 - b. Use only one (1) type and source throughout project.
 - 3. Ground Granulated Blast Furnace Slag (GGBFS): Substitute GGBFS for Portland cement at 20% of the total cementitious content.
 - a. If required to mitigate potential sulfate exposure or aggregate reactivity, up to 50 percent (50%) substitution of Portland cement is allowed.
 - b. ASTM C989, Grade 100 or 120. Use only one (1) type and source throughout project.
 - 4. Maintain air-entrainment at specified levels.
- C. Calcium chloride:
 - 1. Not allowed.

PART 3 EXECUTION

3.1 PREPARATION

- A. Begin paving work only after unsuitable areas have been corrected and are ready to receive paving.

- B. Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

3.2 INSTALLATION

- A. Form Construction:
 - 1. Set forms to required grades and lines, rigidly braced and secured.
 - 2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place minimum of 24 hours after concrete placement.
 - 3. Check completed formwork for grade and alignment to following tolerances:
 - a. Top of forms not more than 1/8 inch in 10'-0".
 - b. Vertical face on longitudinal axis, not more than 1/4 inch in 10'-0".
 - 4. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.
- B. Reinforcement: Fasten reinforcing bars or welded wire fabric (if required) accurately and securely in place with suitable supports and ties. Remove from reinforcement all dirt, oil, loose mill scale, rust, and other substances that will prevent proper bonding of the concrete to the reinforcement.
- C. Concrete Placement:
 - 1. Concrete shall be mixed and placed when the air temperature in the shade and away from artificial heat is a minimum of 35 degrees F (35°F) and rising.
 - 2. Hot and cold weather concreting shall be in accordance with ACI 305R (hot weather) and 306.1 and 306R (cold weather). Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until set at required finish elevation and alignment.
 - 3. Place concrete using methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
 - 4. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place construction joint. Automatic machine may be used for curb and gutter placement. Machine placement shall be at required cross section, line, grade, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified herein.
- D. Joint Construction:
 - 1. Contraction Joints: Construct concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, in uniform sections of length specified on Construction Drawings. Form joints between sections either by steel templates, 1/8 inch in thickness, of length equal to width of curb and gutter, and with depth which will penetrate at least 2 inches below surface of curb and gutter; or with 3/4-inch thick performed expansion joint filler cut to exact cross section of curb and gutter; or by sawing to depth of at least 2 inches while concrete is between 4 and 24 hours old. If steel templates are used, they shall be left in place until concrete has set enough to hold its shape, but shall be removed while forms are still in place.
 - 2. Longitudinal Construction Joints: Tie concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, to concrete pavement with 1/2-inch round deformed reinforcement bars of length and spacing shown on Construction Drawings.
 - 3. Transverse Expansion Joints: Concrete curb, combination concrete curb and gutter, or concrete sidewalk shall have filler cut to exact cross section of curb, gutter, or sidewalk. Joints shall be similar to type of expansion joint used in adjacent pavement. Expansion joints to be located at high points, utility structures, curb returns, cold joints, or 60-foot maximum spacing.
- E. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2 inch or more than 1 inch below finished surface where joint sealer is indicated. Furnish joint fillers in one piece lengths for full width being placed, wherever possible. Where more than one length is required, lace, or clip joint filler sections together.
- F. Joint Sealants: Install in accordance with manufacturer's recommendations.

3.3 CONCRETE FINISHING

- A. After striking off and consolidating concrete, smooth surface by screeding and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10'-0" straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.

- B. Work edges of sidewalks, gutters, back top edge of curb, and formed joints with edging tool, rounding edge to 1/2-inch radius. Eliminate tool marks on concrete surface. After completion of floating and trowelling, when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:
 - 1. Curbs, gutters, and sidewalks: Broom finish by drawing fine-hair broom across surface perpendicular to flow of traffic. Repeat operation as necessary to produce fine line texture.
- C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up minor honeycombed areas. Remove and replace areas or sections with major defects as directed by Developer.
- D. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable work as directed by Developer.

3.4 NIGHT CONCRETING

- A. Concreting operations shall be discontinued due to insufficient natural light, unless an adequate and approved artificial lighting system is provided and operated.

3.5 CURING AND PROTECTION

- A. Protect and cure finished concrete paving using curing compound or with acceptable moist-curing methods in accordance with "water-curing" section of ACI 308. Cure for a period not less than seven days.
- B. Use solvent based curing compound when compound is applied below 40 degrees F (40°F).

3.6 BACKFILL

- A. After concrete has set sufficiently, spaces on either side of concrete curb, combination concrete curb and gutter, or concrete sidewalk shall be refilled to required elevation with suitable material compacted in accordance with WisDOT Standard Specifications Section 02300.

3.7 CLEANING AND PROTECTION

- A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

3.8 FIELD QUALITY CONTROL

- A. Field quality control shall be the responsibility of the Owner's Construction Representative in accordance with Section 01 00 00 and this section. Other field quality control testing and inspection shall be at the discretion of the Contractor as necessary to assure compliance with Contract requirements.

END OF SECTION

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**SECTION 32 17 23
PAVEMENT MARKINGS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Traffic line paint and thermoplastic material for traffic striping and marking.
- B. Application of traffic striping and control markings.

1.2 RELATED SECTIONS

- A. Asphalt pavement is specified in Section 32 12 16.13 - Plant-Mix Asphalt
- B. Concrete curbs, gutters, and walks are specified in Section 32 16 00 - Concrete Curb and Sidewalks.

1.3 REFERENCES

- A. Where reference is made to the "State Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- B. Where reference is made to the "Geotechnical Report", it shall be construed to mean the geotechnical report in Section 02 32 00.
- C. All construction of public facilities and/or work within public lands or rights-of-way shall conform to the requirements and conditions of the City of Stoughton's Construction Standards

1.4 SUBMITTALS

- A. General: Refer to Section 01 00 00 - General Requirements for submittal requirements and procedures.
- B. Shop Drawings: Submit Drawings and diagrams, indicating stripe width of roadway divider stripes and parking stalls, configuration and dimensions of directional arrows, style and size of letters for "compact car" designation, configuration and dimensions of international handicapped symbol, and any other traffic control markings on pavement, such as "in" and "out" or "enter" and "exit" designations as indicated.
- C. Material Certificates, signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing Manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by Manufacturer. Protect stored materials from direct sunlight.

1.6. PROJECT CONDITIONS

- A. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 degrees F (40°F) for oil-based materials, 50 degrees F (50°F) for water-based materials, and not exceeding 95 degrees F (95°F). Paint color shall be as indicated on the Drawings or Directed by the Owner's Construction Representative.

PART 2 PRODUCTS

2.1 PAVEMENT MARKING MATERIALS

- A. Type S or Type N traffic paint in accordance with AASHTO Designation M248. Regular set drying time.
- B. Waterborne Paint: Paints shall conform to FS TT-P-1952.
- C. Solvent Borne Paint: Paint shall conform to FS A-A-2886 or AASHTO M248. Paint shall be non-bleeding, quick drying, and alkyd petroleum base paint suitable for traffic bearing surface and be mixed in accordance with manufacturer's instructions before application for colors White, Yellow, Blue, and Red.

- D. Epoxy marking from the WisDOT approved products list and in accordance with Section 646.2.4.
- E. Glass Beads: AASHTO M 247, Type 1 or FS TT-B-1325, Type 1, Gradation A.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from pavement surfaces. Refer to manufacturer's recommendations for all other surface preparation procedures.

3.2 PAVEMENT MARKING APPLICATION

- A. Pavement markings shall be placed at locations and to dimensions shown on Drawings.
- B. Applied lines shall have a uniform cross section.
- C. Lines shall have sharp cut-off defined edges on both side and ends.
- D. Pavement markings applied to new asphaltic pavement surfaces shall be applied to surface course within seven (7) days of placement and meeting the temperature thresholds per "Protect Conditions" section.
- E. Pavement markings applied to new concrete surfaces shall be applied prior to allowance of any traffic on surface.
- F. Agitate paint for 5-10 minutes prior to application to ensure even distribution of paint pigment.
- G. Paint shall be applied in accordance with manufacturer's recommendations and apply two coats of same color of paint as specified without addition of thinner, with maximum of 100 square feet per gallon or as required to provide a minimum wet film thickness of 15 mils and dry film thickness of 7½ mils per coat.
- H. Dispense paint at ambient degrees Fahrenheit to wet-film thickness of 15 mils.
- I. Apply markings to indicated dimensions at indicated locations.
- J. Prevent splattering and over spray when applying markings.
- K. Apply glass beads at pedestrian crosswalk striping and at lane striping and arrows at driveways connecting to public streets. Broadcast glass beads uniformly into wet markings at a rate of 6 lbs./gal.
- L. Unless material is track free at end of paint application convoy, use traffic cones to protect markings from traffic until track free. When vehicle crosses a marking and tracks it or when splattering or over spray occurs, eradicate affected marking and resultant tracking and apply new markings.
- M. Collect and legally dispose of residues from painting operations.
- N. Accessible parking stalls shall include the International Symbol for Accessibility.
- O. At completion, the Contractor shall check the work thoroughly and shall touchup traffic control markings and parking stalls that are not distinct or thorough in coverage, or are not uniform in color.

3.3 PAVEMENT MARKING APPLICATION – EPOXY PAVEMENT MARKING ITEMS

- A. Application shall be in accordance with Section 646.3 of the State Specifications for the pavement marking type, and location as noted in the construction documents.

END OF SECTION

SECTION 32 31 00
ORNAMENTAL CANTILEVER GATE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Ornamental Cantilever Gate

1.2 RELATED REQUIREMENTS

- A. Section 01 05 00 - Earthwork
- B. Section 03 30 00 - Cast-in-Place Concrete: Concrete base and foundation construction

1.3 SYSTEM DESCRIPTION

- A. The manufacturer shall supply a total industrial ornamental cantilever gate system of the Ameristar® TransPort II® Classic design or approved equal. The system shall include all components (i.e., tracks, uprights, bracing, pickets, hardware, fittings, and fasteners) required.
- B. Automatic opening of gate to be coordinated with the opening of garage door(s) per Section 08 33 23 – Overhead Coiling Doors.

1.4 QUALITY ASSURANCE

- A. The contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

1.5 REFERENCES STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
- C. ASTM B221 – Aluminum and Aluminum Alloy Extruded Bars, Shapes and Tubes
- D. ASTM D523 - Test Method for Specular Gloss.
- E. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.
- F. ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
- G. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
- H. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
- I. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
- J. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.

1.6 SUBMITTALS

- A. See Section 01 00 00 - General Requirements, for submittal procedures.
- B. The manufacturer's submittal package shall be provided prior to installation.

1.7 PRODUCT HANDLING AND STORAGE

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Upon receipt at the job site, all materials shall be checked to ensure that no damages occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. All industrial ornamental cantilever gates shall conform to the Ameristar® TransPort II® gate system, Classic design, manufactured by Ameristar Perimeter Security USA Inc., in Tulsa, Oklahoma. The project gate schedule shall include the following additional information for the cantilever gate included in the project scope: 20' opening, 6' height, right gate travel direction.
- B. Or approved equal.

2.2 MATERIAL

- A. The materials used for cantilever gate framing (uprights & diagonal bracing) shall be manufactured from ASTM B221 aluminum (designation 6063-T-6) with yield strength of 25,000 PSI, a tensile strength of 30,000 PSI and a standard mill finish. The TransPort™ enclosed tracks shall be manufactured from ASTM B221 aluminum (designation 6063-T-6) with a yield strength of 25,000 PSI, a tensile strength of 30,000 PSI and a standard mill finish.
- B. Material for pickets shall be 1" square x 1/8" wall aluminum pickets on gate systems greater than 24-foot openings, gate systems less than 24-foot openings shall have 1-inch square x 16 gauge steel pickets. Picket on center spacing shall not exceed 5". Pickets shall be securely fastened to face of top and bottom enclosed track extrusions.
- C. Material for gate uprights and diagonal bracing shall be 2-inch square x 1/4-inch wall aluminum. The cross-sectional shape of the enclosed-track shall conform to the manufacturers Fast-Trak™ design with as a single extrusion consisting of a 2" x 5" channeled support with integrated 2" x 2" enclosed-track raceway. Gates with less than 24-foot openings shall be constructed as a single track system, gates greater than 24-foot openings shall be constructed as a dual track system.
- D. Steel material for fence posts and pickets shall be galvanized prior to forming in accordance with the requirements of ASTM A653/A653M, with minimum yield strength of 45,000 psi (310 MPa). The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 oz/ft² (276 g/m²), Coating Designation G-90. Material for gate support posts shall be 4-inch square x 11 Ga. tubing.
- E. Suspension Rollers for enclosed tracks shall be used at each support post to track connection. Each truck assembly shall be capable of being adjusted vertically via threaded rod for fine-tune adjustment. Truck assembly shall be constructed in a way so that the primary housing for the truck rollers shall pivot via ball-bearing connection to threaded rod.

2.3 FABRICATION

- A. Gate frame uprights and diagonal bracing shall be pre-fabricated and pre-punched to accept frame fasteners. Enclosed track shall be pre-punched to accept gate uprights. Pickets shall be pre-cut to specified length and pre-drilled to accept picket to track fasteners. Posts shall be pre-cut to specified lengths.
- B. Top and bottom enclosed track extrusions shall be mechanically fastened to vertical gate uprights and intermediate supports, as required by assembly instructions. Diagonal bracing shall be mechanically fastened to vertical gate uprights and intermediate supports, as required by assembly instructions. Pickets shall be mechanically fastened to top and bottom enclosed track, as required by assembly instructions.
- C. The manufactured gate components shall be subjected to the Ameristar thermal stratification coating process (high-temperature, in-line, multi-stage, and multi-layer) including, as a minimum, a six-stage pretreatment/wash and an electrostatic spray application of a polyester finish. The topcoat shall be a "no-mar" TGIC polyester powder coat finish with a minimum thickness of 2 mils (0.0508mm). The color shall be Bronze. The stratification-coated framework shall be capable of meeting the performance requirements for each quality characteristic shown in Table 1.

PART 3 EXECUTION

3.1 PREPARATION

- A. All new installation shall be laid out by the contractor in accordance with the construction plans.

3.2 GATE INSTALLATION

- A. Cantilever support posts shall be set in concrete footers having a minimum depth of 48" (Note: In some cases, local restrictions of freezing weather conditions may require a greater depth). The "Earthwork" and "Concrete" sections of this specification shall govern material requirements for the concrete footer. Posts setting by other methods such as

plated posts or grouted core-drilled footers are permissible only if shown by engineering analysis to be sufficient in strength for the intended application.

- B. Gate to be installed per manufacturers gate installation instructions. Gate shall be installed in compliance with ASTM F2200 standards.
- C. Coordinate opening signal between gate and garage door to actuate opening process for each system from a single signal.

3.3 GATE INSTALLATION MAINTENANCE

- A. When cutting/drilling posts adhere to the following steps to seal the exposed steel surfaces; (1) Remove all metal shavings from cut area. (2) Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry. (3) Apply 2 coats of custom finish paint matching fence color. Failure to seal exposed surfaces per steps 1-3 above will negate warranty. Ameristar spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of non-Ameristar parts or components will negate the manufactures' warranty.

3.4 GATE INSTALLATION

- A. Gate posts shall be spaced according to the manufacturers' drawings, dependent on clear opening. The manufacturers' gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacture of the gate and shall be installed per manufacturer's recommendations.

3.5 CLEANING

- A. The Contractor shall clean the jobsite of excess materials; post-hole excavations shall be scattered uniformly away from posts.

Table 1 - Coating Performance Requirements		
<u>Quality Characteristics</u>	<u>ASTM Test Method</u>	<u>Performance Requirements</u>
Adhesion	D3359 - Method B	Adhesion (Retention of Coating) over 90% of test area (Tape and knife test).
Corrosion Resistance	B117, D714 & D1654	Corrosion Resistance over 1,000 hours (Scribed per D1654; failure mode is accumulation of 1/8" coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inch lb. (Forward impact using 0.625" ball).
Weathering Resistance	D822 D2244, D523 (60° Method)	Weathering Resistance over 1,000 hours (Failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

END OF SECTION

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SECTION 32 31 19
STEEL ORNAMENTAL FENCE SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Welded ornamental steel fence system

1.2 RELATED REQUIREMENTS

- A. Section 01 05 00 - Earthwork
- B. Section 03 30 00 - Cast-In-Place Concrete

1.3 SYSTEM DESCRIPTION

- A. The manufacturer shall supply a total fence system of Montage Plus* standard picket space ***Welded and Rackable*** (ATF - All Terrain Flexibility) Ornamental Steel Classic design or approved equal. The system shall include all components (i.e., panels, posts, gates, and hardware) required.

1.4 QUALITY ASSURANCE

- A. The contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

1.5 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
- C. ASTM D523 - Test Method for Specular Gloss
- D. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.
- E. ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
- F. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
- G. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
- H. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
- I. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.
- J. ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.

1.6 SUBMITTALS

- A. See Section 01 00 00 - General Requirements, for submittal procedures.
- B. The manufacturer's literature shall be submitted prior to installation.

1.7 PRODUCT HANDLING AND STORAGE

- A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

1.8 PRODUCT WARRANTY

- A. All structural fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.
- B. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufacturer's warranty shall be guaranteed for five (5) years from date of original purchase.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. The fence system shall conform to Montage Plus* standard picket space ***Welded and Rackable*** (ATF – All Terrain Flexibility) Ornamental Steel, standard picket space, Classic design, extended picket bottom rail treatment, 2-Rail style manufactured by Ameristar Fence Products, Inc. in Tulsa, Oklahoma, or approved equal.

2.2 MATERIAL

- A. Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 psi (310 MPa) and a minimum zinc (hot-dip galvanized) coating weight of 0.60 oz/ft², Coating Designation G-60.
- B. Material for pickets shall be 3/4 inch square x 18 Ga. tubing. The rails shall be steel channel, 1.5" x 1.4375" x 14 Ga. Picket holes in the rail shall be spaced 4.675-inch o.c. Fence posts and gate posts shall meet the minimum size requirements of Table 1.

2.3 FABRICATION

- A. Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.
- B. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by Ameristar's proprietary fusion welding process, thus completing the rigid panel assembly (Note: The process produces a virtually seamless, spatter-free good-neighbor appearance, equally attractive from either side of the panel).
- C. The manufactured panels and posts shall be subjected to an inline electrode position coating (E-Coat) process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils (0.058 mm). The color shall be Bronze. The coated panels and posts shall be capable of meeting the performance requirements for each quality characteristic shown in Table 2 (Note: The requirements in Table 2 meet or exceed the coating performance criteria of ASTM F2408).
- D. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for Commercial weight fences under ASTM F2408.

PART 3 EXECUTION

3.1 PREPARATION

- A. All new installation shall be laid out by the contractor in accordance with the construction plans.

3.2 INSTALLATION

- A. Fence post shall be spaced according to Table 3, plus or minus (\pm) 1/4 inch. For installations that must be raked to follow sloping grades, the post spacing dimension must be measured along the grade. Fence panels shall be attached to posts with brackets supplied by the manufacturer. Posts shall be set in concrete footers having a minimum depth of 36 inches (Note: In some cases, local restrictions of freezing weather conditions may require a greater depth). The "Earthwork" and "Concrete" sections of this specification shall govern material requirements for the concrete footer. Posts setting by other methods such as plated posts or grouted core-drilled footers are permissible only if shown by engineering analysis to be sufficient in strength for the intended application.

3.3 FENCE INSTALLATION MAINTENANCE

- A. When cutting/drilling rails or posts, adhere to the following steps to seal the exposed steel surfaces:
 - 1. Remove all metal shavings from cut area.
 - 2. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry.
 - 3. Apply two coats of custom finish paint matching fence color. Failure to seal exposed surfaces per steps 1-3 above will negate warranty. Ameristar spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of non-Ameristar parts or components will negate the manufactures' warranty.

3.4 CLEANING

- A. The Contractor shall clean the jobsite of excess materials; post-hole excavations shall be scattered uniformly away from posts.

Table 1 – Minimum Sizes for Montage Plus Posts	
Fence Posts	Panel Height
2½" x 16 gauge.	Up to and including 6-foot height

Table 2 – Coating Performance Requirements		
Quality Characteristics	ASTM Test Method	Performance Requirements
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90% of test area (tape and knife test).
Corrosion Resistance	B117, D714, and D1654	Corrosion Resistance over 1,500 hours (scribed per D1654; failure mode is accumulation of 1/8" coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inch lb. (forward impact using 0.625" ball).
Weathering Resistance	D822, D2244, D523 (60° Method)	Weathering Resistance over 1,000 hours (failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

Table 3 – Montage Plus – Post Spacing by Bracket Type						
Span	For CLASSIC, GENESIS, MAJESTIC, AND WARRIOR 8-Foot Nominal (91.95-Inch Rail)					
	2½"	2½"	2½"	3"	2½"	3"
Post Size	2½"	2½"	2½"	3"	2½"	3"
Bracket Type	Montage Plus Universal (BB112)	Montage Plus Line Blvd. (BB114)	Montage Plus Flat Mount (BB111)		Montage Plus Swivel (BB113)*	
Post Settings ± 1/4" O.C.	95"	95"	95"	95½"	*95"	*95½"
*Note: When using BB113 swivel brackets on either or both ends of a panel installation, care must be taken to ensure the spacing between post and adjoining pickets meets applicable codes. This will require trimming one or both ends of the panel.						

END OF SECTION

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SECTION 32 32 23
SEGMENTAL RETAINING WALL

PART 1 GENERAL

1.1 SUMMARY

- A. The work covered by this section includes the furnishing of all labor, materials, equipment, inspection and construction of a modular concrete Segmental Retaining Wall ("SRW") including drainage system and geosynthetic reinforcement. The work included in this section consists of, but is not limited, to the following:
 - 1. Excavation and foundation soil preparation.
 - 4. Furnish and placement of the Leveling Base.
 - 5. Furnish and placement of the Drainage system.
 - 6. Furnish and placement of Geotextile Filter.
 - 7. Furnish and placement of SRW units.
 - 8. Furnish and placement of Geosynthetic Reinforcement.
 - 9. Furnish, placement, and compaction of Backfill and Drainage Aggregates
 - 10. Furnish final grading.

1.2 REFERENCES

- A. ASTM International, latest edition:
 - 1. Segmental Retaining Wall Units:
 - a. C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
 - b. C1372, Standard Specification for Dry-Cast Segmental Retaining Wall Units
 - 2. Geotextile Filter:
 - a. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity
 - b. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile
 - 3. Soils:
 - a. D422, Standard Test Method for Particle-Size Analysis of Soils
 - b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
 - c. D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
 - d. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
 - e. G51, Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing
 - 4. Drainage Pipe:
 - a. D3034, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe
 - b. F667, Standard Specification for 3 through 24-inch Corrugated Polyethylene (PE) Pipe and Fittings

1.3 SUBMITTALS

- A. Segmental Retaining Wall:
 - 1. Samples for verification: Three representative full-size samples of SRW. Thickness, color, and finish that indicate the range of color variation and texture expected upon project completion.
 - 2. Accepted samples become the standard of acceptance for the product produced.
 - 3. Test results from an independent testing laboratory for compliance of concrete pavers with ASTM C1372.
 - 4. Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.
- B. Leveling Base
 - 1. Test results from an independent testing laboratory for sieve analysis per ASTM C136.
- C. Backfill Aggregate:
 - 1. Test results from an independent testing laboratory for sieve analysis per ASTM C136.
- D. Drainage Aggregate Fill:
 - 1. Test results from an independent testing laboratory for sieve analysis per ASTM C136.
- E. Geotextile Fabric
 - 1. Provide product data sheets.
 - 2. Provide three representative samples 6" x 6".

- F. Geogrid:
 1. Provide product data sheets.
 2. Provide three representative samples 8" x 12".
- G. Underdrainage Pipe:
 1. Provide product data sheets indicating conformance.
 - a. HDPE: ASTM F667
 - b. PVC: ASTM D3034
- H. Paving Installation Contractor:
 1. Job references from a minimum of three projects similar in size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.
 2. Furnish sealed construction documents with detailed structural design calculations.

1.4 QUALITY ASSURANCE

- A. Utilize a Manufacturer having at least ten years of experience manufacturing concrete SRW on projects of similar nature or project size.
- B. Source Limitations:
 1. Obtain SRW from one source location with the resources to provide products of consistent quality in appearance and physical properties.
 2. Obtain Drainage Aggregate and Backfill Aggregate from one source.
- C. SRW Contractor Qualifications:
 1. Utilize an installer having successfully completed SRW installation similar in design, material, and extent indicated on this project.
 2. Utilize an installer that can ensure the SRW is constructed in accordance with the Construction Documents and be qualified in the construction of SRWs, knowledgeable of acceptable methods of construction, and have thoroughly reviewed and understood the Construction Documents.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Conditions of the Contract and Division 1 Product Requirement Section.
- B. Deliver SRW in manufacturer's original, unopened and undamaged container packaging with identification labels intact.
 1. Coordinate delivery and SRW schedule to minimize interference with normal use of streets and sidewalks adjacent to paver installation.
 2. Deliver SRW to the site in steel banded, plastic banded or plastic wrapped packaging capable of transfer by forklift or clamp lift.
 3. Unload SRW at job site in such a manner that no damage occurs to the product or adjacent surfaces.
 4. Store and handle all materials in accordance with manufacturer's recommendations and in a manner to prevent deterioration or damage due to moisture, temperature changes, contaminants, handling, or other causes.
 5. Protect materials free from mud, dirt and other foreign materials.

PART 2 PRODUCTS

2.1 SEGMENTAL RETAINING WALL ("SRW") AND COPING

- A. Basis-of-Design Product: SRW modular, solid, dry-cast concrete blocks based on:
 1. Unilock:
 - a. Pisa 2 XL
 2. As manufactured by:
 - Unilock
 - W4814 County Road A
 - Elkhorn, WI 53121
 - Contact: Phill Glazebrook
 3. The specified products establish minimum requirements that substitutions must meet to be considered acceptable.
 - a. To obtain acceptance of unspecified products, submit written requests at least 7 days before the Bid Date.
 4. Substitutions: Approved equal.

- B. Product requirements:
 - 1. SRW: Pisa 2 XL
 - a. Color: Granite
- C. Provide SRW meeting the requirements set forth in ASTM C1372.
- D. Provide SRW meeting the physical properties listed below as tested using ASTM C140:
 - 1. Dimensional tolerance shall be $\pm 1/8$ inch (3 mm) for height, width, and length.
 - 2. The minimum 28-day compressive strength of 5,000 psi (35 MPa).
 - 3. The maximum moisture absorption shall be 6.5 pounds/cubic foot (1.0 kN/cubic m).
- E. Provide SRW utilizing an integral shear key connection with offset to create:
 - 1. Battered wall.
 - 2. Near vertical wall.
- F. Accept only pigments in concrete pavers conforming to ASTM C979.
Note: ACI Report No. 212.3R provides guidance on the use of pigments.

2.2 LEVELING BASE

- A. Provide non-frost susceptible, well-graded, compacted angular gravel-sand mixture (GW as per ASTM D2487) Leveling Base conforming to ASTM D2940 and gradation requirements as presented in Table 1.

**TABLE 1
BASE AGGREGATE - GRADATION REQUIREMENTS**

ASTM D2940	
Sieve Size	Percent Passing
2 in. (50 mm)	100
1-1/2 in. (37.5 mm)	95 to 100
3/4 in. (19 mm)	70 to 92
3/8 in. (9.5 mm)	50 to 70
No. 4 (4.75 mm)	35 to 55
No. 30 (600 μ m)	12 to 25
No. 200 (75 μ m)	0 to 8*

* In order to prevent damage by frost heaving, it may be necessary to limit the percentages of material passing the No. 200 sieve to less than shown in the tables.

2.3 BACKFILL AGGREGATE

- A. Provide Base Aggregate materials conforming to ASTM D2940 and gradation requirements as presented in Table 2.

**TABLE 2
BACKFILL AGGREGATE - GRADATION REQUIREMENTS**

ASTM D2940	
Sieve Size	Percent Passing
2 in. (50 mm)	100
1-1/2 in. (37.5 mm)	95 to 100
3/4 in. (19 mm)	70 to 92
3/8 in. (9.5 mm)	50 to 70
No. 4 (4.75 mm)	35 to 55
No. 30 (600 μ m)	12 to 25
No. 200 (75 μ m)	0 to 8*

* In order to prevent damage by frost heaving, it may be necessary to limit the percentages of material passing the No. 200 sieve to less than shown in the tables.

2.4 DRAINAGE AGGREGATE FILL

- A. Provide Drainage Aggregate materials conforming to ASTM C33 and gradation requirements of ASTM D448 No. 8 as presented in Table 3.

**TABLE 3
DRAINAGE AGGREGATE - GRADATION REQUIREMENTS**

ASTM No. 8	
Sieve Size	Percent Passing
½ in (12.5 mm)	100
3/8 in (9.5 mm)	85 to 100
No. 4 (4.75 mm)	10 to 30
No. 8 (2.36 mm)	0 to 10
No. 16 (1.18 mm)	0 to 5

2.5 UNDERDRAINAGE PIPE

- A. Provide a minimum 4-inch (100 mm) Underdrainage Pipe using:
 - 1. Perforated corrugated high density polyethylene (HDPE) meeting ASTM F667.
 - 2. Perforated polyvinyl chloride (PVC) pipe meeting ASTM D3034.
- B. Protect with Geotextile Filter to prevent the migration of soil particles into the Underdrainage Pipe.

2.6 GEOTEXTILE FILTER

- A. Provide Geotextile material conforming to the following performance characteristics, measured per the test methods referenced:
 - 1. 4 oz., nonwoven needle punched geotextile composed of 100% polypropylene staple fibers that are inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.
 - 2. Grab Tensile Strength: ASTM D4632: 115 lbs.
 - 3. Grab Tensile Elongation: ASTM D4632: 50%
 - 4. Trapezoidal Tear: ASTM D4533: 50 lbs.
 - 5. Puncture: ASTM D4833: 65 lbs.
 - 6. Apparent Opening Size: ASTM D4751: 0.212 mm, 70 U.S. Sieve
 - 7. Permittivity: ASTM D4491: 2.0 sec⁻¹
 - 8. Flow Rate: ASTM D4491: 140 gal/min/sq. ft.

2.7 GEOSYNTHETIC REINFORCEMENT

- A. Provide Geosynthetic Reinforcement as supplied by Unilock, W4814 County Road A, Elkhorn, WI 53121, Contact: Phill Glazebrook.
 - 1. Stratagrid 200
 - 2. Substitutions: Approved equal

2.8 CONCRETE ADHESIVE

- A. Provide a Concrete Adhesive manufactured by the following:
 - 1. LePage:
 - a. Product Type: PL Premium Polyurethane construction adhesive
 - b. LePage PL 9000 Heavy Duty construction adhesive
 - 2. Alliance:
 - a. Product Type: Gator Glue XP Polyurethane construction adhesive
 - 3. Unilock Concrete Adhesive.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas indicated to receive SRW for compliance with requirements for installation tolerances and other conditions affecting performance for the following items:
 - 1. Verify that subgrade preparation, compacted density and elevations conform to specified requirements.
 - 2. Verify all site services are located outside of SRW construction area unless otherwise noted.
 - 3. Verify the SRW structure or excavation limits are within property boundaries and do not cross into adjacent properties unless approved prior to construction.
 - 4. Verify the SRW drainage system delivers outflow to approved location.
 - 5. Verify the SRW and associated excavation remains outside of the loading influence of other adjacent structures and ensure stability of excavations and conformance with applicable regulations.

- B. Geotechnical Inspection:
 1. Verify soil parameters and groundwater conditions are acceptable for SRW.
 2. Verify subgrade Bearing Capacity meets or exceeds values required for area to receive SRW.
 3. Identify groundwater conditions and/or other water source prior to SRW installation. Note additional water sources such as seepage from the cut embankment.
 4. Ensure that surface water runoff and/or other sources of water are being controlled during construction and directed away from the SRW to a functioning drain.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
 1. Beginning of bedding sand and paver installation signifies acceptance of base and edge restraints.

3.2 CONSTRUCTION TOLERANCES

- A. Installation of SRW facia shall be within all the following acceptable tolerances:
 1. Vertical Control: ± 1.25 inches over a 10-foot distance
 2. Horizontal Control: Straight lines: ± 1.25 inches over a 10-foot distance
 3. Rotation of the SRW face: Maximum 2.0 degrees from established SRW plan batter or $\pm 10.0\%$ from total established horizontal setback
 4. Bulging: ± 1.25 inches over a 10-foot distance

3.3 CONSTRUCTION

- A. SITE PREPARATION
 1. Comply with all current Federal, Provincial/State, and local regulations for execution of the work, including local building codes and excavation regulations. Provide excavation support as required to maintain stability of the area during excavation and SRW construction and to protect existing structures, utilities, landscape features, property, or improvements.
 2. Prior to grading or excavation of the site, confirm the location of the SRW and all underground features, including utility locations within the area of construction. Ensure surrounding structures are protected from effects of SRW excavation.
 3. Coordinate installation of underground utilities with SRW installation.
 4. Control surface water drainage and prevent inundation of the SRW construction area during the construction process.
 5. Excavate the foundation soil to the required grades.
 6. Proof rolled and examined the foundation soils to ensure that it meets the minimum strength requirements to support the SRW. Repair if unacceptable foundation soil is encountered.
 7. Excavated the native soils to the lines and grades indicated in cut situations. Document and remove from the site.
 8. Prevent excavated soils being reused onsite from contamination or overly saturate the stockpiled fill material.
- B. INSTALLING DRAINAGE SYSTEM
 1. Place the Geotextile Filter against the back of the first SRW Unit, over the prepared foundation soil extending towards the back of the excavation, up the excavation face and eventually over the top of the Drainage Fill to the back of the SRW Units near the top of the wall. Overlap Geotextile minimum of 1 foot (300 mm) and shingle down the face of the excavation in order to prevent the migration of particles.
 2. Provide Drainage Pipe in accordance with the overall drainage plan for the site. Slope Drainage Pipe to ensure gravity flow of water from the Backfill Aggregate. Connect Drainage Pipe at a storm sewer catch basin or daylight along slope at an elevation lower than lowest point of pipe within Backfill Aggregate mass, every 50 feet (15 m) maximum.
 3. Provide additional Drainage Pipe if other sources of water are discovered during excavation or anticipated, other drainage measures/systems such as chimney or blanket drains may be required.
- C. LEVELING BASE OR SPREAD FOOTING PLACEMENT
 1. Spread Leveling Base aggregate in areas indicated for SRW in accordance with horizontal and vertical alignments. .
 2. Compact Leveling Base aggregate to a minimum thickness of 6 inches (150 mm) in maximum lifts not to exceed 4 inches (100 mm) to 98% Standard Proctor Density per ASTM D698.
- D. INSTALLATION OF SEGMENTAL RETAINING WALL UNITS
 1. Place the SRW bottom row in the middle of the Leveling Base. Ensure the SRW Units are aligned properly, leveled from side to side and front to back, and in complete contact with the Leveling Base.
 2. Interconnect the SRW shear key creating the specified batter of the SRW face.

3. Sweep the SRW top clean before placing additional courses to ensure that no dirt, concrete, or other foreign materials become lodged between successive lifts.
 4. Offset SRW units to create a running bond pattern with the edge of all units being approximately aligned with the middle of the unit in the course below it. Place cut SRW half units to ensure the vertical line between adjacent SRW units remains within the middle third of the SRW unit below.
 5. Provide Drainage and Backfill Aggregate once three courses above grade have been placed. Backfill with additional aggregates after a maximum of three courses of SRW units have been placed above the previous Backfill and Drainage Aggregate level.
 6. Verify no gaps are formed between successive lifts affect performance and correct before proceeding with additional lifts.
 7. Ensure SRW Units and Geosynthetic Reinforcement are not damaged during handling and placement.
 8. Prevent heavy equipment, for compaction, fill placement or other, within 3 feet (1 m) from back of the SRW Units.
- E. DRAINAGE FILL
1. Provide Drainage Fill between the back of wall and Backfill Aggregate.
 2. Place a minimum width of 1 foot and separated from other soils using the specified Geotextile Filter.
 3. Place Drainage Fill behind the SRW facing in maximum lifts of 6 inches and compacted to a minimum density of 95% Standard Proctor.
- F. BACKFILL AGGREGATE
1. Provide Backfill Aggregate behind SRW and Drainage Fill with a maximum lift thickness of 6 inches (150 mm) and compacted to a minimum density of 95% Standard Proctor Maximum Dry Density (ASTM D698) at a moisture content from 2% below to 2% above optimum.
 3. Place Backfill Aggregate and compact level with the top of the SRW Units at the specified Geosynthetic Reinforcement elevations to ensure no voids exist under the Geosynthetic Reinforcement as it extends over the Backfill Aggregate.
 4. Ensure that the Geosynthetic Reinforcement lays flat and taut during placement of the Backfill Aggregate. Place the Backfill Aggregate on top of the Geosynthetic Reinforcement near the SRW and spreading away from the SRW.
 5. Slope the last lift of Backfill Aggregate away from the SRW facing to rapidly direct runoff away from the SRW at the end of each day's operation. Prevent surface runoff from adjacent areas to enter the SRW construction area.
- G. GEOSYNTHETIC REINFORCEMENT
1. Verify type and primary strength direction of the Geosynthetic Reinforcement.
 2. Sweep the top of the SRW Units to ensure the SRW Units are clean and free of debris.
 3. Cut Geosynthetic Reinforcement in sheets to the length shown in the Construction Documents.
 4. Place Geosynthetic Reinforcement sheets horizontally with the primary strength direction perpendicular to the SRW face and adjacent sheets without overlapping and without gaps between them.
 5. Ensure each Geosynthetic Reinforcement layer corresponds with the correct elevations.
 6. Place the Geosynthetic Reinforcement over the compacted Backfill Aggregate and the SRW Units with the outside edge extending over the shear key of the SRW Unit to within 1 inch (25 mm) of the front facing unit.
 7. Carefully place subsequent SRW Units on top of the lower course to ensure that no pieces of concrete are chipped off and become lodged between courses. Ensure the Geosynthetic Reinforcement is in complete contact with the top and bottom surfaces of the successive SRW courses.
 8. Pull Geosynthetic Reinforcement taut away from SRW Units during Backfill Aggregate placement. Provide Geosynthetic Reinforcement anchoring pins or staples to ensure that there are no wrinkles or slackness prior to Backfill Aggregate placement. Ensure Geosynthetic Reinforcement lays flat when pulled back perpendicular to the back of the SRW.
 9. Prevent construction equipment from operating directly on top of the Geosynthetic Reinforcement until a minimum thickness of 6 inches (150 mm) of Reinforcement Fill has been placed.
 10. Prevent heavy equipment from within 3 feet (1 meter) of the back of the SRW Units.
- H. RETAINED FILL
1. Provide compacted Retained Fill behind the Backfill Aggregate or Drainage Fill in maximum lift thickness of 6 inches (150 mm).
- I. CONTINUING WALL CONSTRUCTION
1. Repeat section 3.03.D through to 3.04.H until the grades indicated are achieved.

J. SECURE COPING

1. Secure SRW Coping to SRW Units with two 3/8 inch (10 mm) beads of Concrete Adhesive positioned 50mm (2 inches) in front and behind the tongue of the last course of SRW Units.

K. FINISHING SRW

1. Finish grading above SRW to direct surface runoff water away. Grade a swale above the SRW sloping away from back of the wall. Establish final grading immediately to ensure and protect the Backfill Aggregate from water infiltration.
2. Prevent additional structures (fences, handrails, vehicular guardrails, buildings, pools/ponds, etc.) or changes to grading/loading (increased height, slopes, parking areas, changes in proximity to water flow, etc.), other than those shown in the Construction Documents, from being installed.
3. Prevent landscaping activities within the Reinforcement Fill to ensure:
 - a. The Geosynthetic Reinforcement is not damaged by excavation for the root ball
 - b. The SRW is not subjected to any additional load from plants or trees.

3.4 REPAIRING, CLEANING AND SEALING

- A. Remove and replace SRW Coping Units that are chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Cleaning: Remove excess dirt, debris, stains, grit, etc. from exposed SRW Units; wash and scrub clean.
 1. Clean SRW Units in accordance with the manufacturer's written recommendations.

3.5 PROTECTION

- A. Protect completed work from damage due to subsequent construction activity on the site.

END OF SECTION

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SECTION 32 91 19

TOPSOIL-SELECT FILL MATERIALS AND APPLICATION

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section shall consist of providing all topsoil, labor, material and equipment required to complete the work described herein in strict accordance with the drawings and/or terms of the contract.
- B. All work on the public lands and/or public rights of way shall conform to the applicable City of Stoughton Standard Construction Specifications stated below.
- C. All work shall be in accordance with applicable manufacturer's instructions.

1.2 RELATED WORK AND PROVISIONS

- A. Applicable provisions of Division 1 shall govern all work:
 - 1. Section 02 20 00 – General Sitework Requirements
 - 2. Section 31 20 00 – Earthmoving
 - 3. Section 31 25 00 – Erosion Control
 - 4. Section 32 92 19 – Seeding and Sodding

1.3 REFERENCES

- A. Where reference is made to the "Construction Specifications", it shall be construed to mean the pertinent section of the City of Stoughton's Standard Construction Specifications, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- B. Where reference is made to the "Standard Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- C. Where reference is made to the "State Specifications", it shall be construed to mean the pertinent section of the WisDOT Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- D. Where reference is made to the "Geotechnical Report", it shall be construed to mean the geotechnical report in Section 02 32 00.

1.4 QUALITY ASSURANCE

- A. Pre-Work Meeting: Convene a pre-work meeting minimum 30 days prior to commencing work on this Section. Review conditions of operations, procedures and coordination with related work. The pre-work meeting shall be set up as a conference call with the Landscape Architect.
 - 1. Review planting schedule and maintenance.
 - 2. Review required inspections, schedule of topsoil testing, and environmental procedures.
- B. Soil-Testing Laboratory Qualifications:
 - 1. Multi-residue Herbicide/Pesticide Screen: A NELAC (National Environmental Laboratory Accreditation Conference) certified independent soil testing laboratory with the experience and capability to conduct the testing indicated based on local conditions.
 - 2. Topsoil Analysis: Independent soil testing laboratory employing a landscape or soil agronomist familiar with the final use of the material and construction practices for large earthwork sites.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Select fill shall be a loamy sand, sandy loam, clay loam, loam, silt loam, sandy clay loam or other soil approved by the Owner's Construction Representative. It shall not have a mixture of subsoil and shall contain no slag, cinders, stones, lumps of soil, sticks, roots, trash or other extraneous materials larger than 1.5 inches in diameter. Select fill

must also be free of viable plants or plant parts of common Bermuda grass, quack grass, Johnson grass, nutsedge, poison ivy, Canada thistle, or others as may be specified. All select fill shall be tested by a reputable laboratory for pH and soluble salts. If needed, pH correction material shall be applied at a rate sufficient to correct the pH to a range of 6.0 to 7.0. Soluble salts shall not be higher than 500 parts per million.

- B. No turfgrass sod shall be placed on soil which has been chemically treated until sufficient time has elapsed to permit dissipation of all toxic materials. The general contractor shall assume full responsibility for any loss or damage to turfgrass sod arising from improper use of chemicals or due to his failure to allow sufficient time to permit dissipation of toxic residues, whether or not such materials are specified herein.
- C. Topsoil on the existing site may often be used; however, it should meet the same standards as set forth in these specifications.
- D. Refer to Drawings for specifications on Engineered Soils and Sand Storage Layers, as specified by Wisconsin Department of Natural Resources (WDNR).

PART 3 EXECUTION

3.1 GRADING

- A. The select fill shall be uniformly distributed on the designated area(s) and it shall be a minimum of 6 inches deep after firming.
- B. No grading shall be done beyond the limits specified within the Grading and Erosion Control Plan.
- C. Spreading shall be performed in such a manner that sod installation can proceed with a minimum of additional soil preparation and tillage.
- D. Any irregularities in the surface resulting from topsoiling or other operations shall be corrected in order to prevent the formation of depressions or water pockets.
- E. Select fill shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or in a condition that may otherwise be detrimental to proper grading or proposed for seeding.

3.2 CLEAN UP

- A. After the select fill has been spread and the final grade approved, it shall be cleared of all grade stakes, surface trash or other objects that would hinder seeding and other plantings.
- B. Paved areas over which hauling operations are conducted shall be kept clean and any soil which may be brought upon the surfacing shall be promptly removed.
- C. The wheels of all vehicles shall be kept clean to avoid tracking soil on the surfacing of roads, walks or other paved areas.

3.3 ACCEPTANCE

- A. Acceptance will be given by the Owner's Construction Representative, upon satisfactory completion of each section or area(s), as indicated on the drawings or as otherwise specified.

END OF SECTION

SECTION 32 92 00
TREES, SHRUBS, AND OTHER PLANTINGS

PART 1 GENERAL

1.1 SCOPE

- A. These specifications, along with contract drawings and lists of plant materials, apply to those items necessary for and incidental to the preparation, execution, completion and maintenance of the landscape planting activities (excluding lawn areas) specified in the contract. The scope includes the planting of trees, shrubs, perennials, and grasses, and the maintenance activities of fertilizing, pruning and watering.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
- B. Section 02 20 00 – General Sitework Requirements
- C. Section 31 10 00 – Site Clearing
- D. Section 31 13 16 – Tree Protection
- E. Section 31 20 00 – Earthmoving
- F. Section 31 25 00 – Erosion Control
- G. Section 32 91 19 – Topsoil-Select Fill Materials and Application
- H. Section 32 92 19 – Seeding and Sodding

1.3 REFERENCE STANDARDS

- A. *American Standards for Nursery Stock, ANSI Z60.1*, current edition. American Association of Nurserymen, Inc.
- B. *Standardized Plant Names, Second Edition (1942)*. American Joint Committee on Horticulture Nomenclature, Horace McFarland Company, Harrisburg, PA.
- C. *American National Standard for Tree Care Operations - Tree, Shrub and Other Woody Plant Maintenance-Standard Practices, ANSI A300*, current edition.
- D. Where reference is made to the "Geotechnical Report", it shall be construed to mean the geotechnical report in Section 02 32 00.

1.4 QUALITY ASSURANCE

- A. All plant material shall conform to the *American Standards for Nursery Stock*, unless noted otherwise herein.
- B. All plant material shall be true to the species and variety/hybrid/cultivar specified, and nursery-grown in accordance with good horticultural practices, and under climatic conditions similar to those of the site location. Specimens' nursery-dug to be replanted shall have been freshly dug and properly prepared for planting.
- C. Trees and Shrubs:
 - 1. Shall be trained in development and appearance as to be superior in form, compactness and symmetry. Trees with multiple leaders, unless specified otherwise, and shrubs with damaged or cut mainstem(s), will be rejected.
 - 2. With a damaged, cut or crooked leader, abrasion of bark, sunscald, frost crack, disfiguring knots, insects (including eggs and larvae) or insect damage, cankers/cankerosus lesions or fungal mats, mold, prematurely-opened buds, or cuts of limbs over 3/4 inches (1.9 cm) in diameter that are not completely callused will be rejected.
 - 3. Shall have healthy, well-developed root systems, and be free from physical damage or other hindrances to healthy growth.
 - 4. Balled and burlapped plants shall be dug with solid balls of a diameter not less than that recommended by the *American Standards for Nursery Stock*, and of sufficient depth to include both fibrous and feeding roots. Balls shall be securely wrapped with burlap, and tightly bound with rope or twine. No plant shall be bound with rope or wire in such manner as to damage bark or break branches. The root flare should be within the top 2 inches (5.1 cm) of the soil ball. Balled and burlapped plants will not be accepted if the ball is dry, cracked, or broken before or during planting.

5. Containerized plants are to be well-established within the container, with a root system sufficiently developed to retain its shape and hold together when removed from the container. Soil within the container should be held together by the roots, in form and whole. Plants shall not be pot-bound, nor have kinked, circling, or bent roots.
- D. Herbaceous perennials and grasses shall only be supplied from nurseries certified by state plant inspectors.

1.5 MEASUREMENT

- A. Plants shall conform to the measurements specified within the contract documents. Specified height and spread dimensions will refer to the main body of the plant, and not from branch tip to branch tip. Plants meeting a specified measurement, but judged to lack the balance between height and spread characteristic of the species will be rejected.
- B. Plants shall be measured when branches are in their normal position.
- C. No plant shall be less than the minimum size specified, and no less than 50% of the plants shall be as large as the maximum size specified.
- D. Caliper measurements shall be taken 54 inches (1.4 m) above ground level
- E. Containerized shrubs shall be measured by height and width for conformity with the plant list
- F. Herbaceous perennials and grasses shall be measured by pot size, not by top growth
- G. All other measurements, such as number of canes, ball sizes, and quality designations, shall conform to *American Standards for Nursery Stock*.

1.6 SUBSTITUTIONS

- A. The substitution of plant materials is not permitted unless authorized, in writing, by the Owner's Representative. If written proof is submitted by the Contractor that a plant of specified species, variety or size is unavailable, consideration will be given towards the nearest available size or variety, or towards an alternate species selection, with a corresponding adjustment of the contract price.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor is to arrange for the acceptance and unloading of plants at the project site.
- B. All plants are to be labeled by plant name and size. Labels shall be attached securely to all plants, bundles, and containers of plant materials when delivered. Labels shall be durable and legible, with information given in weather-resistant ink or embossed process lettering. The Owner should verify all plant labels, upon approval the plant labels shall be removed by the Contractor.
- C. All plant materials, shipments and deliveries shall comply with current state and federal laws and regulations governing the inspection, shipping, selling and handling of plant stock. If required by law or regulation, a certificate of inspection, or a copy thereof, for injurious insects, plant diseases, and other plant pests shall accompany each shipment or delivery of plant material. The certificate shall bear the name(s) and address(es) of the source of the plant stock.
- D. During transport, no plant shall be bound with rope or wire in a manner that damages trunks or breaks branches. Plants shall also not be dragged, lifted or pulled by the trunk, branches or foliage in a damaging way. No plant shall be thrown off of a truck or loader to the ground.
- E. Prior to installation, all plants must be protected from sun and drying winds.
- F. Containerized or balled and burlapped plants not being installed immediately must be kept in a shaded area, well-covered with wood chips, soil, or other approved material, and kept well-watered. Install all plants within three (3) days of delivery.
- G. Fertilizer shall be delivered to the site in original, sealed containers, and stored in a waterproof space. Containers shall bear the manufacturer's name, analysis, trademark and guarantee as per standards of the Wisconsin Department of Agriculture.
- H. Contractor shall protect all plants, lawns, and grass from damage at all times. Damaged plants, lawns or grass areas shall be replaced or treated as required to conform to specifications herein for fresh stock. Damage incurred as a result of replacement or installation operations shall be repaired by Contractor at no cost to Owner.

1.8 PLANTING SCHEDULE

- A. Plants shall be installed as appropriate for that specific plant species to ensure healthy vigorous growth.
- B. All plants shall be guaranteed to be in healthy and flourishing condition for one full year after installation and acceptance by the Owner.
- C. Plants not thriving shall be replaced at no cost to the Owner. The contractor may suggest substitutions for replacement plants.
- D. Replacement plants shall be guaranteed for one year after installation.
- E. At any time during the guarantee period, the Contractor shall remove or replace, without cost to the Owner and within a specified planting period, all plants not in a healthy and flourish conditions as determined by the Owner.

1.9 MAINTENANCE

- A. The Contractor shall maintain plantings and lawn for at least a period of 60 days, or until final acceptance from the Owner. The Contractor is responsible for adequately watering plants and lawn during this 60 day period.
- B. Fertilizing: Any and all chemical applications are to be performed in accordance with current federal, state and local laws, through EPA-registered materials and application techniques, and performed under the supervision of a licensed certified applicator. Apply fertilizer to planted areas at the specified rate, and as per manufacturer's recommendations.
- C. Watering: All plant materials installed under the contract shall be watered within the first 24 hours of initial planting and not less than twice weekly until final acceptance by the Owner. Water used shall be of sufficient quality for irrigation and free of materials harmful to plant growth.
- D. Pesticide: Any use of pesticides during the contracted maintenance period, as determined by the Owner, shall utilize the minimum amount of approved pesticide needed to control pests on plant materials installed under the contract. Pesticide applications are to be performed in accordance with current federal, state and local laws, through EPA-registered materials and application techniques, and performed under the supervision of a licensed certified applicator. Apply at the specified rate, and as per manufacturer's recommendations.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Plant Materials: A complete list of plant materials, including a schedule of quantities, sizes, and other requirements, shall be included in the contract documents. If discrepancies occur between the printed plant list, and the contract drawings, the printed list will take precedent.
- B. Topsoil: Naturally fertile, agricultural soil, capable of sustaining vigorous growth, of uniform composition throughout, without admixtures of subsoil, free of clay, stones larger than 1 inch (2.5 cm) in diameter, roots, trash and debris of any kind, supplied by Contractor at his/her expense, and subject to approval by the Owner's Construction Representative.
- C. Planting Mixture: Material used in tamping around balls and roots during the planting operation shall be prepared on site by mixing two (2) parts topsoil, one (1) part sand and one (1) part compost. All mixing shall be done by mechanical means subject to the approval of the Owner's Construction Representative.
- D. Fertilizer: Granular, non-burning product composed of not less than 50% organic slow-acting, guaranteed analysis professional fertilizer. Commercial fertilizer shall conform to Wisconsin State Statutes, Section 94.64, and meet the standards of the Wisconsin Department of Agriculture as to registration and labeling. Fertilizer shall be specified in the contract documents as to composition, but is subject to revision to suit project site conditions.
- E. Shredded Hardwood Bark Mulch: Shredded hardwood bark mulch, free of material detrimental to healthy plant growth. Mulch shall be finely shredded, weed free, dye-free mulch
- F. Stone Mulch: All planting areas labeled on plan shall receive Midwest Decorative Stone 1½-inch "American Heritage" stone mulch (or approved equal) spread to a minimum and consistent depth of 3 inches. Stone mulch areas shall receive woven weed barrier fabric.

PART 3 EXECUTION

3.1 INSPECTION

- A. Topsoil: Refer to Topsoil-Select Fill Materials and Application Section specifications.
- B. Verify that prepared soil base is ready to receive the work of this Section.
- C. Beginning of installation means acceptance of existing site conditions.

3.2 PREPARATION OF SUBSOIL

- A. Prepare subsoil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
- B. Remove foreign materials, weeds, and undesirable plants and their roots. Remove any contaminated subsoil. Plants can be removed through application of glyphosphate. Follow manufacturer's instructions for proper use.
- C. Scarify subsoil to a depth of 3 inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

3.3 PLACING TOPSOIL

- A. Refer to Topsoil-Select Fill Materials and Application Section specifications.
- B. Spread any needed amendments per soil test and till soil to a depth of 3 to 4 inches. Ideal seed bed will be a combination of soil particles ranging from approximately a quarter inch to a full inch in size.
- C. Topsoil compaction should be below 250 psi, if topsoil compactions are greater soil should be ripped, disced, or otherwise loosened to a depth of at least 12 inches.

3.4 PREPARATION

- A. Stake all planting areas and notify Diggers Hotline (1-800-242-8511 statewide) to verify location of all underground utilities prior to excavation.
- B. Excavate planting areas as shown in included specifications.
- C. Adequately barricade with proper warning devices any planting pit left open when planting work is not in progress, and that poses a hazard to vehicles and/or pedestrians.
- D. Maintain site housekeeping to provide for a safe and orderly project site. Collect and dispose of debris as they accumulate.
- E. The planting pit for containerized and balled and burlapped plants shall be at least 2.5 to 3 times the diameter of the soil ball, or to a dimension otherwise specified.
- F. The planting pit for a single shrub shall be 12 inches (30.5 cm) wider than the root ball.
- G. Loosen the soil beyond the edge of the planting pit. The soil at the base of the planting pit is to remain undisturbed, the depth of which shall correspond to the distance from the bottom of the soil ball to the root flare, or slightly less.
- H. Fence and/or box in all trees and plant material which are to remain at the drip line before work is started. Do not permit heavy equipment or stockpiles within branch spread. Remove interfering branches without injury to trunks, cover scars with tree paint.
- I. For a shrub mass planting, the entire bed area is to be tilled to a depth of 4 to 6 inches (10.2 to 15.2 cm). Excavate individual shrub pits to the proper depth.

3.5 PLANTING OF TREES AND SHRUBS

- A. Remove plant containers by cutting or carefully inverting the container. For plants grown in plastic containers slash the edges of the root ball from top to bottom with vertical 1-inch (2.5 cm) cuts using a sharp blade.
- B. Root balled plants shall have rope, string, wire baskets, burlap and other wrapping material removed from the top half of the ball after the plant has been set in the hole. Remaining wrappings, other than those made from plastic or synthetic material, may be left around the bottom half of the ball.
- C. Shrubs grown using root containment material shall have the containment bag removed prior to setting.
- D. Set trees and shrubs straight and upright, and in the center of the planting hole and on the unexcavated base of the planting pit, with the most desirable face towards the most prominent view.

- E. Root-balled shrubs are to be carried and set in the hole by the root ball.
- F. Backfilling: Backfill pits with excavated soil. No soil in frozen or muddy condition shall be used for backfilling.
- G. When pit is approximately two-thirds backfilled, tamp down and water to eliminate air pockets. After initial watering, add remainder of the soil to the top of pit, water without puddling, and firmly tamp without overcompacting. Form a 2- to 3-inch (5.1 to 7.6 cm) high saucer around the outer rim of the pit prior to mulching.
- H. All trees shall be installed with 5-foot diameter tree ring with 3-inch mulch layer. Tree rings shall have shovel edging.
- I. All parking islands shall receive a minimum of 18 inches of topsoil.

3.6 PLANTING OF PERENNIALS, FORBS, AND GRASSES

- A. Preparation: Loosen soil of the planting bed to a depth of 4 to 6 inches (10.2 to 15.2 cm) by mechanical or hand tilling while soil is dry. For bulbs, the depth of loosened soil will be determined by the type of bulb planted, and specified in the contract or landscape plan.
- B. After soil is loosened, till organic material into the soil across the planting bed to a uniform depth of 2 inches (5.1 cm) for peat moss or 1 inch (2.5 cm) for compost.
- C. Fertilizer, at amounts determined by the soil test, shall be topdressed to the soil.
- D. Apply approved mulch uniformly across the entire planting bed to a depth of 1 to 2 inches (2.5 to 5.1 cm).
- E. Planting: Space as described in the landscape plan.
- F. Unless otherwise specified, install plants no closer than 12 inches (30.5 cm) to the trunks of trees or shrubs within planting bed, and to within 6 inches (15.2 cm) of the edge of the bed.
- G. Prior to planting, biodegradable plant containers shall be split and non-biodegradable containers removed. The root systems of all such plants shall be split or crumbled by hand.
- H. All parking islands that contain perennials (not including bioinfiltration area) shall have a minimum of 18 inches of topsoil. These areas shall also have 3 inches of mushroom compost spread uniformly over the parking island and tilled into the top 6 inches of the soil.

3.7 FINISHING

- A. Finish-grade planting areas to required elevations after plants have fully settled.
- B. No soil is to cover the top of the root ball. All plants shall be completely mulched over the root system with a 3-inch (7.6 cm) layer of specified mulching material immediately after planting. Pull back mulch no less than 3 inches (7.6 cm) and no more than 6 inches (15.2 cm) from the trunk.
- C. Thoroughly water plants immediately after planting and before mulching, primarily within and filling the saucer.
- D. Prune any dead or broken branches. Prune in accordance with NAA Guidelines conforming to the American Standard for Tree Care Operations. Prune shrubs in accordance with standard horticultural practices. On cuts of 3/4 inches in diameter and bruises or scars on bark, trace the inured cambium layer back to living tissues and remove. Smooth and shape wounds so as not to retain water and coat the treated area within approved antiseptic tree paint.
- E. Remove all twine and rope after planting, along with any labels attached around trunks or branches.

3.8 CLEANING

- A. Dispose of excess soil. Remove all cuttings and waste materials.
- B. Soil, branches, binding and wrapping material, rejected plants, or other debris resulting from plant installation shall be promptly cleaned up and removed. New landscape construction in and around the planting areas are to be especially well-cleaned.
- C. Under no condition shall the accumulation of soil, branches or other debris be allowed upon a public property in such a manner as to result in a public hazard. Likewise, under no circumstances shall any debris or incidental materials be allowed upon adjacent private property.

END OF SECTION

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SECTION 32 92 19
SEEDING AND SODDING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Preparation of subsoil.
- B. Placing topsoil.
- C. Fertilizing.
- D. Seeding.
- E. Seed Protection.
- F. Mulching.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
 - 1. Section 02 20 00 – General Site Work Requirements
 - 2. Section 31 10 00 – Site Clearing
 - 3. Section 31 13 16 – Tree Protection
 - 4. Section 31 20 00 – Earthmoving
 - 5. Section 31 25 00 – Erosion Control
 - 6. Section 32 91 19 – Topsoil-Select Fill Materials and Application

1.3 DEFINITIONS

- A. Weeds: Include (for reference refer to the WIDNR Field Guide to Terrestrial Invasive Plants).
- B. Trees: Black Locust, Common Buckthorn, Tree-of-heaven, Princess Tree, Sawtooth Oak.
- C. Shrubs: Eurasian Bush Honeysuckle (L. x bella, maackii, morrowii, tatarica), Tararian Maple, Glossy Buckthorn, Japanese Barberry, Multiflora Rose, Russian and Autumn Olive (Elaeagnus spp.), Scotch Broom, Wineberry.
- D. Vines: Chinese Yam, Japanese Honeysuckle, Japanese Hops, Kudzu, Oriental Bittersweet, Porcelain Berry, Swallow-worts (Vincetoxicum spp), Mile-a-minute Vine.
- E. Grasses and Forbs: Bird’s-foot Trefoil, Canada Thistle, Celandine, Creeping Bellflower, Crown Vetch, Dame’s Rocket, European Marsh Thistle, Garlic Mustard, Giant Hogweed, Hedgeparsely (Torilis spp), Hemp Nettle, Hill Mustard, Hound’s Tongue, Japanese and Gian Knotweed (Fallopia spp.), Poison Hemlock, Purple Loosestrife, Spotted Knapweed, Leafy and Cypress Spurge, White and Yellow Sweet Clover, Tansy, Common and Cut-leaved Teasel, Bull, Musk, and Plumeless Thistle, Wild Chervil, Wild Parsnip, Yellow Star Thistle, Narrow-leaved and Hybrid Cattail, Japanese Stilt Grass, Phragmites, Reed Canary Grass, Tall Manna Grass, Hairy Willow Herb, Helleborine Orchid, Perennial Pepperweed, Sericea Lespedeza, Lyme Grass, Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Perennial Sorrel, and Brome Grass.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Seed shall be delivered to the site in its original, unopened container, labeled as to weight, analysis, and manufacturer. Seed in damaged packaging is not acceptable. Store any seed delivered prior to use in a manner safe from damage from heat or any other deleterious weather conditions.
- B. Planting Season: The regular seeding season is considered April 1st through June 15th and September 1st through October 15th. If planting outside of regular seeding season, the Contractor is responsible for adequately watering the site to obtain vigorous healthy plant growth.

1.5 REFERENCE SPECIFICATIONS

- A. Where reference is made to the “Construction Specifications”, it shall be construed to mean the pertinent section of the City of Stoughton Standard Construction Specifications, current edition, and all supplemental and interim

supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

- B. Where reference is made to the "Standard Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- C. Where reference is made to the "State Specifications", it shall be construed to mean the pertinent section of the WisDOT Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- D. Where reference is made to the "Geotechnical Report", it shall be construed to mean the geotechnical report in Section 02 32 00.

1.6 GUARANTEE

- A. Guarantee plant material for a period of 12 to 19 months following the Substantial Completion Date in accordance with the Extended Maintenance/Warranty Chart included in Part 3 hereinafter.
 - 1. A limit of one replacement of each plant shall be required, except for losses or replacements due to failure to comply with requirements.
 - 2. Remove from site any plant that is dead or unsatisfactory to the Owner, or Landscape Architect. Replace plants during normal planting season.

1.7 SUBMITTALS

- A. Submittals shall be available at all times to the Owner.
- B. Grower/Nursery Information: Submit name, address, phone number and contact person for each Grower/Nursery 30 days prior to plant material selection meeting.
- C. Materials Test Reports: Submit topsoil borrow area test reports to the Owner minimum six (6) weeks prior to delivery to site.
 - 1. Provide location of topsoil area tested.
 - 2. Provide name of independent soil testing laboratory.
 - 3. Provide date of sampling and testing.
- D. Product Data:
 - 1. Submit certification tags from sod and seed verifying type and purity to the Owner
- E. Closeout Submittals:
 - 1. Submit Meetings and Inspections Log prior to Final Completion of the Project.
 - 2. Certification of Conformance: Provide certificate of satisfactory performance of planting operations signed by the Contractor and Landscape Architect.

1.8 MAINTENANCE

- A. The Contractor shall maintain lawn for at least a period of 30 days, or until final acceptance from the Owner. The Contractor is responsible for adequately watering lawn during this 30-day period. Contractor is responsible for establishing healthy vigorous lawn growth. Long-term maintenance is the responsibility of the Owner.

PART 2 PRODUCTS

2.1 SEED MIXTURE

- A. Grass Seed: All grass seed shall conform to the requirements of Wisconsin State Statutes, Chapter 94 (Seed Law), and the Wisconsin Administrative Code Chapter ATCP 20, regarding noxious weed seed content and labeling. Seed shall not be used later than one (1) year following the test date labeled.
- B. Public Seed Mixture: Use State Specifications Mix 40 in the right-of-way.
- C. Grounds Seed Mixture:
 - 1. Use seed mixtures as specified on Drawings.
 - 2. If no seed mixture specification indicated on drawings, use the following:
 - a. Use State Specification Mix #10 on turf lawn areas.

- b. Use State Specification Mix #20 on slope where low maintenance mixes are specified and Mix #70 on slopes where native mixes are specified.
- c. If a slope mix is not specified, use Mix #20.
- D. Detention Basin Seeding:
 - 1. See drawings for plug plantings or native vegetative mat requirements.
 - 2. Use State Specification Mix #20 on slopes above 3 feet above OWHM.

2.2 SOIL MATERIALS

- A. Topsoil: Refer to Section 32 91 19 - Topsoil-Select Fill Materials and Application.

2.3 SOD

- A. Provide sod species suitable as lawn turf for the region. Sod shall be strongly rooted, weed, disease, pest free, and uniform in thickness.
- B. Sod shall be provided and installed in accordance with the State Specifications.

2.4 ACCESSORIES

- A. Mulching Material:
 - 1. Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable
 - 2. Where necessary to maintain erosion control, seed shall be applied using Method B, Hydroseeding from the State Specifications.
- B. Fertilizer: Standard commercial packaged or bulk product in granular form conforming to the requirements of Dane County and the Wisconsin Statutes and of the Wisconsin Administrative Code Chapter Agriculture 17. Provide fertilizer meeting the following requirements: I don't know about the following, so I am going to delete it.
- C. Water: Clean, fresh, and free of substances or matter which could inhibit vigorous growth of grass.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify that prepared soil base is ready to receive the work of this Section.
- B. Beginning of installation means acceptance of existing site conditions.

3.2 PREPARATION OF SUBSOIL

- A. Prepare subsoil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
- B. No seeding shall occur on frozen ground or at temperatures lower than 32°F (0°C).
- C. Remove foreign materials, weeds, and undesirable plants and their roots. Remove any contaminated subsoil. Plants can be removed through application of glyphosate. Follow manufacturer's instructions for proper use.
- D. Scarify subsoil to a depth of 3 inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
- E. Unsuitable Subsoils: Locations containing unsuitable subsoil shall be treated by one or more of the following:
 - 1. Where unsuitability is deemed by the Owner to be due to excessive compaction caused by heavy equipment and where natural subsoil is other than AASHTO classification of A6 or A7, loosen such areas with spikes, discing, or other means to loosen soil to condition acceptable to the Owner. Loosen soil to minimum depth of 12 inches with additional loosening as required to obtain adequate drainage. Contractor may introduce peat moss, sand, or organic matter into the subsoil to obtain adequate drainage. Such remedial measures shall be considered as incidental, without additional cost to the Owner.
 - 2. Where unsuitability is deemed by the Owner to be due to presence of boards, mortar, concrete, or other construction materials in sub grade and where natural subsoil is other than AASHTO classification of A6 or A7, remove debris and objectionable material. Such remedial measures shall be considered as incidental, without additional cost to the Owner.
 - 3. Where unsuitability is deemed by the Owner to be because natural subsoil falls into AASHTO classification of A6 or A7 and contains moisture in excess of 30 percent, then installation of sub drainage system or other

means described elsewhere in Specifications shall be used. Where such conditions have not been known or revealed prior to planting time and they have not been recognized in preparation of the Drawings and Specifications, then the Owner shall issue pricing order to install proper remedial measures.

3.3 PLACING TOPSOIL

- A. Refer to Section 32 91 19 - Topsoil-Select Fill Materials and Application.
- B. Spread any needed amendments per soil test and till soil to a depth of 3 to 4 inches. Ideal seed bed will be a combination of soil particles ranging from approximately a quarter inch to a full inch in size.

3.4 FERTILIZING

- A. Apply seed starter fertilizer at the rate specified by the product manufacturer.
- B. Fertilizer must be phosphorus free and meet Dane County requirements.
- C. Apply after smooth raking of topsoil.
- D. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
- E. Mix thoroughly into upper 2 inches of topsoil.
- F. Lightly water to aid the dissipation of fertilizer

3.5 SEEDING

- A. Firm up soil with light irrigation—lightly dampen soil before seeding.
- B. Sow seed using either Method A or Method B as defined in Section 630.3.3 of Standard Specifications for Highway Construction.
- C. Protect seeded slopes of 4:1 or greater against erosion with erosion control materials specified on grading and erosion control plan.
- D. Apply seed evenly in two directions at a rate specified by the product manufacturer. Rake in lightly. A cultipacker or similar equipment shall be used to enhance soil/seed contact. Care shall be taken to avoid damage to erosion mat in areas where erosion mat is specified. Do not seed areas in excess of that which can be mulched on the same day.
- E. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- F. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- G. Do not use seed that is wet, moldy, or otherwise damaged in transit or storage.
- H. Sow seed at a rate of 1½ pounds per 1,000 square feet. In addition to lawn seed, annual rye shall be applied to all disturbed areas at a rate of 1½ pounds per 1,000 square feet.
- I. Fertilize per manufacturer's recommendations.
- J. Roll seeded area with 24-inch width roller not exceeding 112 pounds.
- K. Immediately following seeding and compacting, apply mulch to a thickness of 1/8 inches.
- L. Apply water with a fine spray immediately after each area has been mulched keeping the top 1 to 2 inches of soil moist but not soaking. Water adequately to achieve a healthy stand of weed free lawn. Do not let soil dry out.
- M. Apply a second application of seed starter fertilizer at the rate specified by the product manufacturer 3 weeks after seeding.
- N. Begin weekly mowing when first seedlings reach 2 inches. Do not mow right after watering. Raise mowing height to 3 inches after six (6) weeks. Never remove more than 1/3 of the grass blade at a time.
- O. Begin standard fertilization and irrigation programs after eight (8) weeks. Do not apply any weed control products until lawn has been mowed at least four (4) times and a minimum of eight (8) weeks have passed. Follow manufacturer's recommendations for new lawns.

3.6 SEED PROTECTION

- A. Identify seeded areas with stakes and string around area periphery. Set string height to 24 inches.

3.7 SODDING

- A. Cut and lay sod on same day. Only healthy vigorous growing sod shall be laid.
- B. Lay sod across slope and tightly together to result in solid coverage free of gaps.
- C. Roll or firmly but lightly tamp new sod with suitable wooden or metal tamper sufficiently to set or press sod into underlying soil.
- D. All finished sodding shall be smooth and free of lumps and depressions.
- E. After sodding has been completed, clean up and thoroughly water newly-sodded areas.

3.8 MAINTENANCE DURING CONSTRUCTION

- A. Begin maintenance operations immediately after each plant is planted and continue as required until acceptance. Water, mulch, weed, prune, spray, fertilize, cultivate, and otherwise maintain and protect plants. Reset settled plants to proper grade and position, restore planting saucers, and remove dead, diseased, or unhealthy plant material. Tighten and repair stakes and wires. Correct defective work as soon as possible after it becomes apparent and weather and season permit.
- B. Upon completion of the planting operations, clean up landscaped areas to be free of stones, containers, trash, and other waste and debris to leave area in a neat and well-groomed appearance.
- C. Supplement rainfall as required to provide an equivalent of 1 inch of water per week until the plants have rooted and are established.
- D. Maintain all plant material in a healthy, vigorous growing condition.
- E. Make weekly inspections to determine moisture content of soil and adjust watering schedule established by irrigation system installer to fit conditions.
- F. After grass growth has started, reseed or sod areas that fail to show uniform stand of grass in accordance with the Drawings and as specified herein. Continue reseeding and sodding such areas repeatedly until areas are covered with satisfactory growth of grass. Perform removal and replacement or topsoil conditioning if required to facilitate establishment of grass.
- G. Water in such manner and as frequently as is deemed necessary by the Owner to assure continued growth of healthy grass. Water areas of site in such a manner as to prevent erosion due to excessive quantities applied over small areas and to avoid damage to finished surface due to watering equipment.
- H. Provide water for execution and maintenance at no expense to the Owner. Furnish portable tanks, pumps, hose, pipe, connections, nozzles, and any other equipment required to transport water from available outlets and apply it to seeded areas in approved manner.
- I. Mowing:
 - 1. Initiate mowing of turf grass areas when grass has attained height of 3 inches and roots are firmly established. Maintain turf grass height at 2½ to 3 inches at subsequent cuttings depending on time of year. Remove no more than 1/3 of grass leaf at any cutting and cutting shall not occur more than ten (10) days apart.
 - 2. Mow native grass areas no more than three (3) times per year to a height of no less than 4 inches.
 - 3. Remove heavy cuttings to prevent destruction of underlying turf. If weeds or other undesirable vegetation threaten to smother planted species, such vegetation shall be mowed or, in case of rank growths, shall be uprooted, raked, and removed from area by methods approved by the Owner.
- J. Remove weeds and other undesirable vegetation by applying herbicides as recommended by the manufacturer or by uprooting. Rake and remove uprooted vegetation from area by methods approved by the Owner.
- K. Protect seeded area from pedestrian or vehicular trespassing while grass is germinating. Provide fences, signs, barriers, or other necessary temporary protective devices. Repair damage resulting from trespass, erosion, washout, settlement, or other causes.
- L. Remove fences, signs, barriers, or other temporary protective devices after final acceptance.
- M. Grassed areas damaged during process of work shall be restored or repaired to condition satisfactory to the Owner. Fill, grade, re-fertilize, replant, or mulch as required to restore to contract requirements.

3.9 EXTENDED MAINTENANCE

- A. Provide landscape maintenance for the site including stormwater conveyance systems as specified below.

- B. Comply with Federal, State, Local or other governmental requirements relating to the general upkeep and maintenance of Stormwater Conveyance Systems, Natural Areas, Natural and Created Wetlands. Failure to follow these standards will fall to the liability of the Contractor.
- C. Commence Extended Maintenance immediately after Substantial Completion Date and continue as indicated on the following chart:

EXTENDED MAINTENANCE / WARRANTY CHART		
Substantial Completion Date	Extended Maintenance / Warranty Expiration	Duration
December	July	19 months
January	July	18 months
February	July	17 months
March	July	16 months
April	July	15 months
May	July	14 months
June	July	13 months
July	July	12 months
August	August	12 months
September	September	12 months
October	October	12 months
November	November	12 months

- D. General Landscaping: Landscape maintenance shall include necessary watering, cultivation, weeding, pruning, wound dressing, disease and insect pest control, protective spraying, straightening plants which lean or sag, adjustments of plants which settle or are planted too low, mowing, replacement of mulch that has been displaced, repairing and reshaping of saucers, and reseeding or replanting of those areas affected. Remove rubbish, waste, tools, and equipment used at end of each workday.
- E. Watering:
 1. Utilize the Owner’s irrigation system for watering. Failure of system does not relieve Contractor's responsibility of maintaining desired level of moisture necessary to maintain vigorous, healthy growth.
 2. Apply water in quantities sufficient to penetrate soil to minimum depth of 8 inches in shrub beds and 6 inches in turf areas at rate that will prevent saturation of soil.
 3. Supplemental on site water will be furnished by the Owner. Contractor shall furnish hose and other watering equipment as required for supplemental watering.
- F. Weeding: Maintain all shrub and groundcover areas free from weeds and undesirable grasses.
- G. Supplement rainfall and irrigation system as required to provide adequate water for vigorous and healthy growth of trees.
- H. Turf Maintenance: Maintain an establish lawn by watering, fertilizing, weeding, mowing, trimming, edging, replanting and operations required to maintain full turf coverage. Roll, re-grade, re-mulch, and replant bare or eroded areas greater one (1) square foot to produce a uniformly smooth lawn. Provide materials and installation techniques the same as those used in the original installation.
- I. Mowing:
 1. Mow turf grass areas at regular intervals to keep turf height from exceeding 3 inches. Maintain turf grass height at 2½ to 3½ inches at subsequent cuttings depending on time of year. Remove no more than 1/3 of grass leaf at any cutting. Mow turf grass at intervals of not more than ten (10) days during growing season. Mow in such manner as to prevent clippings from blowing onto paved areas and sidewalks. Cleanup after mowing shall include sweeping or blowing to clear mowing debris.
 2. Mow native grass areas no more than three (3) times per year to a height of no less than 4 inches.
 3. Edging: Mechanically edge turf areas adjacent to sidewalks, curbs and other paved surfaces with a blade type edger. Perform edging with each mowing interval.
 4. Trimming: Trim grass around valve boxes, poles and other structures with string type trimmers. Do not trim grass around tree trunks with mechanical trimmer. Remove grass adjacent to tree trunk by methods that will not cause damage to trees.

- J. Turf Fertilization: Apply balanced commercial grade fertilizer minimum four (4) times annually. Adjust type, frequency, and quantity of fertilizer to provide lush and healthy turf at all times. Spilled or excess fertilizer shall be swept and properly disposed. Flushing into storm sewer is prohibited.
- K. Turf Weed Control: Develop and maintain a broadleaf weed and foreign grass control program consisting of both post and pre-emergent chemical control. Maintain turf in a weed-free condition.
- L. Clean up: During course of maintenance, excess and waste materials shall be continuously and promptly removed at end of each workday.

END OF SECTION

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SECTION 33 10 00
WATER SYSTEM CONSTRUCTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Installation of water service, accessories, and fittings on the site.
- B. Excavation, installation, bedding cover and backfill of water service facilities.
- C. Protecting existing utilities in and around the site of the work.
- D. Testing and sterilizing the new service.
- E. Coordination of the work to allow inspection by City/County and Owner's Construction Representative.
- F. Adjustment of valve boxes and manholes prior to pavement operations.

1.2 RELATED SECTIONS

- A. Section 31 20 00 - Earthmoving
- B. Section 31 23 16.13 - Trenching
- C. Section 31 25 00 - Erosion Control

1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition.
 - 1. B88 Seamless Copper Water Tube
 - 2. D1557 Test for Moisture-Density Relations of Soils Using 10-lb. (4.5 Kg) Rammer and 18-inch (457 mm) Drop (Modified Proctor)
 - 3. D2487 Classification of Soils for Engineering Purposes
 - 4. D2922 Tests for Density of Soil and Soil - Aggregate in Place by Nuclear Methods (Shallow Depth)
 - 5. D3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- B. American Water Works Association (AWWA) latest edition.
 - 1. C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
 - 2. C105 Polyethylene Encasement for Ductile Iron Piping for Water and other Liquids
 - 3. C116 Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
 - 4. C151 Ductile Iron Pipe, Centrifugally Cast, for Water or Other Liquids
 - 5. C153 Ductile-Iron Compact Fittings for Water Service.
 - 6. C500 Gate Valves, 3 through 48 in NPS, for Water and Sewage Systems
 - 7. C504 Rubber-Seated Butterfly Valves
 - 8. C509 Resilient-Seated Gate Valves for Water Supply Service
 - 9. C550 Protective Interior Coatings for Valves and Hydrants
 - 10. C600 Installation of Ductile Iron Water Mains and Appurtenances
 - 11. C605 Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
 - 12. C651 Disinfecting Water Mains
 - 13. C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4 inches through 12 inches, for Water Distribution
 - 14. M41 Manual of Water Supply Practices
- C. Where reference is made to the "Construction Specifications", it shall be construed to mean the pertinent section of the City of Stoughton Standard Construction Specifications, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- D. Where reference is made to the "Standard Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- E. Where reference is made to the "State Specifications", it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim

supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.

- F. Where reference is made to the "Geotechnical Report", it shall be construed to mean the geotechnical report in Section 02 32 00.

1.4 SUBMITTALS

- A. Conform to Section 01 00 00 - Submittals.
- B. Product Data: If requested by Owner, provide product data on pipe materials, pipe fittings, valves, and accessories.

1.5 QUALITY ASSURANCE

- A. The City of Stoughton Utility will inspect the work.
 - 1. Provide coordination to assure that City of Stoughton Inspectors observe all water service installation work.
- B. All costs related to retesting due to failures shall be paid for by the Contractor at no additional expense to Owner. Provide free access to site for testing activities.
- C. Furnish one (1) copy of results of the meter test and hydrostatic pressure test to the Developer and the City of Stoughton upon completion of water distribution backfilling operations.
- D. Project Record Documents:
 - 1. Disinfection Report: Record the following:
 - a. Type and form of disinfectant used.
 - b. Date and time disinfectant injection start and time of completion.
 - c. Test locations.
 - d. Initial and 24-hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
 - e. Date and time of flushing start and completion.
 - f. Disinfectant residual after flushing in ppm for each outlet tested.
 - 2. Bacteriological Report: Record the following:
 - a. Date issued, project name, testing laboratory name, address, and telephone number.
 - b. Time and date of water sample collection.
 - c. Name of person collecting samples.
 - 3. Test locations.
 - 4. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
 - 5. Coliform bacteria test results for each outlet tested.
 - 6. Certification that water conforms, or fails to conform, to bacterial standards.
 - 7. Bacteriologist's signature and authority.
- E. Accurately record actual locations of piping mains, valves, connections, and top of pipe elevations.
- F. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.
- G. Provide copy of safe water samples to the City of Stoughton prior to placing the new main in service.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products in accordance with provisions of Section 01 00 00 and the manufacturer's instructions.
- B. Deliver and store valves in shipping containers with labeling in place.

1.7 RECORD DRAWINGS

- A. Accurately record location of pipe runs, connection, fittings, and valves

PART 2 PRODUCTS

2.1 MATERIALS

- A. General:
 - 1. Pipe:
 - a. Centrifugally cast, cement mortar lined ductile iron water main meeting the requirements of ANSI/AWWA C151/A21.51 and ANSI/AWWA C104/A21.4.

- b. Unless otherwise specified, ductile water main shall be Class 52 as defined by ANSI/AWWA C151/A21.51.
 - c. Ductile iron water main joints shall be rubber gasket push-on joint or mechanical joint meeting the requirements of ANSI/AWWA C111/A21.11.
 - d. Pipe shall be provided with conductive bonding straps to provide electrical continuity.
 - e. Pipe shall be manufactured in the United States.
 - f. All water mains, including all fittings, valves, and curb boxes, shall be wrapped with polyethylene. The polyethylene shall comply with the requirements of Chapter 8.21.0 of the Standards Specifications.
 - g. Utilize DIP equipped with low profile flexible restrained joints such as Flex Ring or TR Flex for directionally drilled water main. Gripping push-on joint gaskets, or restrained joint gaskets are not permitted.
 - h. All valves and fittings require armor tipped gaskets at mechanical joints. Lead tipped conductivity gaskets and bronze wedges are prohibited.
 - i. Joint Restraint shall be Megalug glands made by Ebaa Iron Inc. Series 1100, or approved equal. Threaded rods for restraint shall be 3/4-inch 304 stainless steel threaded rods with stainless steel nuts and washers.
 - j. All pipe shall be furnished with cable bond conductor or electrobond conductivity strips. Thermite welded straps are allowed provided weld points are thoroughly coated with bitumastic material.
 - k. All buried ductile iron water main piping and fittings shall be polyethylene encased in accordance with AWWA C105. Polyethylene encasement shall be a minimum 8-mil thickness and installed in accordance with AWWA C105.
2. Valves and Valve Boxes Resilient Wedge Gate Valve
- a. Resilient Wedge Gate Valves: All valves 16 inches or smaller shall be resilient seat gate valves meeting the requirements of AWWA C509. Gate valves shall have ductile iron body, resilient wedge, non-rising stem and O-ring packing box, and rated for 250 psi working pressure. All water main gate valves shall have mechanical joint ends unless otherwise specified. Valves shall be American Flow Control resilient wedge gate valves or approved equal. Operators on water main valves shall be 2-inch square nut. Stainless steel bolts shall be used for connection of valve to water main pipe.
 - b. Buried valves shall be epoxy coated in accordance with AWWA C550.
 - c. Valve box stabilizer shall be Adaptor, Inc., or approved equal. Determination of specific model shall be as recommended by the manufacturer.
 - d. Valve boxes shall be Tyler Model No. 6860DD, or equal, with No. 6 base, three (3) piece screw type bow, 5¼-inch shaft and stay-put cover marked "WATER". Valve boxes shall be manufactured in the United States of America and labeled as such. Use of foreign materials is prohibited.
 - e. A minimum of 10-gauge coated copper wire or equivalent shall be used to provide continuity across valve.
3. Hydrants:
- a. All fire hydrants, private and public, shall conform to AWWA C502 with 5¼-inch main valve opening, 6-inch mechanical joint inlet, two 2½-inch National Standard hose connections, one 4½-inch National Standard pumper connection, and 1½-inch pentagon operating nut and caps, open left. No weather shield shall be provided on top operating nut.
 - b. Hydrant shall have bronze seat ring and seat insert, and ductile iron stand pipe, nozzle section, bottom, and cross arm.
 - c. Hydrant shall be Waterous WB-67, 7-foot bury, with breakaway flange and painted red. All areas of hydrant with paint defects shall be repainted with Waterous Touch-up Kit or approved equal. Stainless steel bolts shall be used for connection of hydrant to water main pipe.
 - d. Fire hydrant markers shall be 36-inch, orange, Slimline FH fire hydrant marker manufactured by Flexstake, Inc., Model No. SFH-3.
- B. Rigid Insulation:
- 1. Rigid, closed-cell, extruded polystyrene insulation. Insulation shall be suitable for buried installation.
 - 2. Individual boards shall have minimum dimensions of 8'x4'x2".
 - 3. Dow Styrofoam, 40 PSI minimum, or approved equal.
- C. Bedding and Cover:
- 1. Bedding and cover shall conform to the Standard Specifications and Construction Specifications for the City of Stoughton.

- D. Granular Backfill:
 - 1. Granular Backfill material shall conform to the requirements of the Standard Specifications and City of Stoughton Specifications. Granular backfill shall be used under public and private pavement/walks and where shown in the plans unless otherwise directed by the Owner's Construction Representative or Owner's Construction Representative based on geotechnical evaluation of native materials.
- E. Water Laterals, Lateral Materials, Valve Boxes:
 - 1. Conform to City of Stoughton Specifications.
 - 2. Service laterals will conform to the water main specifications herein.

PART 3 EXECUTION

3.1 GENERAL

- A. Conform to the requirements of the Standard Specifications.
- B. Where conflicts exist between the requirements of this section and the City Specifications, the requirements of the City Specifications shall govern.
- C. City of Stoughton staff will operate all existing valves and hydrants.
- D. City of shall be provided a minimum of two (2) working days' notice prior to any flushing needed.

3.2 EXAMINATION

- A. Verify that water main locations and features are as depicted on the drawings.

3.3 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Protect plant life and existing structures, from excavating equipment and vehicular traffic.
- C. Verify location of utilities in the vicinity of the proposed water main construction by hand excavation.
- D. Protect benchmarks and all other survey monuments from damage or displacement. If a marker needs to be removed, it shall be referenced by a Registered Surveyor and replaced, as necessary, by the same.
- E. Verify that materials to be used are acceptable and available in sufficient quantity to complete the work before closing valves to isolate water service to be replaced.

3.4 EXCAVATION AND BEDDING AND COVER

- A. Excavate pipe trench in accordance with Section 31 23 16.13 for the work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Shore, brace, and drain excavations as necessary to maintain them safe, secure, and free of water at all times.
- C. Maintain optimum moisture content of bedding and cover material to attain required compaction density. Bedding and cover materials shall be sand, crushed stone, or crushed stone screening. Crushed stone shall be used in areas of high ground water.

3.3 INSTALLATION - PIPE

- A. Perform work in accordance with the requirements of Section 4.3.0 of the Standard Specifications.
 - 1. Where conflicts between the requirements of this section and the Standard Specification occur, the requirements of the Standard Specifications shall take precedence.
- B. Route pipe in straight line.
- C. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- D. Install access fittings to permit disinfection of water system.
- E. Encase ductile or cast iron pipe in polyethylene in accordance with the requirements of Section 4.4.4 of the Standard Specifications.
- F. Mega-lug and rodding shall be used for joint restraints at all bends and fittings. Pipe restraint shall be determined using the Restraint Length Calculator at www.ebaa.com or an approved equal to determine restraint requirements.
- G. All fittings shall be wrapped with Poly Wrap.

- H. Establish elevations of buried piping to ensure final cover of no less than 7 feet.

3.4 INSTALLATION - VALVES AND HYDRANTS

- A. Set valve box stabilizer on top of valve. Center and plumb valve box over valve. Set box cover flush with finished grade.
- B. Final adjustments on all valves are incidental to installation.
- C. Install gate valves as indicated on Construction Drawings. Support valve on concrete pads with valve stem vertical and plumb. Install valve boxes in manner that will not transmit loads, stress, or shock to valve body. Center valve box over operating nut of valve vertical and plumb. Securely fit valve box together leaving cover flush with finished surface.
- D. Install fire hydrant assemblies as indicated on Construction Drawings in vertical and plumb position with steamer/pumper nozzle pointed perpendicular to traffic where hydrant is adjacent to street, roadway, or parking lot drive or toward protected building unless otherwise directed by local authorities.
 - 1. Support hydrant assembly on concrete pad and firmly brace on side opposite inlet pipe against undisturbed soil and concrete blocking.
 - 2. Place minimum of 6 cubic feet of crushed stone or gravel around hydrant base and barrel after thrust blocking has cured at least 24 hours. Maintain vertical position of hydrant backfilling and compacting.
 - 3. Install 4 feet behind curb.
 - 4. Install auxiliary valve in pavement.
 - 5. Center pumper nozzle 18 to 23 inches to finished grade.
 - 6. Mega-Lug all auxiliary valve and hydrant joints.
 - 7. Shall be wrapped in polyethylene to within 6 inches of finished grade.

3.5 WATER SERVICE PIPE INSTALLATION

- A. Minimum 6½ feet of cover to top of pipe.
- B. Service pipe shall be seamless from the main to the curb box.
- C. Water services shall extend 5 feet into the lot or within 5 feet of the exterior building foundation.
- D. Point of termination of lot services shall be marked with a 6-foot steel fence post with 1 foot of the post below the end of the service. A 6-foot 4"x4" treated wood post will also be installed at the end of each service with 3 feet of the post being buried below grade. The exposed portion of the post shall be painted blue.
- E. Water Service Fitting shall be direct tap for 1¼-inch. Use tapping saddle for all taps over 1 inch.

3.6 DISINFECTION OF WATER SYSTEM

- A. Disinfect system in accordance with the City of Stoughton Specifications.
- B. The cost for water system disinfection is incidental to the price bid for Water Service Construction.

3.7 TESTING OF WATER SYSTEM

- A. Perform hydrostatic pressure and leakage test on all pipe, fittings, services and joints in accordance with AWWA C600 and the City of Stoughton Standards.
- B. The Contractor is responsible for conducting and reporting the results of all testing.

END OF SECTION

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SECTION 33 40 00
STORM SEWER CONSTRUCTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Storm sewer pipe and accessories.

1.2 RELATED SECTIONS

- A. Section 31 23 16.13 - Trenching
- B. Section 31 25 00 - Erosion Control

1.3 REFERENCES

- A. ASTM A615-89 – Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- B. ASTM C76-90 – Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
- C. ASTM D698-91 – Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-pound (2.5kg) Rammer and 12-inch (304.8-mm) Drop
- D. AASHTO M-198 – Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Water tight Gaskets
- E. AWWA C905 – PVC Pressure Pipe and Fabricated Fittings, 14 inches through 48 inches for Water Transmission and Distribution
- F. AWWA C906 – PE Pressure Pipe and Fittings 4 inches through 63 inches for Water Transmission and Distribution
- G. Where reference is made to the “Construction Specifications”, it shall be construed to mean the pertinent section of the City of Stoughton Standard Construction Specifications, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- H. Where reference is made to the “Standard Specifications”, it shall be construed to mean the pertinent section of the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- I. Where reference is made to the “State Specifications”, it shall be construed to mean the pertinent section of the Standard Specifications for Highway and Structure Construction, current edition, and all supplemental and interim supplemental specifications, as they may pertain, except the method of measurement and basis of payment shall not apply.
- J. Where reference is made to the “Geotechnical Report”, it shall be construed to mean the geotechnical report in Section 02 32 00.

1.4 REGULATORY AGENCIES

- A. The City of Stoughton.
- B. The Wisconsin Department of Natural Resources (WDNR).

1.5 SUBMITTALS

- A. Submit product data under provisions of Section 01 00 00 - Submittals.
- B. Submit product data for pipe and pipe accessories.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Section 01 00 00 - Submittals.
- B. Accurately record location of pipe runs, connections, manhole rim elevations and invert elevations.

1.7 MEASUREMENT AND PAYMENT

- A. Measurement and payment for storm sewer construction and related work specified herein shall be by unit price as shown on the Bid Form. Work shall include all labor, equipment and materials related to storm sewer construction.
 - 1. Lengths of storm sewer construction are from center of structure to center of structure.

PART 2 PRODUCTS

2.1 SEWER PIPE MATERIALS

- A. Reinforced Concrete:
 - 1. Pipe: Reinforced concrete pipe meeting requirements of ASTM C76 or ASTM C507. Provide Class III unless indicated otherwise in the Specifications or on the Drawings.
 - 2. Joints:
 - a. Circular Pipe: Tongue and groove meeting requirements of ASTM C443.
 - 3. Joint ties shall be in accordance with Detail Drawings.
 - 4. All Public Storm Sewer shall be concrete pipe.
- B. PVC Pipe:
 - 1. Conform to ASTM D3034 with solvent weld or elastomeric joints.
 - 2. Pipe shall be SDR-35, unless otherwise noted. Pipe over 15 inches in diameter shall meet the requirements of ASTM F679-03. Do not mix different manufacturer's products, or fittings.
- C. HDPE Solid Wall Pipe:
 - 1. Conform to ASTM D3350 for PE material with a cell classification of 335434C or better. Pipe shall be SDR 11, unless otherwise noted.
 - 2. Joints shall be thermal butt fusion in accordance with the manufacturer's recommendation.
- D. HDPE Corrugated Wall Pipe:
 - 1. Corrugated pipe with an integrally formed smooth liner.
 - 2. Pipes which are between 4-inch diameter and 36-inch diameter shall meet the requirements of AASHTO M252 and M294, Type S.
 - 3. Pipe and fittings shall be manufactured from virgin PE compounds conforming to the requirements of ASTM D3350, cell class 324420C.
 - 4. Joints for fittings and pipe shall be soil-tight bell and spigot, provided with rubber gasket. Rubber gasket shall be installed by the pipe manufacturer.

2.2 STORM SEWER PRE-CAST MANHOLES AND INLETS

- A. Frames, grates, and manhole lids shall be constructed and installed per City of Stoughton Construction Specifications and are considered incidental to the price of the structure.
 - 1. Manhole castings shall be Neenah R-1550 with non-rocking lids and Type D grates.
 - 2. Inlet castings shall be R-3067 with Type R grates at low points and where grades are less than 1%.

2.3 PRE-CAST STORM SEWER PIPE END SECTIONS AND WELDED GRATES

- A. Pre-cast apron end walls shall be provided and installed with hinged metal grates in accordance with Section 502 of the State Specifications. Apron end walls shall be provided with cut-off walls to prevent undermining.

2.4 BEDDING AND COVER MATERIAL

- A. Provide 3/4-inch clear stone bedding and cover material in accordance with the Drawings and Section 31 23 16.13 - Trenching.
- B. Granular Backfill material shall conform to the requirements of the Standard Specifications. Granular backfill shall be used under public and private pavement/walks and where shown in the plans unless otherwise directed by the Owner's Construction Representative based on geotechnical evaluation of native materials.

2.5 CRUSHED STONE

- A. Provide crushed stone base in accordance with the Drawings and Section 31 23 16.13 - Trenching.

2.6 LOCATOR TAPE

- A. Detectable metal locator tape shall be specifically manufactured for marking utilities.

- B. Tape shall be a minimum of 6 inches wide and shall be marked with "STORM".

2.7 DRAIN BASINS AND INLETS

A. General:

- 1. PVC surface drainage inlets shall include the drain basin type as indicated on the contract drawing and referenced within the contract specifications. The ductile iron grates for each of these fittings are to be considered an integral part of the surface drainage inlet and shall be furnished by the same manufacturer. The surface drainage inlets shall be as manufactured by Nyloplast a division of Advanced Drainage Systems, Inc., or prior approved equal.

B. Materials:

- 1. The drain basins required for this contract shall be manufactured from PVC pipe stock, utilizing a thermoforming process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454.
- 2. The grates and frames furnished for all surface drainage inlets shall be ductile iron for sizes 8", 10", 12", 15", 18", 24", and 30" and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for drain basins shall be capable of supporting various wheel loads as specified by Nyloplast. 12-inch and 15-inch square grates will be hinged to the frame using pins. Ductile iron used in the manufacture of the castings shall conform to ASTM A536 Grade 70-50-05. Grates and covers shall be provided painted black.
- 3. Where shown, the basins shall be provided with the sump specified.

PART 3 EXECUTION

3.1 HANDLING OF MATERIALS

- A. Handle materials with care to avoid damage. Do not dump or drop materials. Remove all damaged or flawed materials from the site.
- B. Arrange for suitable sites for material storage.

3.2 LINES AND GRADE

- A. Benchmarks and Construction Layout.
 - 1. Engineer will provide vertical and horizontal control.
 - 2. Contractor shall provide construction layout.
- B. Contractor shall provide all materials, equipment and labor to maintain line and grade.
 - 1. The laser beam method is the preferred method for controlling line and grade. Equipment shall be operated in accordance with the manufacturer's instructions. A person who is competent with the operation of the laser equipment shall be present at the jobsite whenever it is being used.
 - 2. Grade boards may be used. Use straight and even-edged 2X6 boards nailed or clamped to substantial stakes on either side of the trench. Use stout twill line fastened at the center of the alignment, pulled sufficiently tight to remove any noticeable or measurable sag. Measure down from the line to set the alignment of the pipe. Maintain a minimum of three boards at all times.
 - 3. Banjo strings may be used only when approved by the Engineer.

3.3 JOINTS

- A. Construct joints as described herein and in accordance with manufacturer's installation instructions. Provide pipe joint type for soil tight, silt tight, or watertight only silt tight or watertight only watertight joint performance in accordance with the following table. The table applies only to the extent as applicable to the pipe and joint type and the joint performance as shown or specified.

Pipe and Joint Type	Joint Performance		
	Watertight	Silt Tight	Soil Tight
RCP			
Rubber O-Ring Gasket	x	x	x
Bitumen or Butyl Rubber Sealant			x
HDPE			
Rubber Gasket			
Hancor BLUE SEAL	x	x	x
ADS N-12 WT	x	x	x
Hancor Sure-Lok		x	x
ADS N-12 ST		x	x
Corrugated Coupling Bands			
Hancor Hi-Q			x
ADS N-12			x
PE Wrap			x
PVC			
Restrained Gasket	x	x	x

3.4 UNSTABLE FOUNDATION

- A. Remove undesirable material below the trench bottom, such as organic soils, which cannot support the pipe. Replace the material with crushed stone meeting the requirements of Section 31 23 16.13 for 2-inch crushed stone base material.
- B. Crushed stone base material will be paid for at the unit price bid or on the basis of a negotiated price if there is no bid price. Payment for crushed stone base will be made only if the Owner's representative is notified prior to its placement. Payment will not be made for crushed stone base used for dewatering the trench.

3.5 LAYING OF PIPE

- A. Lay pipe uniformly to line and grade so that the finished sewer presents a uniform bore. Noticeable variations from true alignment and grade will be sufficient cause for rejection of the work.
- B. Commence at the lowest point and proceed to the upper end. Lay pipe with bell-end pointing up-grade.
- C. Provide a minimum of six inches between the pipe or box wall and the trench wall.
- D. Rest each pipe on the full length of its barrel. Place box culvert sections on 6 inches of bedding material.
- E. Do not lay the next pipe until the previous pipe is back-filled sufficiently to prevent movement during joining.
- F. Keep water out of the pipe. Do not let water rise into or around the pipe until the trench is filled at least one foot above the pipe.
- G. When work is stopped for any reason, securely plug the end of the pipe.
- H. Pipe Jointing: Assemble joints in accordance with the pipe manufacturer's instructions.

3.6 BEDDING AND COVER

- A. Use the following bedding sections as indicated on the Drawings.
- B. Class C:
 1. Provide a minimum of six inches of bedding material under the pipe barrel and four inches under the bell. Provide crushed stone bedding meeting requirements of Section 31 23 16.13. Spade or shovel-slice the material so that it fills and supports the haunch area and encases the pipe to the limits shown on the Drawing detail. If excavation is carried deeper than 6 inches below the pipe barrel, backfill the excess depth with 1½-inch crushed stone base material meeting requirements of Section 31 23 16.13.
 2. After the pipe has been laid and jointed, place cover material by hand or equally careful means around the sides of the pipe and up to a level 12 inches above the pipe. Provide cover material meeting the requirements of Section 31 23 16.13.

3. For pipes 36 inches in diameter or larger, backfill material may be substituted for cover material. If backfill material is used, the bedding material shall extend to the spring line of the pipe.

3.7 SEPARATION FROM WATER MAIN

- A. Provide a minimum horizontal separation of ten feet when constructing parallel to the water main.
- B. Vertical Separation
 1. When a sewer crosses under a water main, provide a minimum of 12 inches between the bottom of the water main and the top of the sewer.
 2. When a sewer crosses over a water main, provide a minimum of 18 inches between the bottom of the sewer and the top of the water main.
- C. Excess excavated trench material shall be transported and disposed on site in a location approved by the Construction Coordinator. Trench excavation material cannot be cast into piles within the roadway.

3.8 MANHOLES, CATCH BASINS, INLETS, AND JUNCTION BOXES

- A. Construct drainage structures in accordance with details shown on Drawings and in accordance with Section 33 40 00 as applicable.
- B. Precast Sections:
 1. Install precast section with bases in accordance with Sections 33 40 00 or as shown on Drawings.
 2. Align pipe openings to that of the pipe entering and leaving the manhole, etc. Properly pipe with connections to manholes, etc., as shown on the Drawings.
- C. Construct Cast-In-Place sections as shown on the Drawings and in accordance with Section 03 30 00.
 1. Form bottom of excavation clean and smooth to correct elevation.
 2. Form and place cast-in-place concrete base pad, with provision for storm sewer pipe to be placed at proper elevation.
 3. Form and place cast-in-place concrete walls, sleeved at proper elevation to receive storm sewer pipe in accordance with details shown on Drawings.
- D. Invert channels shall be smooth and accurately shaped to a semicircular bottom conforming to the inside of the adjacent sewer section. Shape invert channels and structure bottoms with cement mortar. Changes in size and grade of invert shall be made gradually and evenly. Changes in direction of the sewer entering branch or branches shall have a true curve of as large a radius as the manhole will permit.

END OF SECTION

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