RFB NO. 313072

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

REBID
REQUEST FOR BIDS NO. 313072
ALLIANT ENERGY CENTER PAVILIONS
ALLIANT ENERGY CENTER
1919 ALLIANT ENERGY CENTER WAY
MADISON, WISCONSIN

OCTOBER 29, 2013

VOLUME 2 OF 2

Due Date / Time: **THURSDAY, NOVEMBER 21, 2013 / 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:

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DIVISION 21 – FIRE PROTECTION
SECTION 21 05 10 – GENERAL FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 & Division 22 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Provide all labor, materials, equipment, tools and services for a complete fire protection system as indicated and in specifications. System shall include post indicator valve, fire protection service piping, distribution piping to sprinkler heads, test stations, alarm check valves, alarms, controls, standpipe piping from distribution piping to hose valves and drain piping for sprinkler piping drainage.

B. It is not the intention of these specifications to enumerate each and every item for a complete system, but it shall be distinctly understood that this Contractor is to install the sprinkler system complete in all detailed parts subject to the rules and requirements of the National Fire Protection Agency (NFPA), the Municipal Ordinances, State Requirements and the authority having jurisdiction.

1.3 QUALITY ASSURANCE

A. Products and work shall comply with ANSI/NFPA 13, "Installation of Sprinkler Systems"; ANSI/NFPA 14, "Installation of Standpipe and Hose Systems", ANSI/NFPA 231, Standard for General Storage, and local Fire Department/Marshall regulations.

B. Provide products with appropriate FM and UL labels.

C. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

1.4 SEALING AND FIRESTOPPING

A. Sealing and firestopping of sleeves/opening between piping, etc. and the sleeve or structural opening shall be the responsibility of the contractor whose work penetrates the opening. The contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.

1.5 WORKING DRAWINGS

A. Working drawings of the entire system showing the piping, locations of each sprinkler head, valves, drains, alarms, etc. shall be submitted by this Contractor to the Architect

after approval of the above agencies has been secured.

B. In preparing the working drawings, the Contractor shall cooperate with all other trades involved with the sprinkler work and all pipe runs and sprinkler locations shall be coordinated with all other trades to avoid conflict with ducts, pipes, lighting, etc.

1.6 SYSTEM DESCRIPTION

A. (Used in Heated spaces)
Fire protection system is a "Wet-Pipe" system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by fire.

B. (Used in unheated spaces)
Fire protection system is a "Dry-Pipe" system employing automatic sprinklers attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry-pipe valve. The water then flows into the piping system and out the opened sprinkler.

1.7 SUBMITTALS

A. Product Data: Submit manufacturer's data sheets showing dimensions and materials.

B. Maintenance Data: Submit maintenance instructions and spare parts lists. Include this information in maintenance manuals.

C. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable Victaulic style or series number.

D. SUBMITTAL SHALL BE APPROVED BY AUTHORITY HAVING JURISDICTION PRIOR TO SUBMISSION TO A/E. Obtain departmental approval prior to beginning construction. Pre-submittal to A/E for sensitive areas requiring architectural coordination is permitted.

PART 2 - PRODUCTS

2.1 FIRE PROTECTION PIPING

A. Provide piping materials of factory fabricated piping products of sizes, types, pressure and temperature ratings, and capacities as indicated below. Where not indicated, provide proper selection as determined by industry standards and governing regulations. Where more than one type of materials or products is indicated, selection is Installer's option.

B. Interior Piping: Pipe or tube used in sprinkler systems shall meet or exceed the standards outlined in NFPA 13 "Standards for the Installation of Sprinkler Systems."

C. Piping Materials:

1. Copper Tubing -Drawn Temper: ASTM B 88, Type L.

2. Steel Pipe: ASTM A 795, Schedule 40, seamless, black steel pipe, plain ends.

3. Steel Pipe: ASTM A 795, Schedule 10, seamless, blade steel pipe, plain ends.

D. Fittings:

1. Cast Iron Threaded Fittings: ANSI B 16.4, Class 250, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

2. Malleable Iron Threaded Fittings: ANSI B16.3, Class 300, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

3. Steel Fittings: ASTM A 234, seamless or welded, for welded joints, Steel threaded couplings: ASTM A 865

4. Grooved Mechanical Fittings for Steel Pipe: ASTM A 536, Grade 65-45-12 ductile iron or ASTM A 53, type F or Types E or S, Grade B fabricated steel fittings with grooves or shoulders designed to accept Victaulic grooved end couplings.

5. Grooved Mechanical Couplings for Steel Pipe: Consist of ductile iron housings, a synthetic rubber gasket of a central cavity pressure responsive design; with nuts, bolts, locking pin, locking toggle or lugs to secure roll grooved pipe and fittings. Grooved mechanical couplings including gaskets used on dry pipe systems shall be listed for dry pipe service.

   a. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's recommendations. Contractor shall remove and replace any improperly installed joints.
      1) 1-1/4" thru 4": "Installation Ready" rigid type coupling designed for direct "stab" installation onto grooved end pipe without prior disassembly of the coupling equal to Victaulic FireLock® EZ Style 009.
      2) 5" and Larger: Standard rigid joint equal to Victaulic FireLock® Style 005 or Style 07 Zero-Flex®.
   b. Flexible Type: Use in seismic areas where required by NFPA 13. Victaulic Style 75 or 77.

   c. Coupling gaskets shall be listed for use as follows:

Fire Protection Service	Temperature Range	Gasket Recommendation
Dry Systems	Ambient	FlushSeal® or EZ Style 009 design Grade EPDM, Type A
Water/Wet Systems	Ambient	C-Shape or EZ Style 009 design Grade EPDM, Type A

6 7 4 4 .

6. Grooved Joint Flange Adapters for Steel Pipe: ASTM A536 ductile iron casting, flat face, for incorporating flanged components with ANSI Class 125, 150 and 300 bolt-hole patterns to a grooved system. Victaulic Style 741, 743, or 744.

7. Wrought Copper Fittings: ANSI B16.22, streamlined pattern.

8. Grooved Mechanical Fittings for Copper Tube: UL listed, grooved end fittings shall be ASME B16.22 wrought copper with copper tubing sized grooved ends designed to accept Victaulic couplings. Flaring of tube and fitting ends to IPS dimensions is not permitted.

9. Grooved Mechanical Couplings for Copper Tube: UL listed, grooved copper couplings will consist of two ductile iron housings cast with offsetting, angle-pattern bolt pads coated with copper-colored alkyd enamel. Gasket shall be pressure-responsive, synthetic rubber of a FlushSeal® design, secured together with plated steel bolts and nuts. Victaulic Style 606.

10. Grooved Copper Flange Adapters: UL listed, ductile iron casting coated with copper-colored enamel, flat faced, for engaging into roll grooved copper tube and fittings and bolting directly to flanges with ANSI Class 125 and 150 bolt-hole patterns. Victaulic Style 641.

11. Cast Iron Threaded Flanges: ANSI B16.1, Class 250; raised ground face, bolt holes spot faced.

12. Cast Bronze Flanges: ANSI B16.24, Class 300; raised ground face, bolt holes spot faced.

E. Jointing Materials:

1. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

a. Brazing Filler Metals: AWS A5.8, Classification BAgl (silver).

b. Solder Filler Metals: ASTM B 32, 95-5, Tin Antinomy.

2. Gasket Materials: Thickness, material and type suitable for fluid or gas to be handled and design temperatures and pressures.

2.2 SEALING AND FIRE STOPPING

A. Fire and/or smoke rated penetrations

1. Manufacturers: 3M, Hilti, STI/SpecSeal, Tremco, or approved equal.

2. All firestopping systems shall be provided by the same manufacturer.

3. Submittals: Contractor shall submit product data for each firestop system. Submittals

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

4. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.

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

B. Non-rated penetrations

1. Pipe Penetrations Through Below Grade Walls:

In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated pipe and the cored opening or a water-stop type wall sleeve. The operating bolts of the mechanical type seal shall be accessible from the building interior.

2. Pipe Penetrations:
At pipe penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required, use urethane caulk in annular space between pipe insulation and wall material.

2.3 PIPING SPECIALTIES

A. Provide piping specialties that mate and match piping and equipment connections and are UL listed.

B. Pressure gages (3-1/2" dial) shall be 0-250 psi.

C. General Duty Valves:

1. Gate Valves, 2" and Smaller: Body and bonnet of cast bronze, 175 lb. cold water working pressure, nonshock, threaded ends, solid wedge, outside screw and yoke, rising stem, screw-in bonnet, and malleable iron handwheel. Valves shall be capable of being repacked under pressure, with valve wide open.

2. Gate Valves, 2-1/2" and Larger: Iron body; bronze mounted, 175 lb. cold water working pressure, nonshock. Valves shall have solid taper wedge; outside screw and yoke, rising stem; flanged bonnet, with body and bonnet conforming to ASTM A 126, Class B; replaceable bronze wedge facing rings; flanged ends; and a packing assembly consisting of a cast iron gland flange, brass gland, packing, bonnet and bronze bonnet bushing. Valves shall be capable of being repacked under pressure with valve wide open.

3. Grooved End Gate Valves, 2-1/2” and Larger: Ductile iron body, bronze mounted, 250 psig cold water working pressure. Resilient wedge, outside screw and yoke, brass rising stem, cast iron bonnet, fusion bonded, grooved ends, and cast iron handwheel. Victaulic FireLock® Series 771.

D. Grooved End Butterfly Valves, 2-1/2” and Larger: Ductile iron body, elastomer coated ductile iron disc, 300 psig cold water working pressure, weather-proof gear actuator with pre-wired supervisory switches. Victaulic FireLock® Series 705W.

E. Check valve. Valve shall be rated at 175 PSI working pressure with cast iron body (coated with corrosion resistant red paint), brass clapper with Buna-N "O" ring and brass seat. Valve shall have tappings as required for system piping. Valve seat shall be replaceable without removing the check valve from the line.

F. Grooved End Check Valves, 2-1/2” and Larger: Ductile iron body, aluminum bronze or elastomer coated ductile iron disc, stainless steel spring and shaft, PPS coated or welded-in nickel seat. Victaulic FireLock® Series 717 or 717R with riser check kit.

G. Provide control supply gate valve at inlet of check valve with tappings as required for system piping.

H. Fire department connection valve shall be iron swing check, 175 psi rated.

I. Water flow indicators shall be vane type flow detectors. Interlock wiring to fire alarm system by Electrical Contractor.

J. Provide supervisory switches as required.

K. Flexible stainless steel hose assemblies equal to FlexHead Commercial Sprinkler Connector or AquaFlex. For use to connect sprinkler heads to the branch lines. Assembly shall include stainless steel braided hose with factory attached threaded end connections and matching ceiling attachment. Assembly shall be UL and Factory Mutual approved for installation in proposed system.

L. Flexible Drop System: In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic FireLock® Flexible Drop system may be used to locate sprinklers as required by final finished ceiling tiles and walls. The drop system shall consist of a braided or corrugated type 304/316 stainless steel hose piece, 1" NPT male threaded adapter for connection to header piping and a 1/2" or 3/4" NPT female adapter for connection to the sprinkler head. Unions shall be provided on either end of the flexible hose for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece bracket that can be installed without the use of tools and have a 3" minimum bending radius for installation in narrow or confined spaces. The braided drop system is UL listed and FM approved and the corrugated system is UL listed for sprinkler services to 175 psi.

M. Automatic Sprinklers:

1. Office: Chrome plated, fully concealed, flush pendant equal to Victaulic Model V38.

2. Equipment, Livestock area and Storage Rooms (Unfinished Areas): Upright with

cast brass finish equal to Victaulic Model V27.

3. Provide 165°F fusible links or 155°F frangible glass bulb, except in boiler rooms, which shall be 175°. Provide 10 spares of each type and rating along with three wrenches for each type of head. Locate sprinkler heads as shown on plan. Relocation shall be at contractor's cost.

N. Provide wall mounted post-indicating valve with supervisory switch, interlocked with annunciator panel and remote readout. Reference Section 22 05 23.

O. Provide Victaulic Style 720 TestMaster™ inspectors test and drain lines for each floor.

P. Provide siamese connection, as detailed on the drawing. Install a 90 degree elbow with drain connection at each Siamese connection for complete system drainage. Elbow shall be Victaulic #10-DR.

Wall-Type, Fire Department Connection: UL 405, (175 psi) minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."

Type: Flush, with two inlets and square or rectangular escutcheon plate.

Type: Exposed, projecting, with two inlets and round escutcheon plate.

Finish: Rough chrome-plated.

Q. Exposed, Freestanding-Type, Fire Department Connection: UL 405, [1200 kPa (175 psi) minimum] [2070 kPa (300 psi)] pressure rating; with corrosion-resistant-metal body, brass inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, and bottom outlet with pipe threads. Include brass lugged caps, gaskets, and brass chains; brass lugged swivel connection and drop clapper for each hose-connection inlet; 460mm (18-inch-) high, brass sleeve; and round, floor, brass escutcheon plate with marking "AUTO SPKR & STANDPIPE."

Finish Including Sleeve: Rough chrome-plated.

Fire department siamese connections shall be installed between (18 in. and 36 in.) above the finished grade.

R. Provide remote readout for supervision of the post indicator valve, as detailed on drawing.

S. Alarm Check Valve: 175 psig working pressure, designed for horizontal or vertical installations and have cast iron, flanged inlet and outlet, bronze grooved seat with "O" ring seals, single hinge pin and latch design. Provide trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, drip cup assembly piped without valves separate from main drain line and fill line attachement with strainer.

T. Grooved End Alarm check Valve: UL listed and FMG approved, 225 psig working pressure, designed for horizontal or vertical installations and have ductile iron grooved inlet and outlet or flanged inlet and grooved outlet, brass seat with nitrile seat “O” ring seals, single hinge pin and latch design. Provide valve trim with water bypass line with an in-line check valve, all required pipe, fittings, accessories, and gauges. All internal parts shall be replaceable without having to remove the valve from the installed position. Victaulic FireLock® Series 751.

U. Grooved End Dry-Pipe Valves: UL listed and FMG approved, low differential type, latched clapper design, 300 psig working pressure with ductile iron grooved inlet and outlet for vertical installation, brass seat with Nitrile seat “O” rings, aluminum bronze clapper, EPDM diaphragm and seal. Valve internal parts shall be replaceable without removing the valve from the installed position and be externally resettable. Valve shall be pre-trimmed as a Vic®-Quick Riser with Series 728 or 705W shutoff valve and Series 776 low pressure actuator. Minimum required air pressure is 13 psi and maximum 300 psi water pressure rating. Victaulic FireLock® NXT Series 768.

1. Provide Series 7C7 Compressor Package consisting of a single phase, 1/6 HP or 1/3 HP riser-mounted compressor, Series 757P air maintenance device, and flexible hoses for installation.

V. Dry-Pipe Valves: Differential type, 175 psig working pressure and have cast iron, flanged inlet and outlet, bronze seat with "O" ring seals, single hinge pin and latch design. Provide trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment and fill line attachment.

W. Air-Pressure Maintenance Device, Dry-Pipe System: An automatic device to maintain the correct air pressure in a dry-pipe system or deluge system. system shall have shutoff valves to permit servicing without shutting down the sprinkler system, bypass valve for quick system filling, pressure regulator or switch to maintain system pressure, strainer; pressure ratings 14 to 60 psig adjustable range and 175 psig maximum inlet pressure. Electrical ratings shall match compressor ratings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide sprinkler density and pipe sizing for light hazard occupancy except for equipment, storage rooms, which shall be ordinary hazard, Group II classification.

B. Install piping and products in accordance with manufacturer's written instructions and requirements of applicable ANSI/NFPA regulations. Coordinate installation with work of other trades.

C. Grooved joint piping systems shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by Victaulic. Grooved end shall be clean and free from indentations, projections

and roll marks in the area from pipe end to groove. A Victaulic factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

D. Install sprinkler heads in center of ceiling tile. Offset run outs to each head as required using flexible assemblies or rigid piping and fittings.

E. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors. Do not install sprinkler heads that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

F. Install drain piping at low points of system.

G. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints.

H. Install underground copper service-entrance piping according to NFPA 24.

I. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

J. Mount supervisory switches on each sectional valve.

K. Install air vents at high points of system.

L. Alarm wiring and manual shutoff at each audible alarm station will be provided by the Electrical Contractor.

3.2 SEALING AND FIRE STOPPING

A. Fire and/or Smoke Rated Penetrations:

1. Install approved product in accordance with the manufacturer’s instructions where a pipe penetrates a fire/smoke rated surface. When pipe is insulated, use a product which maintains the integrity of the insulation and vapor barrier.

2. Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Firestop mortar alone is not adequate to support substantial weight.

B. Non-rated penetrations

1. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the pipe and tighten in place, in accordance with manufacturer's instructions.

2. At all interior partitions and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.

3.3 CLEAN AND TEST

A. Before piping is placed in service, flush entire system to remove foreign particles as specified in ANSI/NFPA 13. Continue flushing until water is clear and check to ensure debris has not clogged sprinklers.

B. After flushing system, test piping hydrostatically at 200 psi or 50 psi in excess of maximum static pressure when static pressure is over 200 psi. Test for a period of 2 hours. Check for leakage. Repair or replace as required to eliminate any leakage and retest. Drain.

END SECTION 21 05 10

DIVISION 22 - PLUMBING
SECTION 22 05 13 – COMMON MOTOR REQUIREMENTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of electrical provisions to be provided as mechanical work is indicated in other Division 22 sections, on drawings and as further specified in this section.

B. Types of work normally recognized as electrical but provided as mechanical, specified or partially specified in this section, include but are not necessarily limited to the following:

1. Motors for mechanical equipment.

2. Wiring of field mounted float control switches and similar mechanical-electrical devices provided for mechanical systems to equipment control panels.

C. Refer to other Division 22 sections for specific individual mechanical equipment electrical requirements.

D. Refer to Division 26 sections for starters, junction boxes and disconnect switches required for motors and other electrical units of mechanical equipment.

1.3 SUBMITTALS

A. Listing, Motors of Mechanical Work: Concurrently with submittal of mechanical products listing (Basic Mechanical and Division 1 requirements), submit separate listing showing rating, power characteristics, application (connected equipment) and general location of every motor to be provided with mechanical work. Submit updated information promptly when and if initial data is revised.

1.4 QUALITY ASSURANCE

A. Coordination with Electrical Work: Wherever possible, match elements of electrical provisions of mechanical work with similar elements of electrical work specified in Division 26 sections. Comply with applicable requirements of Division 26 sections for electrical work of this section which is not otherwise specified.

B. Standards: For electrical equipment and products comply with applicable Wisconsin Electrical Code and the NEMA standards and refer to NEMA standards for definitions of terminology herein. Comply with National Electrical Code (NFPA 70) for workmanship and installation requirements.

PART 2 - PRODUCTS

2.1 MOTORS

A. Manufacturer: Except where item of mechanical equipment (which otherwise complies with requirements) must be integrally equipped with motor produced by another manufacturer, provide motors for mechanical equipment manufactured by one of the following:

Allis-Chalmers Corporation	Baldor Electric Company
Century Electric Division, Inc.	Louis Allis Div.; Litton Industrial Products, Inc.
Reliance Electric Company	Marathon Electric Manufacturing Corporation

B. Motor Characteristics: Except where more stringent requirements are indicated, comply with the following requirements for motors of mechanical work:

1. Temperature Rating: Rated for 40^{o}C environment with maximum 50^{o}C temperature rise for continuous duty at full load (Class A Insulation).

2. Starting Capability: Each motor capable of making 2 cold and 1 hot starts per hour.

3. Phases and Current Characteristics: Provide squirrel-cage induction polyphase motors for 1/2 Hp and larger and provide capacitor start single phase motors for 1/3 Hp and smaller. Coordinate current characteristics with power specified in Division 16 sections and with individual equipment requirements specified in other Division 22 requirements. For 2 speed motors provide two separate windings on polyphase motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed and until rotation directions have been confirmed.

4. Frequency Characteristics: Variable frequency motors shall be capable of operating between 6-60 HZ. Motors shall be performance matched to variable frequency drives.

5. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.

6. Power Factor: 0.85 minimum, without external capacitor correction at full load.

C. Motor Construction: Provide general purpose, continuous duty motors, Design "B" except "C" where required for high starting torque.

1. Frames: NEMA No. 48.

2. Bearings: Ball or roller bearings with inner and outer shaft seals, externally regreasable for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in motor, provide bearings designed to resist thrust loading. Refer to individual sections of Division 22 for fractional Hp light-duty motors where sleeve type bearings are permitted.

3. Enclosure Type: Except as otherwise indicated, provide open drip proof motors for indoor use where satisfactorily housed or remotely located during operation and provide guarded drip proof motors where exposed to contact by employees or building occupants. Provide weather protected Type I for outdoor use, Type II where not housed. Refer to individual sections of Division 22 for other enclosure requirements.

D. Overload Protection: Provide built-in thermal overload protection and where indicated provide internal sensing device suitable for signaling and stopping motor at starter.

E. Noise Rating: Provide "Quiet" rating on motors located in occupied spaces of building.

F. Name Plate: Provide metal name plate on each motor indicating full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

2.2 STARTERS AND ELECTRICAL DEVICES AND WIRING

A. Motor Starter Manufacturer: Except where item of mechanical equipment must be integrally furnished with motor starter produced by another manufacturer, provide motor starters for mechanical equipment manufactured by single one of the following:

Allen-Bradley Company
Cutler-Hammer, Inc.
Square D Company

B. Motor Starter Characteristics: Comply with NEMA standards and NEC. Provide Type I general purpose enclosures (unless noted otherwise) with padlock ears and with frames and supports for mounting on wall, floor or panel as indicated. Where starter location is not within sight of motor, provide disconnect switch at motor. Provide type and size of starter as shown on electrical drawings (or as recommended by motor manufacturer and equipment manufacturer for applicable protection and start-up condition); refer to individual equipment sections for basic load requirements.

1. Magnetic Starters: Provide magnetic starters for motors 1/2 Hp and larger and for smaller motors where interlock or automatic operation is indicated. Include the following:

a. Maintained contact push buttons and pilot lights properly arranged for single speed or multi-speed operation as indicated.

b. Trip free thermal overload relays, each phase.

c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls sections.

d. Built in 120-volt control circuit transformer, fused from line side, where service exceeds 120 volts.

e. Externally operated manual reset.

f. Under voltage release or protection.

2.3 EQUIPMENT FABRICATION

A. General: Fabricate mechanical equipment for secure mounting of motors and other electrical items included in work. Provide either permanent alignment of motors with equipment or adjustable mountings as applicable for belt drives, gear drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable and removable guards for motor drives, arranged for lubrication and similar running maintenance without removal of guards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 Hp and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

END SECTION 22 05 13

DVISION 22 -PLUMBING
SECTION 22 05 15 - PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of piping specialties required by this section is indicated on drawings and/or specified in other Division 22 sections.

B. Types of piping specialties specified in this section include the following:

Pipe Escutcheons	Pipeline Strainers
Dielectric Unions	Drip Pans
Sleeves	Sleeve Seals
Freeze Protection	

C. Piping specialties furnished as part of factory fabricated equipment are specified as part of the equipment assembly in other Division 22 sections.

PART 2 - PRODUCTS

2.1 MANUFACTURED PIPING SPECIALTIES

A. General: Provide factory fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service or if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated and connections which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is Installer's option.

B. Pipe Escutcheons:

1. General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.

2. Pipe Escutcheons for Moist Areas: For waterproof floors and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.

3. Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.

C. Low Pressure Y Type Pipeline Strainers:

1. Manufacturer: Subject to requirements, provide products of one of the following: Armstrong Machine Works, Hoffman Specialty, ITT Fluid Handling Division, Metraflex Company, Spirax Sarco Company, Trane Company, Victaulic Co. of America, Watts Regulator Company, or approved equal.

2. General: Comply with FCI 73-1. Provide strainers full line size of connecting piping with ends matching piping system materials. Select strainers for 125 psi working pressure with Type 304 stainless steel screens with 3/64" perforations @ 233 per square inch.

3. Threaded Ends, 2" and Smaller: Cast iron body, screwed screen retainer with centered blow down fitted with pipe plug.

4. Flanged Ends, 2-1/2" and larger: Cast iron body, bolted screen retainer with off center blow down fitted with pipe plug.

5. Butt Welded Ends, 2-1/2" and Larger: Schedule 40 cast carbon steel body, bolted screen retainer with off center blow down fitted with pipe plug.

D. Dielectric Unions: (Domestic Water Piping Only)

1. General: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from nonferrous piping (electrical conductance), prevent galvanic action and stop corrosion.

2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering dielectric unions which may be incorporated in the work include: Atlas Products Company; Capital Manufacturing Company; Eclipse, Inc.; Epco Sales, Inc.; FMC Corporation; McNally, Inc.; PSI Industries; Stockham Valves and Fittings; or approved equal.

E. Fabricated Piping Specialties:

1. Drip Pans: Provide drip pans fabricated from galvanized steel sheet metal with watertight joints and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket and flange at low point for watertight joint and 1" drain line connection.

2. Pipe Sleeves: Provide pipe sleeves of one of the following:

a. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams or welded longitudinal joint. Fabricate from the following gages: 3" and smaller, 20 gage; 4" to 6", 16 gage; over 6", 14 gage.

b. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

c. Iron Pipe: Fabricate from cast iron or ductile iron pipe; remove burrs.

3. Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, roof penetrations or in exterior walls of one of the following:

a. Lead and Oakum: Caulked between sleeve and pipe.

b. Mechanical Sleeve Seals: Modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

Manufacturer: Subject to compliance with requirements, offering mechanical sleeve seals which may be incorporated in the work include, but are not limited to, the following: Thunderline Corporation; or approved equal.

4. Sleeve Seals: Provide sleeve seals for sleeves located in interior walls, floors or other interior construction penetrations of one of the following:

a. Mechanical Sleeve Seals: Modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

b. Mineral Wool and Caulk: Pack space between sleeve and pipe with mineral wool and an expandable fire retardant caulk or putty 1/2" at each end.

c. Fire Barrier Penetration Seals:

1. Cracks, Voids or Holes Up to 4" Diameter: Use putty or caulking, one piece an expandable elastomer, noncorrosive to metal, compatible with synthetic cable jackets and capable of expanding 10 times when exposed to flame or heat, UL listed.

2. Openings 4" or Greater: Use sealing system capable of passing 3 hour fire test in accordance with ASTM E 814, consisting of wall wrap or liner, partitions and end caps capable of expanding when exposed to temperatures of 250-350°. F, UL listed.

d. Manufacturer: Subject to compliance with requirements, provide sleeve seals of the following: Manufacturer: Subject to compliance with requirements, provide sleeve seals of the following: Dow Corning; General Electric 850, 851(Pensil); Flamemaster Flamastic 77; C & R Blaze Barrier; Nelson Electric Flameseal Putty; 3M CP25 Caulk, 303 Putty; Thomas and Betts Flamesafe; Thunderline Corporation; U.S. Gypsum Thermafiber; Hilti or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF MANUFACTURED PIPING SPECIALTIES

A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions and ceilings where penetration is exposed to view (except within mechanical equipment room); and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole and is flush with adjoining surface.

B. Y Type Strainers: Install Y type strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of connection, except for strainers 2" and smaller installed ahead of control valves feeding individual terminals. Where indicated, provide drain line from shutoff valve to plumbing drain, full size of blow down connection.

1. Locate Y type strainers in supply line ahead of the following equipment and elsewhere as indicated, if integral strainer is not included in equipment:

Pumps	Temperature control valves (1" and larger)

C. Dielectric Unions: Install at each domestic water piping joint between ferrous and nonferrous piping. Comply with manufacturer's installation instructions. Dielectric unions to be used on plumbing piping only.

3.2 INSTALLATION OF FABRICATED PIPING SPECIALTIES

A. Drip Pans: Locate drip pans under piping passing over or within 3' horizontally of any electrical equipment and also as indicated below. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection and run to nearest plumbing drain.

1. Within electrical main distribution equipment rooms.
2. Within electrical communications rooms.

B. Sleeves:

1. Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings and roofs. Do not install sleeves through structural members of work except as detailed on drawings or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve including allowance for thermal expansion; but not less than 2 pipe sizes larger than piping run. Where insulation includes vapor barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated and finish flush to surface; except floor sleeves. Extend floor sleeves 1/4" above level floor finish and 3/4" above floor finish sloped to drain. Provide temporary support of sleeves during placement of concrete and other work around sleeves and provide temporary closure to prevent concrete and other materials from entering sleeves.

a. Install sheet metal sleeves at interior partitions.
b. Install steel pipe sleeves at all floor slabs and at all fire rated (1 hour or greater) walls.
c. Install iron pipe sleeves at exterior penetrations, both above and below grade.

C. Sleeve Seals: Install sleeve seals of type indicated in all pipe sleeves. Interior nonfire-rated nonacoustical partition wall sleeve seals may be deleted.

a. Provide fire barrier seals at walls to match wall fire rating.
b. Provide mechanical sleeve seals at all below grade sleeves.
c. Provide caulked sleeve seals at all above grade exterior wall sleeves and at all mechanical & electrical equipment room walls (not noted above) and at all floor slabs (not noted above).

END SECTION 22 05 15

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DIVISION 2 - PLUMBING
SECTION 22 05 23 – GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Provide factory fabricated valves recommended by manufacturer for use in service indicated.

B. Provide valves of sizes, types and pressure ratings indicated with connections that properly mate with pipe, tube and equipment connections.

C. Provide valves at all locations shown on drawings or noted as follows. Provide drain valves at all low points and where required for draining. Provide valves at all automatic control valve locations. Provide valves in all branch take-offs from main supply risers and where necessary to isolate pipe runs. Provide valves on all supply lines to equipment.

D. Butterfly valves (3" and larger) or ball valves (2-1/2" and smaller) may be substituted for gate and globe valves at Contractor's option.

E. Types of Valves specified in this section include the following

Gate	Globe
Ball	Butterfly
Drain	Lift Spring Check
Balance	Backwater Valve
Pressure Reducing	Wafer Check valve

1.3 SUBMITTALS

A. Product Data: Submit catalog cuts, specifications, installation instructions, and dimensioned drawings for each type of valve. Include pressure drop curve or chart for each size and type of valve.

B. Maintenance Data: Submit maintenance data and spare parts lists for each type of valve. Include this in maintenance manual.

1.4 QUALITY ASSURANCE

A. Marking of valves shall comply with MSS SP-25.

B. Domestic water valve stems shall be ASTM B 371-694 alloy A rod (7% zinc maximum).

PART 2 - PRODUCTS

2.1 GATE VALVES

A. Packing: Valves shall be designed for repacking under pressure when fully opened and equipped with packing suitable for service. Valve back seating shall protect packing and stem threads from fluid when valve is fully opened. Valve shall be equipped with gland follower.

B. Standards: Cast Iron Valves - MSS SP-70
Bronze Valves - MSS SP-80
Steel Valves - ANSI B16.34

C. Domestic Water Service: Flanged ends 2-1/2" and larger shall be Class 125, iron body bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge. (Jenkins #651-A or Milwaukee F-2885)

2.2 GLOBE VALVES

A. Packing: Valves shall be designed for repacking under pressure when fully opened and equipped with packing suitable for service. Valve back seating shall protect packing and stem threads from fluid when valve is fully opened. Valve shall be equipped with gland follower.

B. Composition Discs: Material shall be suitable for intended service. Fit composition disc valve with throttling nut for stem throttling service. Provide hardened stainless steel disc and seat ring for metal seated globe valves.

C. Standards: Cast Iron Valves - MSS SP-85
Bronze Valves - MSS SP-80
Steel Valves - ANSI B16.34

D. Domestic Water Service: Flanged ends 2-1/2" and larger shall be Class 125, iron body, bolted bonnet, rising stem, (S&Y, renewable seat and disc. (Jenkins #613 or Milwaukee #F2981)

E. Manufacturer: Subject to compliance with the above, one of the following: Crane; Fairbanks; Grinnell; Hammond; Jenkins; Milwaukee; Nibco Scott; Powell; Stockham; or approved equal.

2.3 DRAIN VALVES

A. Low Pressure Drainage Service: Threaded ends 1-1/2" and smaller shall be Class 125, bronze body, screwed bonnet, nonrising stem, solid wedge. Jenkins #372, Watts B-6000-CC, Watts B-6001-cc, or approved equal.

B. Manufacturer: Subject to compliance with the above, one of the following: Crane; Fairbanks; Grinnell; Hammond; Jenkins; Milwaukee; Nibco Scott; Powell; Stockham; Walworth; or approved equal.

2.4 BALL VALVES

A. Valve shall have port area equal to or greater than connecting pipe area and shall include seat ring designed to hold sealing material.

B. Standards: Cast Iron Valves - MSS SP-72
Steel Valves - ANSI B16.34

C. Domestic Water Service:

1. Threaded ends 2" and smaller shall be Class 125, bronze 2 piece body, bronze ball, bronze stem, and full port.

2. Soldered ends 3" and smaller shall be Class 125, bronze 2 or 3 piece body, chrome plated bronze ball, bronze stem, and full port.

D. Manufacturer: Subject to compliance with the above, one of the following: Apollo 77-200; Crane; Fairbanks; Grinnell; Hammond 8511; Jamesbury; Jenkins; Milwaukee BA400; Nibco Scott S580-70; Powell; Stockham; Walworth; Watts ; Whitey; or approved equal.

2.5 BUTTERFLY VALVES

A. Butterfly valves used as shutoffs for equipment or terminal removal shall be lug type. Valves for other applications shall be wafer-type. Provide ratchet handles on valves 6" and smaller and gear operators on valves 8" and larger. Comply with MSS SP-67.

B. Domestic Water Service:

1. Threaded ends 2" and smaller shall be Class 150, bronze body, full port, stainless steel trim, Viton seal. Milwaukee #BB2-100

2. Soldered ends 2" and smaller shall be Class 150, bronze body, full port, stainless steel trim, Viton seal. Milwaukee #BB2-350

3. Wafer type 3" and larger shall be Class 150, cast-iron body, lever operated, chromium plated ductile iron disc, Type 410 stainless steel stem, EPDM seat. (Jenkins #200-series) (Jenkins # 225-series for high pressure)

4. Lug type 2.5" and larger shall be Class 150, cast iron or ductile iron body, lever operated, chromium plated ductile iron or S.S. disc, Type 416 stainless steel stem, EPDM seat. (Jenkins-series) (Jenkins # 225-series for high pressure)

C. Manufacturer: Subject to compliance with the above, one of the following: Apollo,Crane; DeZurik; Fairbanks; Grinnell; Hammond; Jenkins; Milwaukee; Nibco; Powell; Stockham; Victualic; Watts; or approved equal.

2.6 SWING CHECK VALVES

A. Unless a composition disc is specified, valves 1.5" and smaller shall be bronze, regrinding, with seating angle 40-45°. Provide stop plug as a renewable stop for disc hanger, unless otherwise specified. Disc and hanger shall be separate parts, and the disc free to rotate. Hanger pins shall be supported on both ends by removable side plugs.

B. Standards: Bronze Valves to 150 psi - ANSI/ASTM B 62

Metallic Seated Bronze Valves to 300 psi	- ANSI/ASTM B 61
Iron Body Valves	- ANSI/ASTM A 126, Grade B
All Valves	- MSS SP-71

C. Domestic Water Service:

All water system valves to be rated at not less than 125 water working pressure at 240 degrees F unless noted otherwise.

1. Threaded ends 1.5" and smaller shall be Class 125, bronze body, screwed cap, horizontal swing, bronze disc. Crane 1342, Hammond IB941, Nibco S413B, Watts CVYS, Jomar, Apollo, Milwaukee, or approved equal.

2. Soldered ends 2" and smaller shall be Class 125, bronze body, screwed cap, horizontal swing, bronze disc. (Jenkins #1222)

3. Flanged ends 2" and larger shall be Class 125, iron body bronze mounted, bronze trim, bolted cap, horizontal swing, non asbestos gasket, renewable bronze disc. Crane 383, Milwaukee F2974, Nibco F918B, or approved equal.

D. Manufacturer: Subject to compliance with the above, one of the following: Crane; Jenkins; Nibco Scott; Powell; Stockham; Walworth; Milwaukee; Hammond; Watts; Jomar; Apollo; or approved equal.

2.7 WAFER CHECK VALVES

A. Provide wafer style, butterfly type spring actuated check valves that are designed to be installed with gaskets between standard Class 125 flanges.

B. Standards: Iron Valves - ANSI/ASTM A-126, Grade B

C. Water Service: 2.5" and larger shall be Class 125, cast iron body, bronze or stainless steel trim, bronze disc, bronze or EPDM seat. (Nibco Scott W-910)

D. Manufacturer: Subject to compliance with the above, one of the following: APCO 300/600; Bell and Gossett; Centerline CLC with full body options; Hammond IR9354; Milwaukee 1800; Jenkins; Nibco Scott; Stockham; Val-Matic 1400/1800/8000; Vitaulic; or approved equal.

2.8 LIFT CHECK VALVES

A. Valves 2" and smaller shall be bronze (or forged steel for HP steam).

B. Valves 2.5” and larger shall be cast or ductile iron, wafer or globe type.

C. Standards: Bronze Valves - ANSI/ASTM B 62
All Valves - ANSI/FCI 74-1

D. Horizontal lift check valves shall be straight pattern, threaded ends, rated for 150 psi saturated steam, renewable composition disc, screw-over cap, bronze body. (Jenkins #117-A)

E. Vertical lift check valves shall be straight pattern, threaded ends, rated for 150 psi saturated steam, renewable composition disc, screw-in hub, bronze body. (Jenkins #119)

F. Spring loaded horizontal lift check valves shall be straight pattern, threaded ends, rated for 150 psi saturated steam, renewable composition disc, phosphor bronze spring, screw-over cap, bronze body. (Jenkins #655-A)

G. Manufacturer: Subject to compliance with the above, one of the following:

1.) 2” and smaller, ConBraCo , Mueller 203BP, Nibco S480Y, and Val-Matic S1400.
2.) 2.5” and larger APCO 300, Centerline, Hammond, Milwaukee 1800, Mueller 101 AP, Nibco W910 or F910, Val-Matic 1400/1800/8000.

2.9 PRESSURE REDUCING VALVES:

A. Bronze body, diaphram operated, with an integral thermal expansion bypass, inlet union, stainless steel strainer, renewable monel or stainless steel seat and adjustable reduced pressure range, 300 plig at 160°F. Preset for the scheduled water pressure (80 psig for domestic water service).

B. Manufacturer: Subject to compliance with the above, one of the following: Conbraco; Watts; Wilkins or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valves according to manufacturer's recommendations. Locate valves so as to be accessible for operating and servicing with access panels provided where required. Install valves with stems horizontal or above. Provide dielectric unions only on plumbing piping between valves and piping when dissimilar metals are to be joined.

B. Mount valves in locations which allow access for operation, servicing and replacement.

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

D. Install shut-off valves at each piece of equipment, at each branch take-off from mains for isolation or repair and elsewhere as indicated.

END SECTION 22 05 23

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DVISION 22 - PLUMBING AND SEWERING
SECTION 22 05 29 - SUPPORTS, ANCHORS AND SEALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of supports, anchors and seals required by this section is indicated on drawings and/or specified in other Division 22 sections.

B. Supports, anchors and seals furnished as part of factory fabricated equipment are specified as part of the equipment assembly in other Division 22 sections.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacturer of supports, anchors and seals of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Code Compliance: Comply with applicable plumbing codes pertaining to product materials and installation of supports, anchors and seals.

C. UL and FM Compliance: Provide products which are Underwriters Laboratories listed and Factory Mutual approved.

D. MSS Standard Compliance:

1. Provide pipe hangers and supports of which materials, design and manufacture comply with ANSI/MSS SP-58 and the latest requirements of ANSI code.

2. Select and apply pipe hangers and supports, complying with MSS SP-69 & SP-58.

PART 2 - PRODUCTS

2.1 MANUFACTURERS OF HANGERS AND SUPPORTS

A. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following: Copper B-Line, F & S Central Manufacturing; Fee & Mason Manufacturing; ITT Grinnel/Anvil International; Caddy, Cooper, Unistrut or approved equal.

2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports complying with ANSI/MSS SP-58 of one of the following types listed, selected by Installer to suit horizontal piping systems in accordance with manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper plated hangers and supports for copper piping systems. For plenum return applications ensure hangers meet UL 2043 flame and smoke testing. Provide the following or approved equal.

B. Adjustable Steel Clevises: (1/2" - 2") Grinnell Fig. 65 or 260.

C. Adjustable Steel Clevises: (2-1/2" - 30") Grinnell Fig. 260, B line B3100, or Anvil 260.

D. Alloy Steel Pipe Clamps: (high temp 4" to 20") Grinnell F224 and 246. B-Line type S with B-2000 Series clamps, Anvil type PS 200H with PS 1200 clamps. Use B-line B1999 Vibra Cushion for insulated copper piping or manufacturers clamp and cushion assembly.

E. Steel Pipe Clamps: (1/2" - 12" w/no insulation) Grinnell Fig. 212 and 216. B-Line type S with B-2000 Series clamps, Anvil type PS 200H with PS 1200 clamps. Use B-line B1999 Vibra Cushion for insulated copper piping or manufacturers clamp and cushion assembly.

F. Adjustable Steel Band Hangers: (1/2" - 2" noninsulated) Grinnell Fig. 269.

G. Split Pipe Rings: (3/8" - 2" noninsulated) Grinnell Fig. 108.

H. U-Bolt: Grinnell 137 and 137C.

I. Clips: Grinnell PS 1100 (Non-hanging).

J. Pipe Slides and Slide Plates: Grinnell 438, Type 2 and 3.

K. Pipe Stanchion Saddles: Grinnell 259, including steel pipe base support and cast iron floor flange.

L. Single Pipe Rolls: Grinnell 171.

M. Adjustable Roller Hangers: Grinnell 181.

N. Pipe Roll Stands: Grinnell 271.

O. Pipe Rolls and Plates: Grinnell 277.

2.3 VERTICAL PIPING CLAMPS

A. General: Except as otherwise indicated, provide factory fabricated vertical piping clamps complying with ANSI/MSS SP-62 of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper plated clamps for copper piping systems.

B. Two Bolt Riser Clamps: Grinnell Fig. 261 and 261C or B-Line B3373, Anvil 261 for above floor use.

2.4 HANGER ROD ATTACHMENTS

A. General: Except as otherwise indicated, provide factory fabricated hanger rod attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal piping hangers and building attachments in accordance with manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger rod attachments to suit hanger rods. Provide copper plated hanger rod attachments for copper piping systems.

B. 1/2” & 3/8” Grinnell 89.

C. 5/8” to 1-1/2” Grinnell 228.

D. Steel Turnbuckles: Grinnell 230.

E. Swivel Turnbuckles: Grinnell 114.

2.5 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated, provide factory fabricated building attachments complying with ANSI/MSS SP-58 and MSS SP-69 of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper plated building attachments for copper piping systems.

B. Concrete Inserts: Grinnell Fig. 282 and 281.

C. Side Beam or Channel Clamps: Grinnell Fig. 226 and 266 and 265.

D. Center Beam Clamps: Grinnell Fig. 131.

E. Welded Attachments: Grinnell Fig. 66.

F. C Clamps: Grinnell Fig. 86 and 87.

G. Malleable Beam Clamps: Grinnell Fig. 229. Malleable black iron B-Line B3036L/B3034, Anvil 86/92, or approved equal.

H. Forged Steel Jaw type clamp: MSS SP-69 Type 28 or Type 29, B-Line B3054, Anvil 228 or approved equal.

I. Steel Brackets: One of the following for indicated loading:

Light Duty:	(600#)	Grinnell 194
Medium Duty:	(1200#)	Grinnell 195
Heavy Duty:	(2400#)	Grinnell 199

2.6 SADDLES AND SHIELDS

A. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory fabricated for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

B. Protection Saddles: Grinnell 160-166A; fill interior voids with segments of insulation matching adjoining insulation.

C. Protection Shields: Grinnell 167; of length recommended by manufacturer to prevent crushing of insulation.

2.7 SPRING HANGERS AND SUPPORTS

A. General: Except as otherwise indicated, provide factory fabricated spring hangers and supports complying with ANSI/MSS SP-58 and 69, of one of the following MSS types listed, selected by Installer to suit piping systems, in accordance with manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.

B. Spring Cushion Hangers: Grinnell Fig. 82.

C. Spring Cushion Roll Hangers: Grinnell Fig. 178.

2.8 MISCELLANEOUS MATERIALS

A. Metal Framing: Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars: Provide products complying with ANSI/ASTM A36.

C. Cement Grout: Portland Cement (ANSI/ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ANSI/ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand by volume with a minimum amount of water required for placement and hydration.

D. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards. Provide steel channels with welded spacers and hanger rods.

E. Pipe Guides: Provide factory fabricated guides of cast semisteel or heavy fabricated steel consisting of a bolted two section outer cylinder and base with a two section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any) and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed.

B. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments. Attachments to structural steel shall be completed prior to installation of structural fireproofing.

3.2 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations within concrete or on structural steel prior to installation of structural fireproofing for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69.

B. Install additional building attachments where support is required for additional concentrated loads including valves, flanges, guides, strainers, expansion joints and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping. Support spacing shall be based on midspan deflection of 0.5" maximum and allowable bending stress of 10,000 psi.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Equipment room piping over 3-1/2" shall be supported by spring cushion hangers.

D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated or by other recognized industry methods.

E. Provisions for Movement: Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

F. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.

H. Insulated Piping: Comply with the following installation requirements:

1. Clamps: Attach clamps to hot water and steam piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

2. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields. For pipe 8" and over install wood insulation saddles.

3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

3.4 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent transfer of loading and stresses to connected equipment. Use welding steel shapes, plates, and bars to secure piping to the structure.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure prior to installation of structure fireproofing. Comply with ANSI B31 and with AWS standards.

C. Where expansion compensators are indicated install anchors in accordance with expansion unit manufacturer's written instructions to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required accommodating both expansion and contraction of piping.

3.5 ADJUSTMENT OF HANGERS AND SUPPORTS

A. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

3.6 EQUIPMENT BASES

A. Use structural steel members welded to and supported by pipe supports. Clean, prime, and coat with 3 coats of rust inhibiting alkyd paint or one coat epoxy mastic. Where exposed to weather, treat with atmospheric coating.

B. Concrete housekeeping bases shown on drawings will be provided as work of Division 3. Furnish to Contractor, scaled layouts of all required bases with dimensions of bases and location to column center lines. Furnish templates, anchor bolts and accessories necessary for base construction.

END SECTION 22 05 29

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DIVISION 22 – PLUMBING
SECTION 22 07 00 – PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 REFERENCES

A. ANSI/ASTM C533 – Calcium Silicate Block and Pipe Thermal Insulation

B. ANSI/ASTM C534 – Elastomeric Foam Insulation.

C. ASTM C591 – Unfaced Preformed Rigid Cellular Polyisocyanurate Insulation

D. ASTM E84 – Surface Burning Characteristics of Building Materials.

E. NFPA 255 – Surface Burning Characteristics of Building Materials.

F. UL 723 – Surface Burning Characteristics of Building Materials.

1.3 DESCRIPTION OF WORK

A. Provide thermal insulation for piping and equipment as specified herein.

B. Insulation thicknesses required for the various system types are as scheduled on plans, as required by the Wisconsin Administrative Code, and as specified herein. In case of conflict, the more rigid requirement shall apply. All insulation thicknesses listed are based on a minimum thermal efficiency (R-Value) with the intent to provide a minimum thermal efficiency. Install insulation in accordance with latest MICA standards and manufacturer instructions.

1.4 SUBMITTALS

A. Certifications: Submit certifications or other data as necessary to show compliance with these specifications and governing regulations.

B. Submit a schedule indicating Service (HW, CW, Equipment, etc.), Insulation type, and Insulation Thickness.

1.5 QUALITY ASSURANCE

A. Installer shall be firm trained and regularly engaged in the application of mechanical insulations. Installer shall be responsible for all debris, rubbish and damages to building parts caused by his operation.

B. Materials: Flame Spread/Smoke developed rating of 25/50 in accordance with ASTM E84,NFPA 255, or UL 723 (where required)

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following: Armstrong; Certainteed; Gustin Bacon; Knauf; Manville Co.; Owens-Corning; United States Gypsum; or approved equals.

2.2 FLAME SPREAD/SMOKE DEVELOPED RATING

A. Insulation systems shall have a flame spread/smoke developed rating of 25/50 or less.

2.3 FIBERGLASS PIPE INSULATION

A. Fiberglass pipe insulation shall be rigid heavy density insulation with "K" factor of .23 at 75^{o}F and factory applied fire retardant vapor barrier jacket of white kraft bonded to aluminum foil with fiberglass reinforcing. Manville Microlok 650 or equal.

B. Fiberglass Pipe Fitting Insulation:

1. Hot water pipe fittings and valves shall be insulated with premolded fiberglass fittings or mineral wool cement with 1/4" coat of hydraulic setting finishing cement to a thickness equal to adjacent pipe insulation. Vapor seal fittings with fiberglass tape and completely seal with Benjamin Foster 30-35. Preformed PVC jackets may be used.

2. All other pipe fittings and valves may be insulated with fiberglass miter segments of equal thickness of adjoining insulation with 1/4" coat of hydraulic setting finishing cement. Vapor seal fittings with fiberglass tape and completely seal with Benjamin Foster 30-35.

3. ANSI/ASTM C547, .24 maximum “K” value at 75° F non-combustible. All purpose, white kraft jacket bonded to aluminum foil and reinforced with fiberglass, 25/50 flame spread/smoke developed rating.

2.4 FLEXIBLE ELASTOMERIC PIPE INSULATION

A. Flexible elastomeric pipe insulation shall have "K" factor of .27 at 75^{o}F ANSI/ASTM C534, flexible plastic, 25/50 flame/smoke developed rating. Armstrong Armaflex II with Armstrong 520 sealant, or equal.

B. Flexible elastomeric pipe insulation fittings shall be fabricated from miter cut piping insulation or sheet insulation.

2.5 UNDER SINK/LAVATORY PIPE INSULATION

A. Provide molded closed cell vinyl insulating wrap for all exposed piping under all handicapped accessible sinks and lavatories. System shall be equal to “Handi Lav-Guard” by Truebro, Inc.

2.6 FLEXIBLE FIBERGLASS EQUIPMENT INSULATION

A. Flexible fiberglass equipment insulation shall be semirigid fiberglass with fibers perpendicular to jacketing, "K" factor of .25 at 75^{o}F, 3 lbs./cubic foot density, 450^{o}F temperature rating and factory applied fire retardant vapor barrier jacket of white kraft bonded to aluminum foil with fiberglass. Knauf Elevated Temperature Flex-Wrap.

2.7 FOAM-PLASTIC BOARD INSULATION (Use for buried pipe)

A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. DiversiFoam Products.
2. Dow Chemical Company (The).
3. Owens Corning.
4. Pactiv Corporation.

C. Classifications and tests:

1. Type V, 100 psi (690 kPa).
2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

2.8 FIRE BARRIER PLENUM WRAP

A. Fire resistant flexible fiber wrap consisting of inorganic blanket encapsulated with a scrim-reinforced foil providing a non-combustible enclosure for combustible plastic pipes in return air plenums as tested to UL 910. 3M Fire Barrier Plenum Wrap 5A or equal.

2.9 ACCESSORIES

A. Bedding Compounds: Nonshrinking, permanently flexible, compatible with insulation.

B. Vapor Barrier Coating: Nonflammable, fire resistant, polymeric resin, compatible with insulation.

C. Insulating Cement: ANSI/ASTM C195, hydraulic setting mineral wool.

D. Wire Mesh: Corrosive resistant metal, hexagonal pattern.

PART 3 - EXECUTION

3.1 DOMESTIC WATER PIPING INSULATION

A. Domestic cold and hot water piping shall be insulated as scheduled. Cold piping shall be provided with vapor barrier.

3.2 EQUIPMENT INSULATION

A. Insulate equipment as scheduled.

3.3 COMBUSTIBLE PIPE MATERIALS LOCATED IN RETURN AIR PLENUMS

A. Insulate combustible piping where located in return air plenums with fire barrier plenum wrap. Fire barrier plenum wrap replaces thermal insulation where scheduled to be ½" thick. Where thermal insulation is scheduled to be thicker than ½", the pipe material shall be non-combustible.

3.4 INSULATION INSTALLATION

A. Install insulation products in accordance with manufacturer's written instructions and in accordance with recognized industry standards to ensure that insulation serves its intended purpose. Clean and dry surfaces prior to installation. Apply when surfaces to be insulated are at room temperature. Use adhesives, sealers, protective finishes, staples, bands, wires, studs, pins, clips, etc. as recommended by manufacturer. Staples or other fasteners that may puncture vapor barrier shall not be used on cold water piping. Maintain integrity of vapor barriers. Extend insulation without interruption through walls, floors and similar penetrations, except where otherwise indicated. Install protective metal shields and insulated inserts wherever needed to prevent compression of insulation. Do not insulate over nameplates and labels; bevel and seal around such. Fill cracks, joints, seams and depressions with bedding compound or vapor barrier cement. Provide smooth finish on all insulated surfaces.

B. Fiberglass pipe insulation shall be continuous, uninterrupted through the hanger. Hanger shall be sized for the outside diameter of the pipe insulation. Install sheet metal shield between bearing point of hanger and insulation. Provide inserts where required. All Insulation material shall be applied only when ambient temperature is between 40° F and 110° F. Adhesive and lap must be free from dirt and water. Pressurize lap seal repeatedly with sealing tool. Wrap end joints with 3" wide vapor barrier tape. Seal off ends of pipe insulation with glass cloth and vapor barrier coating.

C. Flexible elastomeric pipe insulation shall be completely sealed along seams and butt joints with full covering of adhesive on both surfaces to be joined. Insulation shall not be stretched or forced to a longer length. Paint insulation to match adjacent insulation. Exterior piping insulation shall be painted with UV protective paint.

D. Fire barrier plenum wrap system shall be installed in accordance with UL 910 and the manufacturer's instructions using appropriate size sheets, specified perimeter and longitudinal material overlaps, filament tape, minimum ½" wide steel or 16 gauge steel wire banding material.

3.5 INSULATION SCHEDULES

Piping Service	**Insulation Type ***	**Insulation Thickness by Pipe Size**				
		1" and smaller	1-1/4" to 2"	2-1/2" to 4"	5" to 6"	8" and larger .
Hot Water (Sply & Rtn)	rigid fiberglass	1-1/2"	1-1/2"	2"	2"	2-1/2"
Cold Water	rigid fiberglass	1"	1"	1"	1"	1"
Vents (within 6 lf of roof outlet), unless PVC	rigid fiberglass	1/2"	1/2"	1/2"	1/2"	1/2"

***** Provide a protective metal jacket for all insulated piping exposed to the weather and in the following locations:

****** Fire barrier plenum wrap replaces thermal insulation where scheduled to be ½" thick. Where the thermal insulation is scheduled to be thicker than ½", the pipe material shall be non-combustible.

EQUIPMENT INSULATION

Do not insulate over equipment access manholes, fittings, nameplates or ASME stamps. Bevel and seal insulation at these locations.

SEMI-RIGID FIBERGLASS:

Apply insulation to equipment shells using weld pins, bonding adhesive, banded and wired in place. Fill all joints, seams and depressions with insulating cement to a smooth, even surface. Cover with reinforcing fabric and 2 coats of mastic. . Use vapor barrier mastic on systems requiring a vapor barrier.

EQUIPMENT INSULATION SCHEDULE:
Provide equipment insulation as follows:

Equipment Type	**Insulation Type**	**Thickness**
Water heaters	flexible fiberglass	2"
Pumps and strainers (hot and cold media)	rigid fiberglass	1-1/2"
Water Meter	Elastomeric	1 /2"

END SECTION 22 07 00

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DIVISION 22 - PLUMBING
SECTION 22 10 50 - PIPE, TUBE AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.
B. Section - 22 07 00 Plumbing Insulation

1.2 DESCRIPTION OF WORK

A. Extent of pipe, tube and fittings required by this section is indicated on drawings and/or specified in other Division 22 sections.

B. Types of pipe, tube and fittings specified in this section include the following:

1. Piping Materials:
   Steel Pipe
   Copper Tube
   Cast Iron Pressure Pipe
   Cast Iron Soil Pipe
   Concrete Pipe
   Plastic Pipe
   Plastic Tubing

2. Pipe/Tube Fittings:
   Fittings for Steel Pipe
   Fittings for Copper Tube
   Fittings for Cast Iron Pressure Pipe
   Fittings for Cast Iron Soil Pipe
   Fittings for Plastic Pipe
   Fittings for Plastic Tubing

3. Grooved Piping Products

4. Miscellaneous Piping Materials/Products

C. Pipe, tube and fittings furnished as part of factory fabricated equipment are specified as part of the equipment assembly in other Division 22 sections.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacturer of pipe, tube and fittings of types and sizes required, whose products have been in satisfactory use in similar service

for not less than 5 years.

B. Welding: Quality welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9 as applicable, for shop and project site welding of piping work.

Certify welding of piping work using the Standard Procedure Specifications by and welders tested under supervision of the National Certified Pipe Welding Bureau (NCPWB).

C. Brazing: Certify brazing procedures, brazers and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job site brazing of piping work.

1.4 DELIVERY, STORAGE AND HANDLING

A. Except for concrete, hub and spigot and similar units of pipe, provide factory applied plastic end caps on each length of pipe and tube. Maintain end caps through shipping, storage and handling as required to prevent pipe end damage and eliminate dirt and moisture from inside of pipe and tube.

B. Where possible store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure or by packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. General: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service.

B. Steel Pipe (4" and larger shall be seamless):

1. Black Steel Pipe: ANSI/ASTM A53.
2. Galvanized Steel Pipe: ANSI/ASTM A53.
3. Seamless Steel Pipe: ANSI/ASTM A53.
4. Galvanized Seamless Steel Pipe: ANSI/ASTM A53.
5. Electric Resistance Welded Steel Pipe: ANSI/ASTM A135.
6. Steel Water Pipe: ANSI/AWWA C200 for pipe 6" and larger.

C. Copper Tube:

1. Copper Tube: ANSI/ASTM B88;
   a. Type L for Domestic Water above grade; hard drawn temper.
   b. Type K for direct buried Domestic Water; soft copper without joints below grade.

2. DWV Copper Tube: ANSI/ASTM B306.
3. ACR Copper Tube: ANSI/ASTM B280.
   a. Type L for above grade medical gases; hard drawn temper.

D. Cast Iron Pressure Pipe:

1. Cast Iron Pressure Pipe: ANSI A21.6; ANSI/AWWA C106 and B16.4.
2. Ductile Iron Pipe: ANSI A21.5; ANSI/AWWA C151.
3. Cement Mortar Lining for Cast Iron and Ductile Iron Pipe and Fittings: ANSI A21.4; ANSI/AWWA C104.

E. Cast Iron Soil Pipe:

1. Hub less Cast Iron Soil Pipe: CISPI 301; include coupling assembly; CISPI 310.
2. Cast Iron Hub and Spigot Soil Pipe: ANSI/ASTM A74.

F. Concrete Pipe: Reinforced concrete pipe ANSI/ASTM C76 with modified tongue and groove compression gasket joints complying with ANSI/ASTM C443.

G. Plastic Pipe:

1. Polyvinyl Chloride Pipe (PVC): ANSI/ASTM D1785. D2466 for schedule 40.
2. Polyvinyl Chloride Sewer Pipe (PVC): ANSI/ASTM D2729. 2464 for schedule 80.
3. Polyvinyl Chloride Plastic Drain, Waste and Vent Pipe (PVC): ANSI/ASTM D2665.
4. ABS Waste and Vent Pipe: ASTM D3311.
5. Chlorinated Polyvinyl Chloride CPVC ASTM D1784.
6. Polyvinylidene Fluoride (PVDF).

H. Plastic Tubing:

1. Polyethylene Plastic Tubing (PE): ASTM D2737.

I. PVC Coated Steel Pipe: Black steel (seamless) pipe, schedule 40, machine wrapped with 1/32" PVC tape with 50% overlap.

2.2 PIPE/TUBE FITTINGS

A. General: Provide factory fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, and valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections and with pipe manufacturer's recommendations where applicable.

B. Fittings for Steel Pipe:

1. General: Piping 2-1/2" and larger shall be welded and piping 2" and smaller may

have screwed fittings.

2. Malleable Iron Threaded Fittings: ANSI B16.3; plain or galvanized as indicated.

3. Malleable Iron Threaded Unions: ANSI B16.39; selected by Installer for proper piping fabrication and service requirements including style, end connections and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated.

4. Threaded Pipe Plugs: ANSI B16.14.

5. Steel Flanges/Fittings: ANSI B16.5 including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated:

   a. Material Group: Group 1.1
   b. End Connections: Butt Welding
   c. Facings: Raised face

6. Steel Pipe flanges for Waterworks Service: ANSI/AWWA C207.

7. Forged Steel Socket Welding and Threaded Fittings: ANSI B16.11 except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe. Use of welded branchlets will be allowed.

8. Wrought Steel Butt-welding Fittings: ANSI B16.9 except ANSI B16.28 for short radius elbows and returns; rated to match connected pipe.

9. Cast Iron Threaded Drainage Fittings: ANSI B16.12.

10. Forged Branch Connection Fittings: Except as otherwise indicated, provide type as determined by Installer to comply with installation requirements.

11. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2" and where pipe size is less than 1-1/2" and do not thread nipples full length (no close nipples).

12. PVC fittings: Welded joints and fittings shall be protected with hand wrapped PVC tape (12 mill) using 150% overlap extending 6" beyond end of machine wrap.

C. Fittings for Copper Tube:

1. Wrought Copper Solder Joint Fittings: ANSI B16.22 and ASTM B32.
2. Wrought Copper Solder Joint Drainage Fittings: ANSI B16.29
3. Cast Copper Flared Tube Fittings: ANSI B16.26.
4. Bronze Pipe Flanges/Fittings: ANSI B16.24.
5. Nonferrous Pipe Flanges: ANSI B16.31.

6. Copper Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.

D. Fittings for Cast Iron and Ductile Iron Pressure Pipe:

1. Cast Iron Fittings: ANSI A21.10; ANSI/AWWA C110 and ANSI B16.4.
2. Ductile Iron Fittings: ANSI A21.10; ANSI/AWWA C110.
3. Rubber Gasket Joints: ANSI A21.11; ANSI/AWWA C111.

E. Fittings for Cast Iron Soil Pipe:

1. Hubless Cast Iron Soil Pipe Fittings: CISPI 301; and complying with governing regulations.
2. Cast Iron Hub and Spigot Soil Pipe Fittings: Match soil pipe units; complying with same standards (ANSI/ASTM A74).
3. Compression Gaskets: CISPI Standard HSN.
4. Lead/Oakum Joint Materials: Provide products complying with governing regulations for use in service indicated.

F. Fittings for Plastic Pipe:

1. PE Pipe Fittings: ASTM D2609 for insert fittings; ANSI/ASTM D3261 for Schedule 40 and 80.
2. PVC Sewer Pipe Fittings: Match PVC sewer pipe; comply with same standard (ANSI/ASTM D2729); ANSI/ASTM D2564 for solvent cement.
3. ABS Pipe fittings ASTM 2661 Match ABS sewer pipe ASTM D2255 for solvent cement.
4. Chlorinated Polyvinyl Chloride (CPVC) ASTM-F-493 solvent cement.
5. Polyvinylidene Fluoride (PVDF) heat fusion joints.

G. Fittings for Plastic Tubing:

1. General: Provide fittings of type indicated, matching tubing. Where not otherwise indicated, provide fittings produced and recommended for service indicated by manufacturer of tubing.

2.3 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.

1. Comply with Section II, Part C, ASME Boiler and Pressure
2. Vessel Code for welding materials.

B. Soldering Materials: Except as otherwise indicated, provide soldering materials as determined by Installer to comply with installation requirements.

1. Tin Antimony Solder (95-5 solder): ANSI/ASTM B32, Grade 95TA.

2. Silver Solder (15% silver minimum): ANSI/ASTM B32, Grade 96.5TS.
3. Flux ASTM B813.

C. Brazing Materials: Except as otherwise indicated, provide brazing materials as determined by Installer to comply with installation requirements.

1. Comply with Section IX, ASME Boiler and Pressure Vessel
2. Code for brazing materials.
3. Copper phosphorous brazing alloy, AWS A5.8 BCuP

D. Gaskets for Flanged Joints: ANSI B16.21; full faced for cast iron flanges; raised face for steel flanges, unless otherwise indicated.

E. Piping Connectors for Dissimilar No pressure Pipe: Elastomeric annular ring insert or elastomeric flexible couplings secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code. Provide as required by plumbing code.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leak-proof piping systems capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/ replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections within 1/16" misalignment tolerance.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent enclosure elements of building; limit clearance to 1/2" where furring is shown for enclosure or concealment of piping but allow for insulation thickness, if any. Where possible, locate insulated piping for 1.0" clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions except as indicated.

C. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures. Install drip pan under piping located above and within 3' horizontally of electrical panels.

D. Piping installed in Plenums:

1. All piping installed in air plenums shall be constructed of materials having a 25/50 flame spread/smoke developed rating or less, or have fire barrier plenum wrap installed to achieve required rating per UL 910. See section 22 07 00 Plumbing Insulation.

E. Piping System Joints: Provide joints of type indicated in each piping system.

1. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer on male threads at each joint and tighten joint to leave not more than 3 threads exposed. No hard setting pipe thread cement permitted.

2. Braze copper tube and fitting joints where indicated in accordance with ANSI B31.

3. Solder copper tube and fitting joints where indicated in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

4. Weld pipe joints in accordance with ANSI B31 and recognized industry practice and as follows:

a. Weld pipe joints only when ambient temperature is above 0^{o}F (-18^{o}C).

b. Bevel pipe ends at a 37.5° angle, smooth rough-cuts and clean to remove slag, metal particles and dirt.

c. Install welding rings for butt-welded joints (for HP steam only).

d. Use pipe clamps or tack weld joints with 1" long welds; 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".

e. Build up welds with stringer beam pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow holes and nonmetallic inclusions.

f. Do not weld out piping system imperfections by tack welding procedures; refabricate to comply with requirements.

g. At Installer's option, install forged branch connection fittings wherever branch pipe is indicated, or install regular "T" fitting, or install welded

branch let.

h. At Installer's option, install forged branch connection fittings wherever branch pipe of size smaller than main pipe is indicated; or install regular "T" fitting.

5. Weld pipe joints of steel water pipe in accordance with AWWA C206.

6. Flanged Joints: Match flanges within piping system and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

7. Lead Joint Installation: Tightly pack joint with joint packing material. Do not permit packing to enter bore of finished joint. Clean joint after packing. Fill remaining joint space with one pouring of lead to indicate minimum depth measured from face of bell. After lead has cooled, caulk joint tightly by use of hammer and caulking iron.

8. Hubless Cast Iron Joints: Comply with CISPI 310.

9. Plastic Pipe/Tube Joints: Comply with manufacturer's instructions and recommendations and with applicable industry standards:

a. Heat Joining of Thermoplastic Pipe: ANSI/ASTM D2657.
b. Making Solvent Cemented Joints: ANSI/ASTM D2235, ANSI/ASTM F402, and ASTM D2855.

10. Install gray and ductile cast iron water mains and appurtenances in accordance with ANSI/AWWA C600.

11. Install concrete pipe in accordance with American Concrete Pipe Association "Concrete Pipe Field Manual."

3.2 CLEANING, FLUSHING, INSPECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items. Inspect pressure piping in accordance with procedures of ANSI B31.

B. As soon as the water distribution system has been flushed out as above specified, it shall be sterilized in accordance with the requirements of the Health Department or in the absence of such, by the following method:

1. Introduce chlorine or solution of calcium or sodium hypochlorite, filling the lines slowly and applying the sterilizing agent at a rate of 50 parts per million of chlorine for 24 hours, as determined by residual chlorine tests at the ends of the

lines. Open and close all valves and hydrants while the system is being chlorinated.

2. Tests shall be conducted to determine the plate count after the system has been rinsed of chlorine. The system shall be sterilized and rinsed until a plate count of less than 10 colonies per milliliter is maintained. Three copies of the final test shall be submitted to the owner. Test to confirm an absence of coliform bacteria.

3.3 PIPING TESTS

A. Test pressure piping in accordance with ANSI B31.

B. General: Notify owner's construction supervisor two working days prior to testing and cleaning piping systems. Owner's construction supervisor to witness and approve procedures and results. Provide temporary equipment for testing including pump and gages. Test piping system before insulation is installed wherever feasible and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.

System	Test Pressure	Remarks	Duration
Below Ground Domestic Water	150 psig	-	8 hr
Above Ground Domestic Water	100 psig	-	8 hr
Sanitary Waste and Vent	10' water	-	2 hr
Storm and Clearwater Waste	10' water	-	2 hr
Pressurized Storm and Clearwater Waste	100 psig	-	2 hr

Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.

C. Isolate or remove components from system which are not rated for test pressure. Test piping in sections or entire system as required by sequence of construction. Do not insulate or conceal pipe until it has been successfully tested.

D. Repair piping systems sections that fail required piping test by disassembly and reinstallation, using new materials to extent required to overcome leakage. Do not use chemicals, stop leak compounds, mastics or other temporary repair methods.

E. Drain test water from piping systems after testing and repair work has been completed

F. Reference other Division 22 sections for piping system sterilization and cleaning procedures required.

G. Prepare test report for each piping system showing piping service, test pressure, test period, required repairs if any, retest data, cleaning and sterilization compounds used. Owner's construction supervisor to witness testing and cleaning procedures and provide approval signature on completed form verifying report data. Submit test report to

architect for approval.

END SECTION 22 10 50

DIVISION 22 - PLUMBING
SECTION 22 11 00 – FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Provide a complete system of domestic hot, cold and recirculation water piping as indicated on drawings and in specifications. Provide a new water meter in conformance with city utility requirements.

PART 2 - PRODUCTS

2.1 DOMESTIC HOT, COLD AND RECIRCULATION WATER PIPING:

A. General: Provide piping materials of factory fabricated piping products of sizes, types, pressure and temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by industry standards and governing regulations. Where more than one type of materials or products is indicated, selection is Installer's option.

B. Above Grade Piping: Type "L" hard drawn copper tube ASTM B88; with wrought copper pressure fittings and solder joints.

H (drawn) temper, ASTM B88; wrought copper pressure fittings, ANSI B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; copper phosporous brazing alloy, AWS A5.8 BCuP. Copper mechanical grooved fittings and couplings on roll grooved pipe may be used in lieu of soldered fittings.

C. Above Grade Piping: Schedule 40 galvanized steel.

D. Below Ground 3” and Larger:

Ductile iron pipe, mechanical or push on joint, thickness Class 52, AWWA C151; with standard thickness cement mortar lining, AWWA C104; ductile iron or gray iron mechanical joint cement mortar lined fittings, Class 250, AWWA C110; ductile iron mechanical joint compact fittings, Class 350, AWWA C153; rubber gasket joints with non-toxic gasket lubricant, AWWA C111. Provide 8 mil tube or sheet polyethylene encasement of iron pipe and pipe fittings, AWWA C105.

PVC pressure pipe, DR 18, Class 150, AWWA C900 and C905; with integral bell and elastomeric gaskets, ASTM D3139. Fittings and fitting polyethylene encasement to be same as noted above for ductile iron.

E. BELOW GROUND 2-1/2" AND SMALLER:
Type K copper water tube, O (annealed) temper, ASTM B88; with cast copper pressure fittings, ANSI B16.18; wrought copper pressure fittings, ANSI B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; or cast copper flared pressure fittings, ANSI B16.26.

F. UNDERGROUND TO INTERIOR BUILDING ENTRANCE PIPING 3" AND LARGER:
Ductile iron as specified above with factory threaded and machined flanges.

2.2 SPECIALTIES:

A. Water hammer Arrestors: Provide and locate water hammer arrestors as shown on drawings and at solenoid actuated and quick closing valves, as manufactured by PPP Industries, Sioux Chief, Wade, Watts.

1. Water hammer arrestors shall be of same material as piping system and be full size of piping served.

2. Water hammer arrestors shall be ANSI A112.26.1, ASSE 1010; sized in accordance with PDI WH-201, precharged piston type constructed of hard drawn Type K copper, threaded brass adapter, brass piston with o-ring seals, FDA approved silicone lubricant, suitable for operation in temperature range 35 to 150 degrees F, maximum 250 psig working pressure, 1500 psig surge pressure. Air chambers will not be acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valves at each branch and valves and shock stops as indicated and as required by SPS 382.40.

B. Provide vacuum breakers and backflow preventers as indicated and as required by SPS 382.41.

C. Extend hot and cold water piping to plumbing fixtures and mechanical fixtures as indicated.

D. Install water hammer arrestors in accessible locations.

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

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

G. DOMESTIC WATER
Maintain piping system in clean condition during installation. Remove dirt and debris from assembly of piping as work progresses. Cap open pipe ends where left unattended or subject to contamination.

Install exterior water piping below predicted frost level in accordance with SPS Table 382.30-6, but in no case less than 6' bury depth to top of pipe. Maintain minimum of 8' horizontal distance between 2-1/2" and larger water piping and sanitary sewer piping. Maintain minimum of 30" horizontal and 12" vertical distance, water on top, between 2" and smaller water piping and sanitary sewer piping. Where water piping crosses a sanitary sewer, provide minimum 18" vertical clearance and waterproof PVC water pipe sleeve (reference sanitary sewer materials) sealed at both ends for distance of 10' from sewer in both directions.

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

I. UNIONS AND FLANGES
Install a union or flange at each connection to each piece of equipment and at other items which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

3.2 TESTING

A. Before pipes are covered, test entire piping systems at 100 psi hydrostatic pressure for period of 2 hours showing no leaks. Isolate or remove components from system which are not rated for test pressure. Test piping in sections or entire system as required by sequence of construction. Do not insulate or conceal pipe until it has been successfully tested.

3.3 STERILIZATION

A. Flush entire pipe system with clean potable water until no dirty water appears at outlets. Sterilize system with water and chlorine solution containing at least 250 parts per million of available chlorine. Allow to stand for at least 3 hours. Operate valves within system. Flush solution from system until no chlorine remains.

B. Procedure shall be repeated until bacteria plate count is less than 10 colonies/milliliter for all water piping up to the fire deluge valves, the HVAC make-up valves, and all fixtures. Submit test report to Owner and receive a receipt from Owner prior to occupancy.

END SECTION 22 11 00

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DIVISION 22 - PLUMBING
SECTION 22 13 00 – FACILITY SANITARY SEWERAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Provide complete system of soil and waste piping as indicated on drawings and in specifications.

PART 2 - PRODUCTS

2.1 SOIL WASTE AND VENT PIPING

A. General: Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings and capacities as indicated. Where not indicated, provide proper selection as determined by industry standards and governing regulations. Where more than one type of materials or products is indicated, selection is Installer's option.

B. Above Ground Piping:

1. Service weight cast iron hub and spigot soil pipe with lead and oakum joints.

2. Service weight cast iron no-hub soil pipe ASTM A888 with no-hub joints conforming to Cast Iron Soil Pipe Institute 301-72, CISPI 310, ASTM A74 and be listed by NSF International. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Pipe Institute or receive prior approval of the Engineer. Cast iron piping and fittings shall be of A B & I Foundry, Charlotte Pipe and Foundry, or Tyler Pipe manufacturers.

3. Schedule 40 galvanized steel pipe with Class 125 galvanized drainage pattern cast iron screwed joints where Code approved.

4. Copper Tube ASTM B306, Type DWV for Pipe, and cast bronze, Drainage pattern fittings, with soldered joints.

   Solder filler materials ASTM B32 50-50 tin-lead solder.

5. ABS Type DWV Plastic Pipe and Fittings, ASTM D2661 pipe and fittings, with solvent cemented joints; DWV plastic fittings patterns shall conform to ASTM D3311. Solvent ASTM D2255.

6. PVC Type DWV Pipe and Fittings: Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

C. Underground Piping:

1. Service weight cast iron hub and spigot soil pipe with lead and oakum joints.

2. Cast iron soil pipe and fittings, hub and spigot, service weight, ASTM A74, with neoprene rubber compression gaskets, ASTM C564, CISPI 301, and CISPI HSN 85. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Pipe Institute. Cast iron piping and fittings shall be of A B & I Foundry, Charlotte Pipe and Foundry, or Tyler Pipe manufacturers.

3. ABS Plastic Sewer Pipe ASTM D2751 pipe and fittings. Solvent ASTM D2235.

4. PVC Type DWV Pipe ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665 with solvent cemented joints: DWV plastic fitting patterns shall conform to ASTM D3311; primer, ASTM F656; Solvent ASTM D2564.

2.2 SPECIALTIES

A. Soil Waste and Vent

1. Cleanout plugs shall be cast bronze, threads complying with ANSI B2.1.

2. Vent flashing sleeves shall be cast iron caulking type roof coupling for cast iron stacks, cast iron threaded roof type coupling for steel stacks.

3. Floor drains shall be cast iron body and flashing collar with nickel bronze strainer head and secured square hole grate. See plumbing fixture schedule, section 22 42 00.

4. Wall cleanouts shall be cast iron body adaptable to pipe with cast bronze or brass cleanout plug; stainless steel cover including screws.

5. Floor cleanouts shall be cast iron body and frame, with cleanout plug and adjustable round top, nickel-bronze top.

6. Flashing Flanges: Cast iron watertight stack or wall sleeve with membrane flashing ring. Provide under deck clamp and sleeve length as required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Building Drain Piping: Install building drains as indicated and in accordance with State of Wisconsin Plumbing Code. Lay building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clean interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. All piping shall be concealed and/or built in walls, etc. except as specifically indicated. Install soil and vent piping pitched to drain at minimum slope of 1/4" per foot where possible and in no case less than 1/8" per foot.

B. Install exterior piping below predicted frost level and not less than 5' bury depth to top of pipe wherever possible. Where piping is located above predicted frost level, provide frost protection in accordance with SPS 382.30(11)(c).

C. Cleanouts shall be installed in sanitary piping as indicated, as required by State of Wisconsin Plumbing Code, at each change in direction greater than 45^{o}, at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping and at base of each vertical soil or waste stack.

D. Vent flashing sleeves compatible with roofing system shall be installed on stacks passing through roof. Secure over stack flashing in accordance with manufacturer's instructions.

E. Provide soil and waste piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated.

F. Floor drains shall be installed at low points of surface areas to be drained with top flush with finished floor. Where waterproof membranes are being penetrated, properly flash drains to maintain membrane integrity.

G. Soil and waste water piping for humidifier, steam condensate, or other discharge exceeding 140°F shall be metal.

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

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

3.2 TESTING

A. Test soil and waste piping systems in accordance with requirements of State of Wisconsin SPS 382.21.

B. Isolate or remove components from system which are not rated for test pressure. Perform final testing for medical and lab gas with all system components in place. Test piping in sections or entire system as required by sequence of construction. Do not insulate or conceal pipe until it has been successfully tested.

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

END SECTION 22 13 00

DIVISION 22 - PLUMBING
SECTION 22 14 00 – FACILTY STORM DRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Provide complete system of storm water piping as indicated on drawings and in specifications.

PART 2 - PRODUCTS

2.1 STORM WATER PIPING

A. General: Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings and capacities as indicated. Where not indicated, provide proper selection as determined by industry standards and governing regulations. Where more than one type of materials or products is indicated, selection is Installer's option.

B. Above Ground Piping:

1. Service weight cast iron hub and spigot soil pipe with lead and oakum joints.

2. Service weight cast iron no-hub soil pipe with no-hub joints conforming to Cast Iron Soil Pipe Institute 301-72.

3. Schedule 40 galvanized steel pipe, type F, Grade A, ASTM A53, with cast iron threaded drainage fittings, ASTM B16.12.

4. Copper Tube: ASTM B306, Type DWV for pipe, and cast bronze, drainage pattern fittings, with soldered joints. Solder Filler Materials ASTM B32, 50-50 tin-lead solder.

5. ABS Type DWV Plastic Pipe And Fittings ASTM D2662 pipe and fittings, with solvent cemented joints; DWV plastic fitting patterns shall conform to ASTM D3311. Solvent ASTM D2255.

6. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

C. Underground Piping

1. Service weight cast iron hub and spigot soil pipe with compressing gasket joints conforming to ASTM C564 where code approved.

2. ABS Plastic Sewer Pipe: ASTM D2751 pipe and fittings. Solvent ASTM D2235.

3. PVC, Type DWV Pipe and Fittings: ASTM D2665 pipe and fittings, with solvent cemented joints; DWV plastic fitting patterns shall conform to ASTM D3311. Solvent ASTM D2564.

4. High Density Polyethylene corrugated pipe with an integrally formed smooth interior.

5. Pipe and Fittings: Conform to ASTM D1248. Couplings shall be corrugated to match the pipe corrugations. The width shall not be less than 1/2 the nominal diameter of the pipe.

2.2 CLEAR WATER WASTE PIPING

A. General: Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings and capacities as indicated. Where not indicated, provide proper selection as determined by industry standards and governing regulations. Where more than one type of materials or products is indicated, selection is Installer's option.

B. Above Ground Piping:

1. Service weight cast iron no-hub soil pipe with no-hub joints conforming to Cast Iron Soil Pipe Institute 301-72.

2. Schedule 40 galvanized steel pipe with Class 125 galvanized drainage pattern cast iron screwed joints where Code approved.

3. Copper Tube: ASTM B306, Type DWV for pipe, and cast bronze drainage pattern fittings, with soldered joints. Solder Filler Materials ASTM B32, 50-50 tin-lead solder.

4. ABS Type DWV Plastic Pipe And Fittings ATM D2661 pipe and patterns shall conform to ASTM D3311. Solvent ASTM D2255.

5. PVC, Type DWV Pipe And Fittings: ASTM D2665 pipe and fittings, with solvent cemented joints; DWV plastic fitting patterns shall conform to ASTM D3311. Solvent ASTM D2564.

C. Underground Piping:

1. Service weight cast iron hub and spigot soil pipe with compression gasket joints conforming to ASTM C564 where Code approved.

2. ABS Plastic Sewer Pipe: ASTM D2751 pipe and fittings. Solvent ASTM D2235.

3. PVC Type DWV Pipe and Fittings ASTM D2665 pipe and fittings, with solvent cemented joints: DWV plastic fitting patterns shall conform to ASTM D3311. Solvent ASTM D2564.

2.3 SPECIALTIES

A. Cleanout plugs shall be cast bronze, threads complying with ANSI B2.1.

B. Roof drains shall be cast iron body complete with flashing collar and gravel stop, cast iron dome, under deck clamp. See plumbing fixture schedule, specification section 22 42 00.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Building Drain Piping: Install building drains as indicated and in accordance with State of Wisconsin Plumbing Code. Lay building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clean interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. All piping shall be concealed and/or built in walls, etc. except as specifically indicated. Install storm water piping pitched to drain at minimum slope of 1/4" per foot where possible and in no case less than 1/8" per foot.

B. Cleanouts shall be installed in storm water piping as indicated, as required by State of Wisconsin Plumbing Code, at each change in direction greater than 45°, at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping and at base of each vertical stack. Install floor and wall cleanout covers for concealed piping.

C. Roof drains shall be provided in locations indicated. Locate at low point of surface to be drained. Coordinate installation with roofing work to maintain integrity of waterproof membrane.

3.2 TESTING:

A. Test storm water piping systems in accordance with requirements of State of Wisconsin SPS 382.21.

B. Test clear water waste piping systems in accordance with requirements of State of Wisconsin SPS 382.21.

END SECTION 22 14 00

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DIVISION 22 - PLUMBING
SECTION 22 15 00 – GENERAL SERVICE COMPRESSED AIR SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Provide complete system of air piping as indicated on drawings and in specifications. **Compressed Air System & Compressed air piping are not Medical Grade.**

PART 2 - PRODUCTS

2.1 AIR PIPING

A. General: Provide piping materials of factory fabricated piping products of sizes, types, pressure and temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by industry standards and governing regulations.

B. Pipe and Fittings: Shall be Type "L" hard temper copper tubing, ASTM B88, with cast copper pressure fittings, ANSI B16.18; wrought copper pressure fittings, ANSI B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813;copper brazing alloy, AWS A5.8 BCuP. All piping shall be general cleaned and degreased.

C. 2" AND SMALLER TOOL AIR:
Black steel pipe, Schedule 40, Type F, Grade A, ASTM A53; with black malleable iron threaded fittings, Class 150, ASTM A197/ANSI B16.3; seamless carbon steel weld fittings, standard weight, ASTM A234 grade WPB/ANSI B16.9.

D. Compressed air piping to be installed at 1/16” / ft to incorporate moisture drainage; Drain valves to be installed at low points.

2.2 SPECIALTIES

A. Air Cocks: Provide Nibco-Scott series 590 valves of size and as located on drawings.

PART 3 - EXECUTION

3.1 PIPING AND SPECIALTIES INSTALLATION

A. Install valves as indicated and as required by drawings and other specification sections.

B. After installation and prior to connecting equipment, all lines shall be blown or purged with oil free, nonflammable medium at design pressure and flow from each outlet until a white rag is no longer discolored by dust.

C. Before pipes are covered, test entire piping system at 150 psi pressure for period of 24 hours, showing no leaks.

D. Install a 4" minimum depth dirt leg at the bottom of each vertical run and at each outlet connection with shutoff valve at bottom of dirt leg.

E. Do not route piping through transformer vaults or above transformers, panel boards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment

END SECTION 22 15 00

DIVISION 22 - PLUMBING
SECTION 22 30 00 – PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Work of this section shall conform to requirements of Division 26.

1.2 DESCRIPTION OF WORK

A. Provide Water and Waste Equipment as indicated on drawings and in specifications. Provide factory tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size and capacity of each pump are listed in pump schedule. Provide pumps of same type by same manufacturer.

1.3 SUBMITTALS

A. Product Data: Submit catalog cuts, specifications, installation instructions and dimensioned drawings for components of system.

B. Maintenance Data: Submit maintenance data and spare parts lists. Include this data in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical components shall be listed and labeled by Underwriters Laboratory and comply with NEMA standards. Installation of electrical components shall comply with National Electrical Code.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 – PRODUCTS

2.1 COMMERCIAL GAS FIRED WATER HEATERS (WH-1)

A. General: Provide commercial gas fired water heaters of sizes and capacities as indicated. Provide certification (ext.) (VERIFY-SCHEDULED ON DRGS?)

B. Type: Power vented natural gas fired atmospheric storage water heater. Design to be AGA certified with 1 year commercial tank and parts warranty.

C. Type: Gas fired sealed combustion condensing commercial storage water heater, minimum 92% thermal efficiency. Design to be AGA certified with 3 year tank warranty and 1 year parts warranty. (Used on high efficiency sealed combustion units.)

Storage capacity:	100 gallons
Input Rating:	250,000 BTU/hour
Recovery Capacity:	411 GPH at 70°F temperature rise
Blower Motor:	1/3 HP, 6.2 amps/120V

D. Heater: Construct Steel glass or nickel lined tank rated for working pressure of 150 PSI ASME construction and stamped; boiler type hand hole cleanout; magnesium anode rod; 3/4" tapping for relief valve; glass lining on internal surfaces exposed to water.

E. 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.

F. Draft Hood: Equip with AGA certified draft hood.

G. Jacket: Insulate tank with vermin-proof glass fiber insulation. Provide outer steel jacket with baked enamel finish over bonderized undercoating.

H. Accessories: Provide brass drain valve; 3/4" pressure and temperature relief valve; and radiant floor shield. Comply with SPS 382.40 safety valve requirements.

I. Controls: Provide gas pressure regulator; pilot gas regulator; thermostat; and temperature limit control.

J. Controls: 120 volt, 1 phase, 60 Hz electronic controls, intermittent spark or hot surface ignition, operating thermostat with 110°-180°F adjustable temperature control, energy cutoff with manual reset, blower pressure switch, gas valve and pressure regulator.

K. Vent: 3" or 4” PVC, CPVC or ABS combustion air intake and flue gas outlet with DWV solvent weld fittings. (Used on high efficiency sealed combustion units.)

L. NFPA Compliance: Install gas fired water heaters in accordance with requirements of NFPA 54, "National Fuel Gas Code".

M. AGA and NSF Labels: Provide water heaters that are listed and labeled by American Gas Association and National Sanitation Foundation.

N. ASME Code Symbol Stamps: Provide water heaters and safety relief valves which comply with ASME Boiler and Pressure Vessel Code, and are stamped with appropriate code symbols. Projects in Wisconsin shall comply with SPS 382.40 safety valve requirements.

O. ASHRAE Compliance: Provide water heaters with Performance Efficiencies not less than prescribed in ASHRAE 90A, "Energy Conservation in New Building Design".

P. Controls: 120 volt, 1 phase, 60 Hz controls consisting of operating thermostat with adjustable temperature control, energy cutoff, gas valve, integral pressure regulator, intermittent spark ignition, blower pressure switches, blower interlock and 6' power cord and plug. (Tank type high efficiency units)

Q. Vent: Schedule 40 PVC with DWV solvent weld fittings with weatherproof screened outlet tee or elbow as recommended by manufacturer. (Tank type high efficiency units)

R. Manufacturers: Subject to compliance with requirements, provide commercial gas fired water heaters of one of the following: Bock Water Heaters, Inc.; Lockinvar Water Heater Corp.; PVI Industries, Inc.; Rheem Water Heater; Ruud Water Heater; Smith Corp. (A.O.); State Industries, Inc.; Viking Superior Corp.

2.2 ELECTRIC WATER HEATERS (WH-3/WH-4)

A. General: Provide electric water heaters of sizes and capacities as indicated on Schedule.

B. Heater: Construct for working pressure of 150 PSI; 3/4" tapping for relief valve; glass lining on internal surfaces exposed to water.

C. Safety Controls: Equip with automatic shutoff device to shut off power in event of excessive temperature in tank.

D. Jacket: Insulate tank with vermin-proof glass fiber insulation. Provide outer steel jacket with baked enamel finish over bonderized undercoating.

E. Accessories: Provide brass drain valve; 3/4" pressure and temperature relief valve; and radiant floor shield.

F. Controls: Provide thermostat, element staging controls, and temperature limit control.

G. Water heater shall be UL listed.

H. ASME Code Symbol Stamps: Provide water heaters and safety relief valves which comply with ASME Boiler and Pressure Vessel Code, and are stamped with appropriate code symbols.

I. ASHRAE Compliance: Provide water heaters with Performance Efficiencies not less than prescribed in ASHRAE 90A, "Energy Conservation in New Building Design".

J. Manufacturers: Subject to compliance with requirements, provide commercial gas fired water heaters of one of the following: Bock Water Heaters, Inc.; Lockinvar Water Heater Corp.; PVI Industries, Inc.; Rheem Water Heater; Ruud Water Heater; Smith Corp. (A.O.); State Industries, Inc.; Viking Superior Corp.

2.3 OIL INTERCEPTOR (OI-1)

A. Interceptor:

1. Model: No. 8599.
2. Description: Steel interceptor with diamond plate cover, duco coating inside and coal tar outside, with flow control fitting.
3. 100 gallon storage tank.
4. 4” Inlet and Outlet.
5. Lift out sediment bucket.

Accessories

1. Traffic Rated cover – H20
2. 4” clean out access
3. High Level sensor and control panel – CBS

Storage capacity:	100 gallons
Flow Rate:	75 gallons max.

B. Description:
Fabricated Steel with diamond plate cover. The one piece cover equipped with a single lock and lift ring (two on large sizes). No bolts or nuts. Locking device is a practical feature of the cover assembly. Duco coated inside and coal tar outside. Complete with flow control fitting.

C. Interceptors shall have an air relief to eliminate the possibility of siphonage, and are Furnished with a separate flow control device to insure the interceptor will function Within its rated capacity.

2.4 WATER SOFTENER (Commercial unit) (WS-3) (Maintenance Shop-Building - E)

A. General: There shall be Simplex softener, which shall produce a constant softened water supply with time delay regeneration. The softener shall include a brine mixing and storage tank. Resin vessel shall have grain removal capacity, and rated service flow GPM.

B. Control Valve: The main operating control valve shall be a solid lead-free 1-1/4-inch brass valve with an electro-deposited epoxy coating NSF food grade material to protect against corrosion, 12-volt output with AC adapter for safe and easy installation, DC drive, single piston, 1-piece seal/ spacer stack assembly, and have an internal brine piston. System design shall incorporate brine pre-fill. Post-fill is not acceptable. Control valve that do not meet these specifications including NSF epoxy coating, internal brine piston and brine pre-fill are not acceptable.

C. Microprocessor Controller: 12-volt solid state microprocessor shall be able to show time of day, current flow rate, volume remaining, dealer name and phone number, it shall be capable of initiating regeneration via an electronic meter on a delayed or immediate basis, time clock or pressure differential. All cycle times shall be fully programmable and capable of providing up to nine maximum cycle sequences including multiple cycles for each of the following: backwash, brine/slow rinse, fast rinse and brine tank refill with treated water on either a pre-fill or post-fill basis. A minimum of two relay output signals shall be available to be controlled by the microprocessor to allow output signals based on time, a specific regeneration cycle window or volume of processed water from the meter output signal or both. An optional Service Alarm capability shall be included that can be programmed on time, volume of gallons processed or both with both a display on the dot matrix screen and to allow for a relay output for an external signal/alarm.

D. METER: (1) 1-1/4" inline stainless steel electronic meter. Each meter shall be accurate from 1.5 – 80 gallons per minute at +/- 5%.

E. SIMPLEX UNIT: single unit system shall utilize the proven and reliable 12V drive system of the control valve to operate the 2-way piston driven (MAV) motorized alternating valve purposes. The MAV valve shall have full 2" ports for minimal pressure loss and can provide treated or non-treated water regeneration. MAV valve shall be operated by the control valves 12-volt electronic microprocessor. The MAV has a sight glass to view which unit is on line and which is on standby without removing any covers. The software that operates the MAV valve for alternating provides the option of an added rinse feature which is a bed freshener cycle and is initiated on the standby unit when the unit that has been on standby mode for greater than 12 hours. After 12 hours of no flow, at 6:00am and/or 6:00pm, whichever comes first. This rinse option minimizes hardness or iron leakage from a stagnant bed.

F. Brine Tank: Brine tank shall have listed minimum salt capacity, and shall be constructed of polyethylene material with polyethylene cover. Brine tank shall have safety overflow float valve and air check system.

G. Resin vessels shall be 125 psig design working pressure fiberglass material, Park International or equal, to contain a full 2 cubic feet of resin plus the gravel to cover the distribution tube and maintain the specified freeboard.

H. WS-3: Equal to Hellenbrand H-125-128, WQA S-100 tested:

4.0 Mineral CF
112,000 gr. (40 LBS) Med. Salt Capacity
25 gpm/15 psi Service Flow Rating
34 gpm Flow Rate @ 25 psi
300 lbs Brine Tank Salt Storage

I. Manufacturers: Subject to compliance with requirements, provide commercial water softeners of one of the following: Capitol Water Softener, Culligan International, Hellenbrand, Marlo, or approved equal.

2.5 WATER SOFTENER (Commercial unit) (WS-1/WS-2) (Building –A&B)

A. General: There shall be an alternate-operating twin softener, which shall produce a constant softened water supply. The softener shall include a brine mixing and storage tank. Each resin vessel shall have grain removal capacity, and rated service flow GPM.

B. Control Valves: The main operating control valves shall be a solid lead-free two-inch brass valve with an electro-deposited epoxy coating NSF food grade material to protect against corrosion, 12-volt output with AC adapter for safe and easy installation, DC drive, single piston, 1-piece seal/ spacer stack assembly, and have an internal brine piston. System design shall incorporate brine pre-fill. Post-fill is not acceptable. Control valves that do not meet these specifications including NSF epoxy coating, internal brine piston and brine pre-fill are not acceptable. (2) Control valves required.

C. Microprocessor Controller: 12-volt solid state microprocessor shall be able to show time of day, current flow rate, volume remaining, dealer name and phone number, it shall be capable of initiating regeneration via an electronic meter on a delayed or immediate basis, time clock or pressure differential. All cycle times shall be fully programmable and capable of providing up to nine maximum cycle sequences including multiple cycles for each of the following: backwash, brine/slow rinse, fast rinse and brine tank refill with treated water on either a pre-fill or post-fill basis. A minimum of two relay output signals shall be available to be controlled by the microprocessor to allow output signals based on time, a specific regeneration cycle window or volume of processed water from the meter output signal or both. An optional Service Alarm capability shall be included that can be programmed on time, volume of gallons processed or both with both a display on the dot matrix screen and to allow for a relay output for an external signal/alarm.

D. METER: (1) Two-inch inline stainless steel electronic meters. Each meter shall be accurate from 1.5 – 150 gallons per minute at +/- 5%.

E. TWIN ALTERNATING: Twin alternating system shall utilize the proven and reliable 12V drive system of the control valve to operate the 3-way piston driven (MAV) motorized alternating valve for alternating purposes. The MAV valve shall have full 2” ports for minimal pressure loss and can provide treated or non-treated water regeneration. MAV valve shall be operated by the control valves 12-volt electronic microprocessor. The MAV has a sight glass to view which unit is on line and which is on stand by without removing any covers. The software that operates the MAV valve for alternating provides the option of an added rinse feature which is a bed freshener cycle and is initiated on the standby unit when the unit that has been on standby mode for greater than 12 hours. After 12 hours of no flow, at 6:00am and/or 6:00pm, whichever comes first, an alternation occurs. This rinse option minimizes hardness or iron leakage from a stagnant bed.

F. Brine Tank: Brine tank shall have listed minimum salt capacity, and shall be constructed of polyethylene material with polyethylene cover. Brine tank shall have safety overflow float valveand air check system.

G. Resin vessels shall be 125 psig design working pressure fiberglass material, Park International or equal, to contain a full 2 cubic feet of resin plus the gravel to cover the distribution tube and maintain the specified freeboard.

H. WS-1/WS-2: Equal to Hellenbrand TNT-300-24, WQA S-100 tested:

10 Mineral CF
280,000 gr. (100 LBS) Med. Salt Capacity
120 gpm Flow Rate @ 15 psi
170 gpm Flow Rate @ 25 psi
1,100 lbs Brine Tank Salt Storage

I. Manufacturers: Subject to compliance with requirements, provide commercial water softeners of one of the following: Capitol Water Softener, Culligan International, Hellenbrand, Marlo, or approved equal

2.6 SEDIMENT SEPERATOR TANKS (SST-1)

A. General: Provide a 2000 gallon heavy duty interceptor for exterior installation complying with SPS 382.34 (5) (c) and suitable for installation under drive way.

B. Type: Class 3, construct of 5000 psi concrete with tank design conforming to ASTM C-1227-90, ASTM C 890-06, ASTM C 318-02 and ASTM 1613-06. Include sanitary tees or baffles at inlet and outlet. All joints shall be sealed watertight. **Concrete shall contain Xypex C-1000 mix. Provide built-up (stronger) top when dirt cover is more then 7 ft.**

C. Manholes: Provide 2 manholes, one at each section, with extensions to grade elevation. Covers shall be cast iron, bolted and sealed, equal to NF R6462 or equal. Each cover shall be permanently marked with the words SEDIMENT SEPERATOR TANKS.

D. Manufacturers: Subject to compliance with requirements, provide concrete tank as manufactured by Crest Precast Inc. or equal.

2.7 GREASE INTERCEPTOR (GI-1)

A. General: Provide High Density Polythylene with minimum 3/8" uniform wall thickness. Interceptor shall be furnished for below grade installation. Interceptor shall be built in accordance to ASME A112.14.3 (type C) with field adjustable riser system, built-in flow control. Built-in test caps and three outlet options. Interceptor flow rate shall be 100 gpm (125 total). Interceptor grease capacity shall be 1,076 lbs.; Cover shall be provided water/gas tight seal and have minimum 2,000 lbs. load capacity. Maximum operating temperature 190°F continuous.

B. Provide teleglide field adjustable riser to extend access covers to grade.

C. Install to meet required inverts, provide extension to grade as required. Contract shall meet all Wisconsin plumbing code requirements and manufacturers' installation requirements.

D. System based on Schier GB-250

E. Acceptable manufactures, schier, Rockford, JR Smith, or approved equal.

2.8 IN-LINE CIRCULATOR PUMPS: (CP-1,CP-2,CP-3)

A. General: Provide in-line circulator pump where indicated with capacity as shown on plans.

B. Type: Horizontal, oil lubricated, designed for 125 psi working pressure, 225°F continuous water temperature and specifically designed for quiet operation.

C. Body: Bronze for domestic water service.

D. Shaft: Stainless steel or carbon steel with stainless steel or bronze sleeve, integral thrust collar.

E. Bearings: Two horizontal sleeve bearings designed for circulating oil.

F. Seal: Mechanical, with carbon seal face rotating against ceramic seat.

G. Motor: Nonoverloading at any point on pump curve, open, dripproof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection.

H. Manufacturer: Subject to compliance with requirements, provide in-line booster pumps of one of the following: Amtrol, Inc.; Armstrong Pumps, Inc.; Bell & Gossett ITT; Dunham-Bush, Inc.; Taco, Inc.; Grundfos or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which water 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 OIL INTERCEPTORS

A. Install components in accordance with manufacturer's instructions and approved product data submittals.

B. Set plumb, level, and rigid.

3.3 INSTALLATION OF WATER SOFTENERS

A. General: Set level and plumb, orient so controls and devices requiring service are easily accessible.

B. Piping: Connect piping with unions and shut off valves with bypass line.

C. Field Quality Control: Install, start up and test and adjust in accordance with manufacturer's recommendations. Cycle softeners and adjust for specified exchange rate, regeneration time, consumption, backflow rate, etc. Provide initial salt fill of brine tank.

3.4 INSTALLATION OF WATER HEATERS

A. General: Install water storage tank and heater in accordance with manufacturer's installation instructions. Install unit plumb and level, firmly anchored in location indicated, and maintain manufacturer's recommended clearances.

B. Support: Provide cradles and place unit on concrete pad, orient so controls and devices needing service and maintenance have adequate access.

C. Piping: Connect inlet hot water and outlet hot water piping to unit with shutoff valves and unions. Connect recirculating water line to unit with shutoff valve, check valve, and union. Extend relief valve discharge to closest floor drain, or as indicated.

D. Gages: Provide thermometers on inlet and outlet piping of water storage tank, in accordance with Section 22 05 00.

E. Field Quality Control: Start-up, test, and adjust water storage heater in accordance with manufacturer's start-up instructions. Check and calibrate controls. Provide certificate of factory test, where specified.

3.5 INSTALLATION OF SEDIMENT SEPERATOR TANKS

A. Install tanks where indicated and connect to sewer inlet and outlet piping. Confirm grade elevation and piping inverts. Install in accordance with manufacturer's published installation instructions and per Wisconsin Plumbing Code SPS 382.34 (3).

B. Install cleanouts in inlet piping at all changes in direction.

C. Excavate for sediment separator tanks, setting precast bases on granular compacted base of 6” stone or sand under ¾”. Base material shall support weight of tank and back fill without settlement. Seal joints between base, top sections, risers and castings with EZ stick mastic per ASTM C990. Back Fill and compact soil around grease interceptor in 12” lifts. Back fill material to be dry and under 3” size. Tank shall be vacuum tested after installation to insure structure is water tight per ASTM 1663-06 using 4 inch of mercury for 5 minutes or to meet state codes. (use if job is requiring exterior tank)

3.6 INSTALLATION OF GREASE INTERCEPTOR

A. Install grease interceptor where indicated and connect to sewer inlet and outlet piping. Confirm grade elevation and piping inverts. Install in accordance with manufacturer's published installation instructions and per SPS 382.34 (5).

B. Install cleanouts in inlet piping at all changes in direction.

3.7 INSTALLATION OF PUMPS

A. Install pumps where indicated, in accordance with manufacturer's published installation instructions, with recommended clearances provided for service and maintenance.

B. Install in-line pumps supported from piping system and hanger.

C. Basins: Install sump pump basins in indicated locations and connect to sewer inlets. Brace interior of basin in accordance with manufacturer's instructions, to prevent distortion or collapse during concrete placement. Refer to Division 3 for concrete work; not work of this section. Set cover over basin, fasten to top flange of basin. Install so cover is flush with finished floor.

D. Install high-pressure, multi-stage, centrifugal pumps per manufacturer’s recommendations with vibration isolated mounting frame on concrete housekeeping pad provided by others.

E. Provide piping, accessories, hangers, supports, anchors, valves, meters, gages, vibration isolation as indicated for complete installation.

F. Check alignment and where necessary realign shafts of motors and pumps within recommended tolerances by manufacturer's service representative.

G. Lubricate pumps before start up. Start up in accordance with manufacturer's instructions.

END SECTION 22 30 00

DIVISION 22 - PLUMBING
SECTION 22 42 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Refer to Division 22 sections for domestic water and soil and waste piping systems used in conjunction with plumbing fixtures; not work of this section.

1.2 DESCRIPTION OF WORK

A. Provide plumbing fixtures and trim as indicated in this section. The Contractor shall check fixture schedules for convenience but is required to furnish all fixtures complete with trim, etc. necessary to the work and as reasonably indicated or implied.

1.3 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. Maintenance Data: Submit maintenance data and spare parts lists. Include this data in maintenance manual.

1.4 QUALITY ASSURANCE

A. Fixture descriptions are an indication of minimum quality and do not express preference as to manufacturer. Fixtures may be Kohler or Elkay as specified, American Standard or approved equal.

B. Comply with applicable portions of State of Wisconsin Plumbing Code pertaining to materials and installation of plumbing fixtures. Comply with applicable ANSI and PDI standards pertaining to plumbing fixtures, handicapped fixtures and fixture supports.

Provide UL and ARI labels on electric water coolers.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver plumbing fixtures in factory fabricated containers. Handle carefully to prevent breakage, chipping and scoring of finish. Do not install damaged units; replace and return to manufacturer.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

A. Provide factory-fabricated fixtures of type, style and material indicated. For each fixture provide trim, carrier, seats, valves, etc. as indicated on plumbing fixture schedule and as required for proper operation.

2.2 PLUMBING FITTINGS, TRIM AND ACCESSORIES

A. Where fittings, trim and accessories are exposed, provide bright chrome plated or polished stainless steel units. Provide copper or brass where not exposed.

B. Water Outlets: Provide commercial quality faucets, valves, or dispensing devices of type and size as indicated. Include manual shutoff valves and supply stem pipes to permit outlet servicing without shutdown of water supply system.

C. Vacuum Breakers: Provide where required by Code including locations where water outlets are equipped for hose attachment.

D. P-Traps: Include removable P-traps where drains are indicated for direct connection. All brass sink and lavatory tailpieces and traps shall be 17 gage.

E. Carriers:

1. Lavatory Supports: Cast iron supports, having tubular steel uprights with concealed arms and sleeves, mounted on adjustable headers with escutcheons and complete with heavy cast iron short feet, alignment trusses and mounting fasteners.

F. Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps to match fixture finish.

G. Escutcheons: Provide chrome plated sheet steel escutcheons with friction clips where fixture supplies and drains penetrate walls in exposed locations.

H. Supplies and Stops for Lavatories and Sinks: Polished chrome plated, loose keyed angle stop having 1/2" inlet and 3/8" o.d. x 12" long flexible tubing outlet and wall flange and escutcheon.

I. Supplies and Stops for Tank Type Water Closets: Polished chrome plated, loose keyed angle stop having 1/2" inlet and 3/8" o.d. x 12" long flexible tubing outlet with collar and wall flange and escutcheon.

PLUMBING FIXTURES

FLOOR DRAIN (FD-1): Smith No. 2005-A round top floor drain with 4" outlet and 8” brass strainer head. Provide cast iron body for all fixtures in mechanical rooms.

FLOOR DRAIN (FD-2): Smith No. 2005-A round top floor drain with 2" outlet and 5" nickel bronze plated strainer head.

FLOOR DRAIN (FD-3): Smith No. 2142-g round top floor drain with sediment bucket. 12" diameter nickel bronze strainer head and 4" outlet. 3 1/2" deep removable slotted sediment bucket with lift bar.

FLOOR DRAIN (FD-4): Smith No. 2142-G-SC (Additional solid cover) round top floor drain with sediment bucket. 12" diameter nickel bronze strainer head and 4" outlet. 3 1/2" deep removable slotted sediment bucket with lift bar. **(Order solid cover in addition to grate for special events to exclude dirt entering floor drain)**

FLOOR DRAIN (FD-5): Smith No. 2495-NB-SB round top floor drain with sediment bucket. 8-1/2" diameter nickel bronze strainer head and 4" outlet. 5 1/2" deep removable solid sediment bucket with lift bar.

FLOOR SINK (FS-1) JR SMITH No. 3441 12" Square strainer head, acid resistant coated. 10" deep receptor with sediment bucket. 4" outlet. - 28 sq.in. free area.

FLOOR SINK (FS-2) (CONCESSION AREAS) JR SMITH No. 3440-12 (1/2 A.R.C grate) 12" Square top less grate, acid resistant coated. 10" deep receptor with dome strainer, 4" outlet. – 26 sq. in. free area.

TRAP GUARD
Proset trap guard or equivalent. "Provent Trap Guard. Insert unit into rarely used floor drains to prevent trap from running dry.

TRENCH DRAIN (TD-1): Aco Drain S300K system, with slotted ductile iron grate (loading rating Class E), galvanized steel frame, and all accessories for a complete system of length indicated on Drawings. Minimum built-in base slop 0f 0.6% to drain connections.

HOSE BIBB (HB-1) (1/2" Supply): Woodford Model 65 series, automatic draining, freezeless wall hydrant with 3/4" hose connections, vacuum breaker and key operated valve. Contractor shall be responsible for unit length to suit installation condition.

HOSE BIBB (HB-2) (3/4" Supply): Woodford Model 65 series, automatic draining, freezeless wall hydrant with 3/4" hose connections, vacuum breaker and key operated valve. Contractor shall be responsible for unit length to suit installation condition.

HOSE BIBB (HB-3) (3/4" Supply): Woodford Model 24 series, automatic draining, freezeless wall hydrant with 3/4" hose connections, vacuum breaker and key operated valve. Contractor shall be responsible for unit length to suit installation condition.

Reuse existing 6 qty lavatory faucets.

LAVATORY (L-1): Kohler, "Kingston" K-2007, wall-mounted, vitreous china, with single hole faucet centered on sink and wall mounting concealed arm carrier. Size shall be 21" x 18". ADA.
Faucets: Chicago Faucet Metering faucet 3500-E2805ABCP, ADA, 4" spout .5 gpm vandal proof aerator, MVP Metering Adjustable Cycle Time Closure Cartridge, Chrome Plated solid brass construction. Perforated grate drain, with 1-1/4" tailpiece.
ADA Mounting Height: 34" floor to rim.
Waste: Kohler K-9000, 1-1/4" cast brass "P" trap.
Color: Selected by Architect.

LAVATORY (L-2): Kohler, "Kingston" K-2005, wall-mounted, vitreous china, with 4" faucet centers and wall mounting concealed arm carrier. Size shall be 21" x 18". ADA.
Faucets: American Standard faucet 6114-111-002, ADA, 4" spout 1.5 gpm vandal proof aerator, less pop-up drain, rod & hole. Chrome Plated solid brass construction. Perforated grate drain, with 1-1/4" tailpiece.
ADA Mounting Height: 34" floor to rim.
Waste: Kohler K-9000, 1-1/4" cast brass "P" trap.
Color: Selected by Architect.

WATER CLOSET (WC-1): Handicap, Kohler K-4302 "Highcrest", top spud supply, vitreous china, elongated bowl, floor mounted, with 2-1/4" passageway complete with Manual Sloan flush Royal model 111 (1.6 gpf) gallons per flush valve assembly. Include K-4670-CA elongated solid plastic seat with stainless steel check hinge and open front, less cover.
Mount valve with handle towards open side of stall, per ADA.
Mounting Height: 16-1/2" floor to rim.

WATER CLOSET (WC-2): Handicap, Kohler K-4406 "Wellworth", top spud supply, vitreous china, elongated bowl, floor mounted, with 2-1/4" passageway complete with Manual Sloan dual flush WES-111 (1.6/1.1 gpf) gallons per flush valve assembly. Include K-4670-CA elongated solid plastic seat with stainless steel check hinge and open front, less cover.
Mount valve with handle towards open side of stall.
Mounting Height: 15" floor to rim.

WATER CLOSET (WC-3): Handicap, Kohler K-3519, "Highline Pressure Lite" vitreous china, siphon action Sloan flushmate, elongated toilet with 2-1/4" trapway. With Kohler No. K-4650-CA Anti-microbial white elongated solid plastic seat with check hinge and open front, less cover. 1.0 gallon flush. Mount valve with handle towards open side of stall, per ADA.
Mounting Height: 17½" floor to rim; ADA Compliant.

URINAL (U-1/U-2): Kohler K-4904-ET Bardon 1/8 gpf manually operated system, vitreous china, washout action wall urinal with 3/4" top spud inlet. 2" IPS outlet, vandal resistant outlet strainer.
Sloan 186 -.125 flush valve, .125 (1/8) gallon flush.
Mounting Height: 17" floor to rim for Handicap (ADA) unit (1 per toilet room) and 22" floor to rim for remaining units in the room, unless noted otherwise on Drawings.

MOP BASIN (MB-1): Fiat Model MSB-2424, 24"x24"x10"D, stainless steel or brass drain, body and combination dome strainer and lint basket.
Chicago Faucet No. 911 fitting with 892-G vacuum outlet and No. 633 handles.
Fiat No. 832-AA hose and hose bracket.
Fiat No. 889-CC mop hanger.
Fiat No. E-77-AA, vinyl bumper guard.

SINK (S-1): Elkay Model LR-1918 Lustertone, 18 gage, 304 stainless steel, self-rim, single compartment sink with undercoating and 2 faucet holes, bowl size 16”x11.5”x7.5” (LxWxD).
Chicago No. 895-317E35ABCP deck-mounted with 3.5" spout, 1.5 gpm aerator, and 3/8” inlet tubes.
Strainer basket with neoprene stop and 1-1/2" tailpiece.
1-1/2" cast brass trap.

SINK (S-2): Elkay Model ESSB2520C, 14 gauge, type 304 stainless steel service sink, 25"L x 19-1/2"W x 12"D, self-rimming.
Chicago No. 305-VBRXKCP, panel-mounted sink fitting with 3/4” threaded hose outlet (Provide ASSE 1011 Vacuum breaker), Ceramic ¼” Turn Operating cartridge, 2-3/8” lever handles, and 2-1/2” spout.
Material: Solid brass with chrome plate finish. For HW and CW. ADA compliant.
Acid-resistant strainer basket with neoprene stop and 1-1/2" tailpiece.
1-1/2" cast brass trap.
1/2" IPS angle stops.

SINK (S-3): Chicago No. 897-CP-369-PR, Wall-mounted faucet with 3/4” threaded hose outlet (Provide ASSE 1011 Vacuum breaker), XT Ceramic ¼” Turn Operating cartridge, 2-3/8” (369) lever handles, and 2-1/2” spout with pail hook and wall brace.
Material: Solid brass with chrome plate finish. For HW and CW. ADA compliant.
Provide FD-1 floor drain.

EMERGENCY FIXTURE THERMOSTATIC MIXING VALVE (TMV-1):
Shall meet ANSI Z358.1-2009 with integral dial thermometer. Valve shall have a low lead content, intregal strainer checkstops on inlets and meet NSF 61 certification. Unit shall have an adjustable set point with temperature range of +/- 3 degrees F and capacity of 6 GPM @ 20 PSI. Mixing Valves shall have built- in cold water bypass, and positive shutoff of hot water supply when cold is lost.

EMERGENCY EYEWASH (EW-1): Bradley S19224DCPT. Wall-mounted with 10” stainless steel bowl. Eye wash with dust cover. Unit includes tailpiece and p-trap.
Valve: Chrome plated 1/2" IPS stay-open ball valve, hand operated push flag handle. Integral flow control to assure steady flow under varying water supply conditions.
Sign: 14" x 3-1/2" sign designed for wall mounting, reading; "EMERGENCY EYEWASH FOUNTAIN."

ROOF DRAIN (RD): Jay R. Smith Figure No. 1015 C-R-CID with deck clamp, sump receiver, and cast iron dome. Coordinate installation requirements with roof slab insulation. Drain size to be as indicated on drawings.

OVERFLOW ROOF DRAIN (ORD-1) Jay R. Smith Figure No. 1080 C-R-CID with deck clamp, sump receiver, and cast iron dome. Coordinate installation requirements with roof slab insulation. Drain size to be as indicated on drawings. Provide 1770 down spout nozzle at termination, 12" A.F.F.

Reuse existing 6 qty shower valve assemblies on Non-ADA showers.

SHOWER (SH-1): Shower unit and accessories are by others.
Symmons 1-901S-22-131 (Surface mounted shower system) through wall piping configuration with soap dish, ball joint adjustable spray head, pressure balancing shower with standard 2.5 gpm shower head.
Smith No. 2010-B square top shower drain with 3" outlet and 6" nickel bronze strainer head.

SHOWER (SH-2): ADA Shower unit and accessories are by others.
Symmons 1-901S-FSB-22-HC (Surface mounted shower system) through wall piping configuration with soap dish, pressure balancing shower with standard 2.5 gpm shower head, and addition shower head with 60" flexible metal hose with inline vacuum breaker, and 30" mounting slide bar. ADA Compliant.
Smith No. 2010-B square top shower drain with 3" outlet and 6" nickel bronze strainer head.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine roughing-in work of domestic water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Rough in shall be coordinated with floor base height. All piping at the wall shall be above the base. Also examine floor and substrates and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions.

B. Install plumbing fixtures of types and where shown and at indicated heights in accordance with drawings, manufacturer's written instructions and roughing-in drawings. Ensure that plumbing fixtures comply with requirements and serve intended purposes.

C. Fasten plumbing fixtures securely to indicated supports or building structure and ensure that fixtures are level and plumb. Secure plumbing supplies behind or within wall construction so as to be rigid and not subject to pull or push movement.

D. Install barrier free fixtures in compliance with IBC 1108 and 3408, COMM 52, 69 and Federal ADA Accessibility Guidelines. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to 27" above floor to avoid contact by wheelchair users.

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

3.2 CLEAN AND TEST

A. Clean plumbing fixtures of dirt and debris upon completion of installation. Protect fixtures from damage during remainder of construction period.

B. Inspect each unit for damage. Remove and replace damaged units with new units. Test fixtures for proper operation upon water pressurization. Correct or replace malfunctioning units.

C. Furnish special wrenches and other devices necessary for servicing fixtures and trim to Owner. Furnish 1 device for every 10 units.

END SECTION 22 42 00

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SECTION 23 05 00 - HVAC GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Refer to Section 07 84 13 – Through-Penetration Fire stop Systems

1.2 CODES AND PERMITS

A. Perform all work in strict accordance with the requirements of the State of Wisconsin Heating, Ventilation and Air Conditioning Code and State of Wisconsin Plumbing Code. Requirements outlined therein shall be minimum requirements as related to this work.

B. Arrange for Code required inspections and pay for same if not covered by permit costs.

C. Arrange and pay for required meter deposits and utility extension costs.

1.3 DESCRIPTION OF WORK

A. Provide all labor, materials, equipment, tools and services for complete and fully operational systems of heating, ventilating and air conditioning as indicated or reasonably implied by drawings and specifications. If an item is shown or specified, it shall be considered sufficient for inclusion as part of this contract work.

B. Contractor shall verify all job conditions at the site and report any discrepancies to the Engineer immediately.

1.4 WORK PRIORITY AND COORDINATION

A. Contractor, his mechanics and subcontractors shall cooperate with all others so construction may proceed without hindrances and in all cases to the best interests of the Owner. Confer with others regarding any work that may affect this work and arrange piping, ductwork, equipment, etc. in proper relation to that of others. Coordinate prior to installation the arrangement of HVAC work as related to plumbing, fire protection, electrical and general construction work.

1.5 DRAWINGS

A. The drawings are schematic in nature indicating the general location of equipment, ductwork, piping, and apparatus. While the sizes and locations have been indicated, the Contractor shall properly adjust his work to meet conditions as they actually exist on the premises. Equipment, ductwork, and piping arrangements shall provide adequate and acceptable clearance for entry, servicing and maintenance. Minor adjustments shall be discussed with the Engineer with the view to convenience of operation and noninterference with other work. The Engineer reserves the right to change the location of any pipe, duct or piece of equipment to suit conditions, with no added cost to the Owner if the requested change does not modify the scope of work. Should the particular equipment, which any contractor proposes to install, require other space conditions, other utility service, or other structural support than those indicated on the drawings, the Contractor shall arrange for such changes with other affected Contractors and with the

Architect. Required changes shall be noted on the submittal cover sheet. Should changes become necessary the Contractor shall make such changes at his expense.

1.6 SUBMITTALS

A. Furnish shop drawings on all items as indicated in individual sections. Indicate specification section number on each submittal. Refer to section 01 33 00 for general submittal requirements.

B. Furnish 2 sets of Operating and Maintenance manuals for the Owner. Include standard operating instructions and complete repair parts lists for items of equipment and controls. Include a summary of maintenance procedures required monthly, yearly, etc. for all equipment. Include a copy of all stamped submittals at the front of each section. Submit in binders with index and section tabs to Engineer for approval.

1.7 REMODELING WORK

A. Wherever remodeling work or demolition of existing equipment, ductwork, piping, and appurtenances is a part of plans and specifications, Contractor shall visit the site and thoroughly examine all existing conditions. Designated equipment shall be turned over to the Owner at a place and time so designated with all other items removed from the site by the Contractor. Provide all required work necessary for interconnection of existing services with new system and coordinate any down-time with the Owner to minimize disruption to their activities.

B. Contractors shall notify the Architect at least 10 days prior to the bid closing date of any deviations or required changes that are noticed. No allowance for additional costs for work related to existing conditions will be permitted after bidding unless proof of hidden work, breakage or damage could not be determined by inspection or examination by the Contractor.

1.8 HOUSEKEEPING

A. This Contractor shall periodically remove debris caused by his operations. On completion he shall remove all debris from his work and leave same neat and clean, ready for use by the Owner.

1.9 PROTECTION OF MATERIALS AND EQUIPMENT

A. Materials and equipment shall be protected at all times. This Contractor shall be responsible for all damage caused directly or indirectly by his workmen. Pipe and duct openings shall be closed with caps or plugs during installation. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical injury. At the completion of all work, the equipment shall be thoroughly cleaned and delivered to the Owner in a condition satisfactory to the Engineer.

B. Equipment shall not be used during construction unless approved in writing by the Engineer. Equipment used during construction shall be returned to the original condition, which may include such items as replacing filters, cleaning coils, and cleaning ducts

1.10 PAINTING

A. All equipment shall have manufacturer's standard baked enamel finish and shall not be job painted "unless otherwise specified". Equipment in finished rooms shall have color

selected by Engineer from manufacturer's standard colors. All required touch up painting of prefinished surfaces is by this Contractor.

1.11 MECHANICAL IDENTIFICATION

A. Every piece of equipment, starters, disconnect, etc. shall be stenciled with identifying number and area or rooms served, neatly printed and applied on or near item as approved by Engineer. Motors and equipment nameplates and applicable UL labels shall be in place, free from dirt, grease or paint when Project is turned over to Owner.

B. Label all accessible piping with direction of flow arrows and stenciled 1-1/2" identifying letters or snap-on plastic self-coiling sheets with 1" letters and flow arrows. Stencil with black enamel on a light background or light enamel on a black background. Snap-on plastic labels shall be held firmly in place without the use of adhesive, straps, or tape. Label at intervals of not less than every 30' and at points where piping passes through walls, floors or roofs on both sides of partition.

C. Provide 1-1/4" diameter brass valve tag with stamp engraved piping system abbreviation and sequenced valve number. Attach to valve with brass chain. Provide a neatly typed valve schedule stating valve number, service and location. Furnish copies in operating instruction manuals. Exclude HVAC terminal valves.

1.12 INSTRUCTIONS

A. The Contractor shall review with the Owner's representative complete operating and maintenance procedures for equipment and systems installed under this contract. Provide **1** day of instruction during normal working hours when systems are fully operational and before final payment.

PART 2 - PRODUCTS

2.1 QUALITY REQUIREMENTS

A. Items indicated on the drawings and in the specifications are listed by manufacturer in order to describe minimum quality requirements.

B. Materials and equipment shall conform to requirements of Wisconsin Administrative Code.

C. All materials and equipment furnished shall be new and shall be the standard products of manufacturers regularly engaged in the production of HVAC and Controls materials and equipment.

PART 3 - EXECUTION

3.1 NOT USED

END SECTION 23 05 00

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SECTION 23 05 13 - ELECTRICAL PROVISIONS OF HVAC WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of electrical provisions to be provided as mechanical work is indicated in other Division HVAC sections, on drawings and as further specified in this section.

B. Types of work normally recognized as electrical but provided as mechanical, specified or partially specified in this section, include but are not necessarily limited to the following:
   1. Motors for mechanical equipment.
   2. Starters for VFD controlled motors. (All other starters shall be provided by Electrical Contractor).
   3. Wiring of field mounted control switches and similar mechanical-electrical devices provided for mechanical systems to equipment control panels.

C. Refer to Division 23 Controls sections for control system wiring.
   1. Refer to other Division 23 sections for specific individual mechanical equipment electrical requirements.

D. Refer to Division 26 sections for starters, junction boxes and disconnect switches required for motors and other electrical units of mechanical equipment.

1.3 SUBMITTALS

A. Listing, Motors of HVAC Work: Concurrently with submittal of mechanical products listing (Basic Mechanical and Division 1 requirements), submit separate listing showing rating, power characteristics, application (connected equipment) and general location of every motor to be provided with mechanical work. Submit updated information promptly when and if initial data is revised.

1.4 QUALITY ASSURANCE

A. Coordination With Electrical Work: Wherever possible, match elements of electrical provisions of HVAC work with similar elements of electrical work specified in Division 26 sections. Comply with applicable requirements of Division 26 sections for electrical work of this section that is not otherwise specified.

B. Standards: For electrical equipment and products comply with applicable Wisconsin Electrical Code and the NEMA standards and refer to NEMA standards for definitions of terminology herein. Comply with all applicable requirements of the NEC (NFPA 70), NEMA MG-1, IEEE, and ANSI. All motors shall be U.L. listed for specified service.

PART 2 - PRODUCTS

2.1 MOTORS

A. Manufacturer: Except where item of mechanical equipment (which otherwise complies with requirements) must be integrally equipped with motor produced by another manufacturer, provide equipment motors manufactured by one of the following:

Baldor Electric Company	Marathon Electric Manufacturing Corporation
Century Electric Division, Inc.	Reliance Electric Company

B. Motor Characteristics: Except where more stringent requirements are indicated, comply with the following requirements for motors of mechanical work:

1. Temperature Rating: Rated for 40ºC environment with maximum 50ºC temperature rise for continuous duty at full load (Class A Insulation).
2. Starting Capability: Each motor capable of making 2 cold and 1 hot starts per hour.
3. Phases and Current Characteristics: Provide squirrel-cage induction polyphase motors for 1/2 Hp and larger and provide capacitor start single phase motors for 1/3 Hp and smaller unless otherwise indicated. Coordinate current characteristics with power specified in Division 26 sections and with individual equipment requirements specified in other Division 23 requirements. For 2 speed motors provide two separate windings on polyphase motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed and until rotation directions have been confirmed.
4. Frequency Characteristics: Variable frequency motors shall be capable of operating between 6-60 HZ. Motors shall be performance matched to variable frequency drives.
5. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
6. Power Factor: 0.85 minimum, without external capacitor correction at full load.

C. Motor Construction: Provide general purpose, continuous duty motors, Design "B" except "C" where required for high starting torque.

1. Frames: type “T” or “U”.
2. Bearings: Ball or roller bearings with inner and outer shaft seals, externally regreasable for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in motor, provide bearings designed to resist thrust loading. Refer to individual sections of Division 23 for fractional Hp light-duty motors where sleeve type bearings are permitted.
3. Enclosure Type: Except as otherwise indicated, provide open dripproof motors for indoor use where satisfactorily housed or remotely located during operation and provide guarded dripproof motors where exposed to contact by employees or building occupants. Provide weather protected Type I for outdoor use, Type II where not housed. Refer to individual sections of Division 23 for other enclosure requirements.

D. Overload Protection: Provide built-in thermal overload protection and where indicated provide internal sensing device suitable for signaling and stopping motor at starter.

E. Noise Rating: Provide "Quiet" rating on motors located in occupied spaces of building.

F. Efficiency: All motors 1 HP and above shall be "Energy Efficient" or "High Efficiency". Provide motors having minimum efficiency as scheduled when tested in accordance with NEMA MG-1 and IEEE Standard 112.

MOTOR NOMINAL FULL LOAD EFFICIENCY SCHEDULE

MOTOR HP	-----Open Drip-Proof Motors------ -------Nominal Motor Speed------- 1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	80.0
1-1/2	86.5	86.5	85.5
2	87.5	86.5	86.5
3	89.5	89.5	86.5
5	89.5	89.5	89.5
7-1/2	91.7	91.0	89.5
10	91.7	91.7	90.2
15	92.4	93.0	91.0
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	94.1	93.0
40	94.1	94.1	93.6
50	94.1	94.5	93.6
60	95.0	95.0	94.1
75	95.0	95.0	94.5

MOTOR HP	----Totally Enclosed Fan-Cooled---- -------Nominal Motor Speed------ 1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	78.5
1-1/2	87.5	86.5	85.5
2	88.5	86.5	86.5
3	89.5	89.5	88.5
5	89.5	89.5	89.5
7-1/2	91.7	91.7	91.0
10	91.7	91.7	91.7
15	92.4	92.4	91.7
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	94.1
60	94.5	95.0	94.1
75	95.0	95.4	94.5

G. Name Plate: Provide metal name plate on each motor indicating full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

2.2 STARTERS (Variable Frequency Drive Motors) AND ELECTRICAL DEVICES AND WIRING

A. Motor Starter Manufacturer: Except where item of mechanical equipment must be integrally furnished with motor starter produced by another manufacturer, provide motor starters for mechanical equipment manufactured by single one of the following: Cutler-Hammer, Inc., Square D Company

B. Motor Starter Characteristics: Comply with NEMA standards and NEC. Provide Type I general purpose enclosures (unless noted otherwise) with padlock ears and with frames

and supports for mounting on wall, floor or panel as indicated. Where starter location is not within sight of motor, provide disconnect switch at motor. Provide type and size of starter as shown on electrical drawings (or as recommended by motor manufacturer and equipment manufacturer for applicable protection and start-up condition); refer to individual equipment sections for basic load requirements.

1. Magnetic Starters: Provide magnetic starters for motors 1/2 Hp and larger and for smaller motors where interlock or automatic operation is indicated. Include the following:

    a. Maintained contact push buttons and pilot lights properly arranged for single speed or multispeed operation as indicated.
    b. Trip free thermal overload relays, each phase.
    c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls sections.
    d. Built in 120-volt control circuit transformer, fused from line side, where service exceeds 120 volts.
    e. Externally operated manual reset.
    f. Undervoltage release or protection.
    g. Starters serving motors 25 HP or greater shall be a reduced voltage type. "Soft" start is required for all motors over 25 Hp or provided with electronic "soft start" equipment. See schedules for additional requirements.

2.3 EQUIPMENT FABRICATION

A. General: Fabricate mechanical equipment for secure mounting of motors and other electrical items included in work. Provide either permanent alignment of motors with equipment or adjustable mountings as applicable for belt drives, gear drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable and removable guards for motor drives, arranged for lubrication and similar running maintenance without removal of guards.

B. Belt Drives: Where indicated or required for speed adjustment, provide V belts of proper size and number. Belts for motors of 3 Hp or less shall have a capacity of 200% of motor capacity. Belts for motors of 5 Hp and larger shall have a capacity of 175% of motor capacity.

1. Maximum belt speed shall be 5000 fpm.
2. Sheaves shall be fixed type, except Dodge Taper-lock or equivalent may be used prior to final TAB work.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 Hp and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

B. Deliver starters for VFD motors and wiring devices which have not been factory installed on equipment unit to electrical Installer for installation.

END SECTION 23 0513

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SECTION 23 05 14 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

B. Extent of variable frequency drive work is indicated by drawings and by requirements of this section.

C. Refer to Division 26 sections for disconnect switches and power wiring to line voltage devices; not work of this section.

D. Refer to Section 23 09 93 (DDC Automatic Control Sequences) for control used in conjunction with variable frequency drive; not work of this section.

1.3 SUBMITTALS

E. Product Data: Submit manufacturer's data on variable frequency drives with applicable options; input and output performance; voltage, phase, current and over-current characteristics; physical dimensions and weight; installation instructions; protection features and rated environment operating conditions. Submit wiring diagram and block diagrams for variable frequency drives incorporating specified options.

F. Maintenance Data: Submit maintenance data and spare parts lists. Include product data and submit in maintenance manual.

1.4 QUALITY ASSURANCE

G. Electrical Standards: Provide electrical products that have been tested, listed and labeled with Underwriter's Laboratory (UL) or Electrical Testing Laboratory (ETL). Comply with NEC and NEMA as applicable to wiring methods, materials, construction and installation of variable frequency drives.

1.5 DELIVERY, STORAGE AND HANDLING

H. Provide factory shipping cartons for each piece of equipment. Maintain through shipping, handling and storage as required to prevent equipment damage. Store equipment inside and protected from weather.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

I. Design and Construction:
1. The variable speed drive system shall consist of the following:

a. Variable frequency drive and motor.

b. Bypass contact for operation with electronic "Soft Start" through bypass.
c. Step-up or step-down transformer as required.
d. Isolation transformer (if required to meet line notch requirement).

2. Variable speed drives shall be of the solid state, constant torque, modular type, with a variable frequency/voltage output. Drives shall use solid state electronics to affect necessary control functions including control of specified parameters and protection of the motor and drive when abnormal conditions are encountered.
3. Converter section shall be of the full wave diode bridge designs for motors up to 100 HP.
4. Output inverter section may be of the 6-step voltage source or PWM design.
5. Internal control and sensing circuitry shall be electrically isolated from the main power supply to the drive.
6. Provide one normally open and one normally closed auxiliary contactor in each drive. These contacts shall be activated upon drive failure of any kind, including safety shutdowns. Contacts are intended to be used for remote monitoring of drive operation by the central energy management system.
7. Drive enclosure shall be of NEMA 1, gasketed construction, free standing with hinged and lockable door. Provide door mounted disconnect switch to prevent access to enclosure with power on.
8. Operating and monitoring devices mounted on the front cover shall include:

a. Circuit breaker with door interlocked handle.
b. Operating mode selector switch marked "manual-off-automatic."
c. Manual speed control potentiometer.
d. Manual switch to select power through VFD or bypass.
e. "Power On" light with push-to-test feature.
f. Inverter fault indicator light with push-to-test feature.
1) Speed indicating meter (0 to 100%).

9. Where indicated on plans, provide a separate bypass section to house bypass wiring, contactors, relays and all other necessary bypass equipment required to manually bypass the VFD unit in the event of a VFD failure. Bypass equipment shall allow for a "soft" start of motor when on bypass. Soft start shall be electronic type.
10. Full nameplate motor horsepower with specified service factor shall be available to driven device (i.e. fan, pump) when motors are being operated.
11. Motors furnished with variable frequency drives shall have 1.15 service factor and be equipped with Class F (H) insulation.

J. Performance Requirements:
1. Drives shall be able to start into a rotating load without damage.
2. Convertor section line noise shall be limited to a voltage distortion factor of 1% or less, line notch depth of 1% or less (except PWM with diode) as

defined in IEEE Standard 519-1981. Line reactors shall be provided by drive manufacturer as required to meet this standard.

3. Units shall be suitable for input power of 460 volts, 3 phase, 60 Hz.
4. Drives shall be equipped with a fixed or adjustable current limiting control device. Capability shall be provided to limit output current to a maximum of 150% of rated current. Acceptable input power tolerance shall be +10%, -5% voltage +20% frequency.
5. Output power shall be suitable for driving standard NEMA B design, 3 phase AC induction motors at full rated speed with capability of 10:1 turndown. Drives shall have capability to ride through a momentary power outage with duration of 3 cycles.
6. Drives shall be of auto-reset into a rotating load after a present, adjustable time delay following a power outage. After 3 restart attempts, drive shall shut down.

K. Control Features:

1. Control circuits shall be compatible with a 4 to 20 ma, DC isolated and ungrounded control signal when in the automatic mode and from manual speed potentiometer in the manual mode.
2. Drives shall be provided with devices to permit field adjustment of minimum and maximum output frequency.
3. Drives shall be equipped with devices allowing field adjustment of acceleration and deceleration rates. Capability shall exist to allow motor speed to increase from start to full speed in a period of 60 seconds, field adjustable. Adjustability that provides for lower acceleration rates is acceptable.
4. Drives shall be equipped with a fixed or adjustable current limiting control device. Capability shall be provided to limit output current to a maximum of 150% of rated current.

L. Protection Features:

1. Drives shall shutdown upon activation of any one of the safety devices. Electronic protection circuits shall provide an orderly shutdown without fuse of components loss. A visual indication shall be provided on the drive to indicate alarm conditions.
2. Drive circuits shall be fully protected for the following conditions:

    a. Instantaneous overcurrent.
    b. Input power under or overvoltage (+1% - 5%).
    c. Single or three phase short circuit.
    d. Overtemperature.
    e. Output overcurrent.

3. Drives shall be further equipped with DC bus and control circuit fusing, grounded chassis, fault reset pushbutton, magnetic motor starter overload relays and LED diagnostic indicators.
4. Provide input MOV protection up to 3000 volts, in accordance with ANSI C37.90A-1974.
5. Drive shall be capable of starting into a rotating load without failure of drive components.

M. Quality Assurance Testing:

1. Complete drive assembly shall be subjected to a heat stress test under full load for a period of 48 consecutive hours at 40°C (104°F).
2. Field performance testing of variable frequency drive assemblies to determine compliance with specified performance requirements will be performed at the owner's discretion. The cost of initial testing will be borne by the unit manufacturer. Should drive be found to be deficient in any performance category, drive manufacturer will be required to make any and all changes necessary to bring units into compliance with performance guidelines as specified. The cost of changes and the cost of retest will be borne by the unit manufacturer.
3. Variable frequency drive manufacturer's representative shall perform post installation testing of each drive in the presence of the owner's representative.

    a. General inspection to verify proper installation.
    b. Determine the reaction of the drives to a power interruption by simulation of a short and a long power outage. Duration of the simulated outages shall be 2 seconds and 60 seconds in length respectively.
    c. Determination that drive is adequately protected during change of operational mode by switching drives from VFD to bypass mode and from bypass mode to VFD mode.
    d. Determine the voltage distortion factor and line notch depth on the line side of isolation transformer (if one has been provided) or line side of variable frequency drive (if an isolation transformer has not been provided). Test procedures to conform with IEEE Standard 519-1981, "Guide for Harmonic Control and Reactive Compensation of Static Power Convertors."

N. Associated Equipment:
1. Provide each drive with a Class H insulation, dry type isolation transformer mounted in NEMA 1 enclosure. Transformer primary winding to be provided with 4 taps (2-1/2% increments), two above and two below full rated primary voltage. Rated at 115oC.
2. Provide transformers with a heavy gage, ventilated enclosure with baked enamel finish. Ventilation openings shall be designated to prevent the entry of rodents.
3. Transformer to be shielded type. Electrostatic shield to be copper, enveloping the full height of the winding. Secondary voltage and ground taps shall be rigidly mounted for convenient front wiring access.

O. Manufacturer: Subject to compliance with requirements, provide variable frequency drives of one of the following: ABB; Emerson; Graham or approved equal

PART 3 - EXECUTION

3.1 INSTALLATION

P. Install variable frequency drives as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure installation complies with requirements. Isolation transformers shall not be mounted directly below VFD unit but shall be mounted above or adjacent to VFD. Comply with requirements of NEC and applicable portions of NECA "Standard of Installation" pertaining to general electrical installation practices.

Q. Coordinate with other electrical and mechanical work including power wiring, disconnects, temperature controls, etc. to interface installation of variable frequency drives with other work.

R. All electrical wiring, both line and low voltage, including interconnecting wiring between VFD and bypass/starter shall be installed in metal conduit and in accordance with all electrical sections of this specification and all applicable codes.

S. Startup, Operation and Maintenance:

1. Manufacturer shall provide the service of a factory trained engineer to approve the installation; startup, test and adjust units for proper operation; and instruct and train the owner's maintenance personnel in the operation and maintenance of the units. Manufacturer's representative shall demonstrate operational capability of units during instruction and training period.
2. Manufacturer shall provide a line notch test at startup and certify that the system meets the requirements. If the test fails, corrective action is required by the manufacturer.
3. Upon completion of this service, submit a complete report including startup and test log signed by the manufacturer's representative.

END SECTION 23 05 14

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SECTION 23 05 19 - GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Air filter gages are specified in 23 41 00 – Air Treatment Equipment.

C. Air flow stations are specified in Pneumatic/Electric Temperature Controls.

1.2 DESCRIPTION OF WORK

A. Extent of gages required by this section is indicated on drawings and/or specified in other Division 23 sections.

B. Gages furnished as part of factory fabricated equipment are specified as part of the equipment assembly in other Division 23 sections.

C. Types of gages specified in this section include the following:
Temperature gages

1.3 SUBMITTALS

A. Product Data: Submit catalog cuts, specifications, installation instructions and dimensioned drawings for each type of meter and gage. Include scale range, ratings and calibrated performance curves, certified where indicated.

B. Maintenance Data: Submit maintenance data and spare parts lists for each type of meter and gage. Include this data in Maintenance Manual.

1.4 QUALITY ASSURANCE

A. UL Compliance: Comply with applicable UL standards pertaining to meters and gages.

B. ANSI and ISA Compliance: Comply with applicable portions of ANSI and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.

C. Certification: Provide meters and gages whose accuracies, under specified operating conditions, are certified by manufacturer.

PART 2 - PRODUCTS

2.1 TEMPERATURE GAGES

A. Manufacturers:
1. Subject to compliance with requirements, provide glass thermometers of one of the following: Ashcroft; Trerice (H.O.) Company; Weiss (Albert A.) & Son, Inc.; or approved equal.

B. Thermometers for installation BELOW 7’ AFF:

1. General: Provide glass thermometers of materials, capacities and ranges indicated, designed and constructed for use in service indicated.
2. Case: Die cast aluminum finished in baked epoxy enamel, glass front, spring secured, 9" long.
3. Adjustable Joint: Die cast aluminum, finished to match case, 180º adjustment in vertical plane, 360º adjustment in horizontal plane, with locking device.
4. Tube and Capillary: Red liquid filled, magnifying lens, 2% scale range accuracy, shock mounted.
5. Scale: White faced, permanently etched black markings.
6. Stem: Copper plated steel or brass, for separable socket, length to suit installation.
7. Range: Conform to the following:

    a. Air: -20º to 120ºF with 2ºF scale divisions, or
    b. Air (Heating): 30º to 180ºF with 2ºF scale divisions

C. Thermometers for installation ABOVE 7' AFF:
1. General: Provide remote mounting dial thermometers of materials, capacities and ranges indicated, designed and constructed for use in service indicated.
2. Case: Die cast aluminum finished in baked epoxy enamel, glass front, back flanged casing, 3-1/2" diameter scale.
3. Connecting tube: Stainless steel capillary with stainless steel interlocked spiral armor. Bottom connection to case.
4. Tube and Capillary: Liquid or gas filled, 2% scale range accuracy, temperature compensated, capable of field calibration.
5. Scale: White faced, permanently etched black markings.
6. Stem: Copper plated steel or brass, for separable socket, length to suit installation.
7. Range: Same as above.

PART 3 - EXECUTION

3.1 INSTALLATION OF TEMPERATURE GAGES

A. General: Install temperature gages below 7' AFF in vertical upright position and tilted so as to be easily read by observer standing on floor. Install remote read thermostats on a suitable rigid surface, with readout between 4' to 6' AFF.

B. Locations: Install in the following locations and elsewhere as indicated on drawings:
1. At mixed air, and discharge air in each air handling unit.

END SECTION 23 05 19

SECTION 23 05 29 – SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.
   1. Section 23 05 48 - Vibration isolation used in conjunction with work of this section.

1.2 DESCRIPTION OF WORK

A. Extent of supports, anchors and seals required by this section is indicated on drawings and/or specified in other Division 23 sections.

B. Supports, anchors and seals furnished as part of factory fabricated equipment are specified as part of the equipment assembly in other Division 23 sections.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacturer of supports, anchors and seals of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Code Compliance: Comply with applicable ANSI codes pertaining to product materials and installation of supports, anchors and seals for pressure piping.

C. UL and FM Compliance: Provide products that are Underwriters Laboratories listed and Factory Mutual approved.

D. MSS Standard Compliance:
   1. Provide pipe hangers and supports of which materials, design and manufacture comply with ANSI/MSS SP-58.
   2. Select and apply pipe hangers and supports, complying with MSS SP-69.

PART 2 - PRODUCTS

2.1 MANUFACTURERS OF HANGERS AND SUPPORTS

A. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following: Fee & Mason Manufacturing; Grinnell/Anvil International; Caddy, or approved equal. Grinnell model numbers are listed an example of required quality.

2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports complying with ANSI/MSS SP-58 of one of the following types listed, selected by Installer to suit horizontal piping systems in accordance with manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping and to exactly fit around piping insulation with saddle or shield for insulated

piping. Provide copper plated hangers and supports for copper piping systems. For plenum return applications ensure hangers meet UL 2043 flame and smoke testing.

B. Adjustable Steel Clevises: (1/2" - 2") Grinnell Fig. 65 or 260.

C. Adjustable Steel Clevises: (2-1/2" - 30") Grinnell Fig. 260.

D. Saddle w/ U-Bolt: Grinnell Fig. 191 (2” – 6”) and 259 (8” – 30”) including steel pipe base support and cast iron floor flange.

E. Clips: Grinnell PS 1100 (Non-Hanging).

F. Pipe Slides and Slide Plates: Grinnell 438, Type 2 and 3.

G. Pipe Guide: Grinnell Fig. 254 or 255.

H. Tubing channel clips: Caddy TSM/TSMI or Cooper B-Line BPIC/BPRC series.

2.3 VERTICAL PIPING CLAMPS

A. General: Except as otherwise indicated, provide factory fabricated vertical piping clamps complying with ANSI/MSS SP-69 of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper plated clamps for copper piping systems.

B. Two Bolt Riser Clamps: Grinnell Fig. 261.

2.4 HANGER ROD ATTACHMENTS

A. General: Except as otherwise indicated, provide factory fabricated hanger rod attachments complying with ANSI/MSS SP-69, of one of the following MSS types listed, selected by Installer to suit horizontal piping hangers and building attachments in accordance with manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select type of hanger rod attachments to suit hanger rod size.

B. 1/2” & 3/8”: Grinnell 89.

C. 5/8” to 1-1/2”: Grinnell 228.

2.5 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated, provide factory fabricated building attachments complying with ANSI/MSS SP-69 of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper plated building attachments for copper piping systems.

B. Concrete Inserts: Grinnell Fig. 282 and 281.

C. Welded Attachments: Grinnell Fig. 66.

D. Pipe Hanger Flange: Grinnell Fig. 153 (3 hole).

E. Steel Brackets: One of the following for indicated loading:
   1. Light Duty: (600#) Grinnell 194
   2. Medium Duty: (1200#) Grinnell 195
   3. Heavy Duty: (2400#) Grinnell 199

2.6 SPRING HANGERS AND SUPPORTS

A. General: Except as otherwise indicated, provide factory fabricated spring hangers and supports complying with ANSI/MSS SP-58 and 69, of one of the following MSS types listed, selected by Installer to suit piping systems, in accordance with manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.

B. Spring Cushion Hangers: Grinnell Fig. 82.

C. Spring Cushion Roll Hangers: Grinnell Fig. 178.

2.7 ROOF MOUNTED SUPPORT SYSTEMS

A. General: Curb base must be made of 100% recycled rubber and polyurethane prepolymer with a uniform load capacity of 500 pounds per linear foot of support. Base shall be 6 inches wide and 6 ¾ inches high by length required to support multiple pipes. Steel frame shall be 14 gauge strut galvanized per ASTM A653 or 12 gauge strut galvanized per ASTM A653 for bridge series. Attaching hardware to be zinc-plated threaded rod, nuts and attaching hardware per ASTM B633.

B. Equal to Dura-Blok as manufactured by Cooper B-line.

2.8 MISCELLANEOUS MATERIALS

A. Metal Framing: Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars: Provide products complying with ANSI/ASTM A36.

C. Cement Grout: Portland Cement (ANSI/ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ANSI/ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand by volume with a minimum amount of water required for placement and hydration.

D. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

E. Pipe Guides: Provide factory fabricated guides of cast semi-steel or heavy fabricated steel consisting of a bolted two section outer cylinder and base with a two section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any) and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed.

B. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments. Attachments to structural steel shall be completed prior to installation of structural fireproofing.

3.2 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations within concrete or on structural steel prior to installation of structural fireproofing for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69.

B. Install additional building attachments where support is required for additional concentrated loads including valves, flanges, guides, strainers, expansion joints and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping. Support spacing shall be based on midspan deflection of 0.5" maximum and allowable bending stress of 10,000 psi.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Provisions for Movement: Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

D. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

E. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.

3.4 INSTALLATION OF ROOF MOUNTED SUPPORT SYSTEMS

A. Install accordance with manufactures instructions and recommendations.

B. If gravel top roof, gravel must be removed around and under pipe support.

C. Always consult roofing contractor manufacturer for roof membrane compression capacities. If necessary, a compatible sheet of roof material (rubber pad) may be installed under rooftop support to disperse concentrated loads and add further membrane protection.

D. Gas piping support spacing subject to local code.

E. Use properly sized clamps to suit pipe size.

3.5 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure prior to installation of structure fireproofing. Comply with ANSI B31 and with AWS standards.

C. Where expansion compensators are indicated install anchors in accordance with expansion unit manufacturer's written instructions to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 ADJUSTMENT OF HANGERS AND SUPPORTS

A. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

3.7 EQUIPMENT BASES

A. Concrete housekeeping bases shown on drawings will be provided as work of Division 3. Furnish to Contractor, scaled layouts of all required bases with dimensions of bases and location to column centerlines. Furnish templates, anchor bolts and accessories necessary for base construction.

B. Provide structural steel stands to support equipment as indicated on plans and details. Construct of structural steel members or steel pipe and fittings. Provide factory fabricated tank saddles for tanks mounted on steel stands. Use galvanized steel when exposed to the outside or in steam boiler rooms.

END SECTION 23 05 29

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SECTION 23 05 48 - VIBRATION ISOLATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under 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. Types of vibration isolation products specified in this section include the following:
1. Type 1: Neoprene Pad
2. Type 2: Neoprene Mount
3. Type 3: Unhoused Spring with Neoprene
4. Type 4: Housed Spring with Neoprene
5. Type 5: Spring Hanger with Neoprene
6. Type 6: Precompressed Spring with Neoprene
7. Type 7: Spring Hanger with Deflection Indicator
8. Type 8: Spring Hanger with Neoprene
9. Type AG: Vertical Pipe Anchor and Guide
10. Type IB: Inertia Base
11. Type S: Steel Base
12. Type T: Horizontal Thrust Restraint
13. Flexible Piping Connections
14. Flexible Duct Connections

1.3 SUBMITTALS

A. Submit manufacturer's specifications, detailed drawings, performance characteristics data and installation instructions for each type of unit required.

B. Include data for each type and size of unit, showing isolation efficiency, stiffness, natural frequency and transmissibility at lowest operating speed of equipment.

C. For spring units, show wire size, spring diameter, free height, solid compression height, operating height, fatigue characteristics and ratio of horizontal to vertical stiffness.

D. For spring and pad type units show basis of spring rate selection for range of loading weights.

1.4 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide vibration isolation products of one of the following: Consolidated Kinetics Corporation; Korfund Dynamics Corporation; Vibration Eliminator Company, Inc.; or approved equal.

2.2 ISOLATION MATERIALS AND SUPPORT UNITS

A. **TYPES:** The type of isolator is subsequently described and an equivalent Mason Industries model type is indicated to represent the performance and quality specified. Any manufacturer indicated above may submit their equivalent model.

1. TYPE 1: NEOPRENE PAD
    a. Neoprene pad, 60 durometer, Bridge bearing quality per AASHO specifications. Minimum 3/4" thick.
    b. Equivalent to Mason type BBP.
2. TYPE 2: NEOPRENE MOUNT
    a. Double deflection neoprene mount having a minimum static deflection of 0.35 inches. Cover all metal surfaces with neoprene to resist corrosion. Include friction pads on both top and bottom surfaces so mounts need not be bolted to the floor but include bolt holes for those areas where bolting is required. For equipment such as small vent sets and close coupled pumps, include steel rails for use between the isolator and the equipment to accommodate equipment overhang.
    b. Equivalent to Mason type ND or type DNR (with rails).
3. TYPE 3: UNHOUSED SPRING WITH NEOPRENE
    a. Combination freestanding, unhoused spring and neoprene with rib molded antifriction base. Include leveling bolts for securing to the equipment. Springs to be laterally stable under load and selected so they have an additional travel to solid equal to 50% of the rated deflection. Use height saving brackets when appropriate to the application. Equivalent to Mason type SLF.
4. TYPE 4: RESTRAINED SPRING WITH NEOPRENE
    a. Combination spring and neoprene with rib molded base similar to Type 3 mount above, but with a housing that includes vertical limit stops to prevent spring extension when weight is removed such that the installed and operating heights are the same. Maintain a minimum clearance of 1/2" around restraining bolts, and between the housing and the spring, so as not to interfere with the spring action. Design isolator so limit stops are out of contact during normal operation. Use height saving brackets when appropriate to the application.

b. Equivalent to Mason type SLR.

5. TYPE 5: SPRING HANGER WITH NEOPRENE

a. Vibration hanger with a steel spring and 0.3" deflection neoprene element in series. Use neoprene element molded with a rod isolation bushing that passes through the hanger box. Select spring diameters and size hanger box lower holes large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Select springs so they have a minimum additional travel to solid equal to 50% of the rated deflection.

b. Equivalent to Mason type 30N or W30.

6. TYPE 6: PRECOMPRESSED SPRING HANGER WITH NEOPRENE

a. Vibration hanger similar to Type 5 but precompressed to the rated deflection to keep the piping or equipment at a fixed elevation during installation. Design hanger with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load.

b. Equivalent to Mason type PC30N.

7. TYPE 7: SPRING HANGER WITH DEFLECTION INDICATOR

a. Steel spring hanger in a steel housing which include a deflection indicator scale, designed to accommodate vertical pipe expansion. Preset hanger at the factory for the required load. Design hanger for 130% of rated deflection but use no more than 100% of rated deflection when selecting the hanger. Equivalent to Mason type HES.

8. TYPE 8: SPRING HANGER WITH NEOPRENE

a. Steel spring hanger located in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod. Neoprene cup to contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion. Design spring diameter and size hanger box lower hole sufficiently large to permit the hanger rod to swing through a 30° arc before contacting the hole perimeter and short circuiting the spring. Select spring so it has a minimum additional travel to solid equal to 50% of the rated deflection. Provide hanger with an eye bolt on the spring end and provision to attach the housing to the flat iron duct straps.

b. Equivalent to Mason type W30 or 30N.

9. TYPE AG: VERTICAL PIPE ANCHOR AND GUIDE

a. All directional acoustical pipe anchor and guide consisting of a telescopic arrangement of two sizes of steel tubing separated by

a minimum half inch thickness of heavy duty neoprene and duck or neoprene isolation material. Provide vertical restraints of similar material to prevent vertical travel in either direction. Design isolation materials for a maximum allowable load of 500 psi, balanced for equal resistance in any direction. Equivalent to Mason type ADA.

10. TYPE IB: INERTIA BASE

    a. Rectangular structural beam or channel concrete form for floating foundation. Include support for suction and discharge base ells for split case pump bases. Use perimeter steel members with a minimum depth equal to 1/12 of the longest dimension of the base but not less than 6"; base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. Include concrete reinforcements consisting of steel angles or 1/2" bars welded in place on 6" centers running in two layers perpendicular to each other and 1-1/2" above the bottom; provide additional steel if required by the structural conditions. Furnish form with steel bolting templates and anchor bolt sleeves to receive equipment anchor bolts where anchor bolts fall in concrete locations. Use height saving brackets in all mounting locations to maintain a base clearance of at least 1" above the floor or housekeeping pad. Equal to Mason type KSL or BMK.

11. TYPE S: STEEL BASE

    a. Structural steel base, rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be "T" or "L" shaped. Include support for suction and discharge base ells for split case pump bases. Use perimeter steel members with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Use height saving brackets in all mounting locations to provide a base clearance of at least one inch above the floor or housekeeping pad. Equal to Mason type WF.

12. TYPE T: HORIZONTAL THRUST RESTRAINT

    a. Spring element in series with a neoprene pad as described for Type 3 mount with the same deflection as specified for the mounting or hanger. Design the assembly so the spring element is contained within a steel frame, so it can be preset for thrust at the factory, and adjusted in the field for a maximum of 1/4" movement at start and stop. Include threaded rod and angle

brackets for attachment to both equipment and ductwork or equipment and structure. Equivalent to Mason type WB.

2.3 FLEXIBLE PIPING CONNECTIONS

A. Suitable for pressure, temperature, and fluid involved; minimum pressure rating for any system is 125 psig at the design temperature of the fluid. Use 12 inch minimum line length of flexible hose or length required to absorb 3/4" lateral movement, whichever is greater.

B. Manufacturers:
1. Flexonics, Mason, Mercer Rubber, Metraflex, or approved equal.

C. Refrigerant:
1. Seamless bronze corrugated flexible hose with bronze wire braided cover and solder type copper tube ends with the entire assembly fabricated specifically for refrigerant duty.

2.4 FLEXIBLE DUCT CONNECTIONS

A. Provide flexible duct connections wherever ductwork connects to vibration isolated equipment or where otherwise noted. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse and torsional movement and also capable of absorbing vibrations of connected equipment. Materials to be fire retardant, be UL 214 listed, and meet the requirements of NFPA 90A.

B. MANUFACTURERS: Flexonics, Mason, Mercer Rubber, Metraflex, or approved equal.

C. Construction: Indoor General use; Glass fiber fabric double coated with neoprene, air and water tight, suitable for temperatures between -10 and 200 °F, with a nominal weight of 30 ounces per square yard. Outdoor General outdoor use; Double coated with Hypalon and suitable for temperatures between -10 to 250 °F, with a nominal weight of 26 ounces per square yard. Corrosive environments or fume exhaust applications indoors or outdoors; Use a material coated with Teflon that is air and water tight, suitable for temperatures between -20 °F and 500 °F and has a nominal weight of 14 ounces per square yard.

2.5 PERFORMANCE

A. Select vibration isolation devices as indicated below or to provide not less than 95% isolation efficiency, whichever is greater.

	--On Grade--		---20 Feet---		---30 Feet---		---40 Feet---	
TYPE OF EQUIPMENT	Iso Type	Min. Static Defl. In.	Iso Type	Min. Static Defl. In.	Iso Type	Min. Static Defl. In.	Iso Type	Min. Static Defl. In.
AIR-COOLED CONDENSER:	Bolt to pad		3	0.75	3	1.50	3	2.50
AIR-COOLED CONDENSING UNITS:	Bolt to pad		3	0.75	4	1.50	4	2.50

TYPE OF EQUIPMENT	--On Grade-- Iso Type	Min. Static Defl. In.	---20 Feet--- Iso Type	Min. Static Defl. In.	---30 Feet--- Iso Type	Min. Static Defl. In.	---40 Feet--- Iso Type	Min. Static Defl. In.
PACKAGED AIR HANDLING UNITS:								
Suspended								
Thru 5 hp	-	-	5	1.00	5	1.00	5	1.00
7-1/2 hp and over								
Thru 400 rpm	-	-	5	1.50	5	1.50	5	1.50
401 rpm and over	-	-	5	1.00	5	1.00	5	1.50
Floor mounted with internal fan spring isolation								
Thru 5 hp	1	0.10	1	0.10	1	0.10	1	0.10

CENTRIFUGAL BLOWERS

Suspended — Use type 5-T hangers with deflection from blower minimum deflection guide. Type T needed only when air thrust exceeds 10% of equipment weight.

Floor mounted — Use type 3-IB mount with deflection from blower minimum deflection guide.

TUBULAR CENTRIFUGAL AND AXIAL FANS:

Suspended — Use type 5-T hangers with deflection from blower minimum deflection guide. Type T needed only when air thrust exceeds 10% of equipment weight.

Floor mounted with motor on/in fan casing — Use type 2 for 0.35" deflection, type 3 for 0.75" and type 3-S for over 0.75" with deflection from blower minimum deflection guide. Use type 3-S-T for deflection over 4".

Floor mounted — Type 2-IB for .35" deflection and type 3-IB for 0.75" and over with arrangement 1 deflection from blower minimum deflection guide or any separately mounted motor.

PIPING CONNECTED TO ROTATING OR RECIPROCATING EQUIPMENT: Flexible piping connections, and type 5 or 6 hangers for a distance of 100 pipe diameters or a distance of three hangers away from the equipment, whichever is greater. Where piping is floor supported, the above requirement apply, but use type 3 mounts instead of type 5 or 6 hangers.

DUCTWORK IN MECHANICAL EQUIPMENT ROOMS: Use type 8 hanger with .75" minimum deflection for all ducts with a cross sectional area greater than 4.0 square feet and, where either the air velocity is great than 3500 fpm or, the pressure class is 4" water column or higher.

BLOWER MINIMUM DEFLECTION GUIDE

	Required Deflection (Inches)			
Fan Speed (RPM)	On Grade	20' Floor Span	30' Floor Span	40' Floor Span
175-224	0.35	3.50	4.50	4.50
225-299	0.35	3.50	3.50	3.50
300-374	0.35	2.50	2.50	3.50
375-499	0.35	1.50	2.50	3.50
500 and over	0.35	0.75	1.50	2.50

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. 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.
2. Anchor and attach units to substrate and equipment as required for secure operation and to prevent displacement by normal forces and as indicated.
3. 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.
4. Locate isolation hangers as near overhead support structure as possible.
5. Install flexible duct connectors at air handling equipment greater than 200 cfm capacity. Bond flanges of flexible duct connectors to ducts and housings to provide airtight connections. Seal seams and penetrations to prevent air leakage.

B. Flexible Pipe Connectors: Install on equipment side of shut off valves, horizontally and parallel to equipment shafts wherever possible. Provide at all pumps, AHU coils, and fan coil units.

END SECTION 23 05 48

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SECTION 23 07 00 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Section 23 31 13 - Acoustic lined air ducts.

C. Section 23 33 00 – Duct Accessories

1.2 DESCRIPTION OF WORK

A. Provide thermal insulation for piping, ductwork and equipment as specified herein.

B. Insulation thicknesses required for the various system types are as scheduled on plans, as required by the Wisconsin Administrative Code, and as specified herein. In case of conflict, the more rigid requirement shall apply. All insulation thicknesses listed are based on a minimum thermal efficiency (R-Value) with the intent to provide a minimum thermal efficiency.

C. Wrap access doors with approved materials and methods by rating agency.

1.3 SUBMITTALS

A. Submit insulation schedule indicating service location, product type (manufacturer), and product thickness. Include performance data for each type of product used.

B. Certifications: Submit certifications, ESR report for material and methods or other data as necessary to show compliance with these specifications and governing regulations.

1.4 QUALITY ASSURANCE

A. Installer shall be firm trained and regularly engaged in the application of mechanical insulations. Installer shall be responsible for all debris, rubbish and damages to building parts caused by his operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Insulation products: Subject to compliance with requirements, provide products of one of the following: Armstrong; Certainteed; Dow; Knauf; Johns Manville Co.; Owens-Corning; Rubatex; or approved equals.

B. Jacketing products: Subject to compliance with requirements, provide products of one of the following: Alumaguard; MFM Building Products; Venture Clad or approved equals.

2.2 FLAME SPREAD/SMOKE DEVELOPED RATING

A. Insulation systems shall have a flame spread/smoke developed rating of 25/50 or less.

2.3 FLEXIBLE ELASTOMERIC PIPE OR EQUIPMENT INSULATION

A. Flexible closed cell, minimum nominal density of 5.5 lbs. per cu. ft., thermal conductivity of not more than 0.27 at 75 degrees F, minimum compressive strength of 4.5 psi at 25% deformation, maximum water vapor permeability of 0.05 perm inch, maximum water absorption of 0.2% by weight, rated for service range of -20 degrees F to 220 degrees F on piping and 180 degrees F where adhered to equipment or ductwork. Systems 1" thick or less shall have a flame spread/smoke developed rating of 25/50 or less. Armaflex, or equal. Use only manufacturer approved sealant.

B. Flexible pipe insulation fittings shall be fabricated from miter cut piping insulation or sheet insulation.

2.4 FLEXIBLE FIBERGLASS DUCTWORK INSULATION

A. Flexible fiberglass duct wrap shall be blanket type insulation with "K" factor of .26 at 75^{o}F, 1.0 lbs./cubic foot density and aluminum foil scrim kraft facing. Manville Microlite.

2.5 RIGID FIBERGLASS DUCTWORK INSULATION

A. Rigid fiberglass ductwork insulation shall be board type insulation with "K" factor of .25 at 75^{o}F, 6.0 lbs./cubic foot density and foil reinforced kraft facing. Owens-Corning Type 705.

2.6 KITCHEN GREASE DUCT FIREPROOFING WRAP:

A. Inorganic flexible fiber 2 hour fire rated duct enclosure wrap with zero clearance to adjacent combustible construction, tested per ASTM E2336, and installed per the requirements of an approved ESR report. Submit ESR report.

B. Provide grease duct fireproofing systems of one of the following: ConQuest Firespray Flamebar BW11 with Unifrax FyreWrap Max 2.0, Morgan Thermal Ceramics FireMaster FastWrap XL, or approved equal

2.7 ACCESSORIES

A. Bedding Compounds: Non-shrinking, permanently flexible, compatible with insulation.

B. Vapor Barrier Coating: Nonflammable, fire resistant, polymeric resin, compatible with insulation.

C. Insulating Cement: ANSI/ASTM C195, hydraulic setting mineral wool.

D. Wire Mesh: Corrosive resistant metal, hexagonal pattern.

2.8 JACKETS

A. METAL JACKET: 0.016" thick aluminum, or 0.010" thick stainless steel with safety edge.

B. FLEXIBLE METAL JACKETING SYSTEM: Laminated, flexible, self adhering without additional mechanical attachment, sheet-type weather proof cover for interior or exterior use, consisting rubberized adhesive for continuous use temperature between (-20°F to + 175°F) double layer of high density polyethylene reinforcement and a UV resistant aluminum outer surface. Jacketing material is to have a maximum flame spread/smoke developed index of 25/20, per ASTM-E 84 test, 0.0000 perms water vapor permeability rating per ASTM E-96, and mold inhibitors. Material shall have a 10 year manufacturer's warranty to be free from leaks caused by defects in manufacturing when the membrane is installed according to published directions. Color to be natural aluminum. Surface to be rough embossed. Equal to VentureClad 1577CW.

PART 3 - EXECUTION

3.1 EXTERIOR EXHAUST DUCTWORK INSULATION

A. Exterior exhaust ductwork shall be insulated per schedule, from roof penetration to exhaust fan on roof. Cover exterior insulated ducts with flexible metal jacket.

3.2 EXTERIOR SUPPLY DUCTWORK INSULATION

A. Exterior supply ductwork shall be insulated per schedule, from rooftop unit casing to roof penetration. Cover exterior insulated ducts with flexible metal jacket.

3.3 INTERIOR SUPPLY DUCTWORK INSULATION

A. Interior supply ductwork shall be insulated with rigid exterior fiberglass duct board or flexible fiberglass duct wrap, per schedule. Vapor barrier shall be provided. Provide sound attenuating duct liner with perforated metal covering in main air handling unit supply and return ducts before and after supply and exhaust/return fans, as specified in Section 23 31 13 and to points indicated on drawings. See schedule for thickness. Interior dimensions of lined ducts to be as noted on drawings. See schedule for thickness.

B. Where preinsulated flexible ductwork is used, wrap uninsulated flex duct connections to sheet metal duct and to diffuser with flexible fiberglass duct wrap.

C. Where uninsulated plenum diffusers are utilized, wrap exterior of plenum with flexible fiberglass duct wrap.

3.4 OUTSIDE AIR DUCTWORK INSULATION

A. Interior outside air ductwork shall be insulated per schedule, with vapor barrier.

3.5 INTERIOR EXHAUST AIR DUCTWORK

A. Exhaust air ductwork shall be insulated per schedule, as specified in Section 23 31 13 (Medium & Low pressure Ductwork) and to points indicated on drawings.

3.6 INTAKE AND EXHAUST PLENUMS INSULATION

A. Intake and exhaust air plenums and louver closure panels shall be insulated as scheduled for outside air ducts.

3.7 EQUIPMENT INSULATION

A. Insulate cold and hot surfaces of equipment as scheduled.

B. Insulate AHU access door sections, including doors and floor sections where not internally insulated.

3.8 INSULATION INSTALLATION

A. Install insulation products in accordance with manufacturer's written instructions and in accordance with recognized industry standards to ensure that insulation serves its intended purpose. Clean and dry surfaces prior to installation. Apply when surfaces to be insulated are at room temperature. Use adhesives, sealers, protective finishes, staples, bands, wires, studs, pins, clips, etc. as recommended by manufacturer. Staples or other fasteners that may puncture vapor barrier shall not be used on chilled water, supply air duct or condensate drains. Maintain integrity of vapor barriers. Extend insulation without interruption through walls, floors and similar penetrations, except where otherwise indicated. Install protective metal shields and insulated inserts wherever needed to prevent compression of insulation. Do not insulate over nameplates and labels, bevel and seal around such. Fill cracks, joints, seams and depressions with bedding compound or vapor barrier cement. Provide smooth finish on all insulated surfaces.

B. Flexible elastomeric insulation shall be completely sealed along seams and butt joints with full covering of adhesive on both surfaces to be joined. Insulation shall not be stretched or forced to a longer length. Cover exterior elastomeric insulation with 1 coat of vapor barrier mastic and flexible metal jacket.

C. Flexible fiberglass duct wrap shall be secured to ducts over 22” in wide with weld pins, cup pins or speed clips on bottom and sides. Fasten in accordance with the latest addition of SMACNA, but not less than 18” on center or less as required to prevent sagging. Butt all seams and joints, cover with 4” tape and staple tape. Vapor seal all seams, joints, and penetrations.

D. Rigid fiberglass ductwork insulation shall be impaled over suitable mechanical fasteners attached 18" on center maximum and secured with speed washers. Seal all joints and cracks with vapor barrier tape.

E. Flexible fiberglass equipment insulation shall be impaled over mechanical fasteners at 18" on center maximum and secured with speed washers. Butt adjacent sections and seal with vapor barrier tape. Apply adhesive and cover with canvas or glass jacketing and seal with vapor barrier coating.

F. Kitchen grease duct fire proofing wrap shall be installed on ductwork and access doors per ESR report for manufacturer’s product. Also cover the entire top surface of each grease hood per manufacturer’s requirements to maintain the same rating as duct.

3.9 CONDENSATE DRAIN PIPING

A. Condensate drain piping from AHU drain pans, intake and exhaust plenums shall be insulated as scheduled for cold water piping, unless piping is PVC piping.

3.10 REFRIGERANT SUCTION PIPING

A. All refrigerant suction piping shall be insulated as scheduled. Paint insulation to match adjacent insulation. Cover exterior piping with flexible metal jacket.

3.11 JACKETS

A. PVC jacket: Lap seams and joints a minimum of 2 inches and continuously seal with welding solvent recommended by jacket manufacturer. Lap slip joint ends 4" without fasteners where required to absorb expansion and contraction. For sections where vapor barrier is not required and jacket requires routine removal, tack fasteners may be used.

B. Metal jacket:Lap seams a minimum of 2 inches. Secure with metal bands for end-to-end joints, and rivets or sheetmetal screws for longitudinal joints. Rivets, screws, and bands to be constructed of the same material as the jacket. Locate seams on bottom for exterior applications.

C. Flexible metal jacket: Install per manufactures instructions by preparing the surface by insuring insulation is clean, dry and secured. Apply with appropriate lap joints and supports.

3.12 INSULATION SCHEDULES

Piping Service	**Insulation Type**	**Insulation Thickness by Pipe Size**				
		1" and smaller	1- ¼ " to1-½"	2" to 4"	5" to 6"	8" and larger
Refrigerant Suction	elastomeric	½"	1"	1-½"	1-½"	1-½"
Hot Gas Bypass	rigid fiberglass	1"	1-½"	1-½"	1-½"	1-½"
Cool. Coil Condensate	rigid fiberglass	1"	1"	1"	1"	1"

Duct Service	**Insulation Type**	**Thickness**
Outside air ducts and fresh air ducts downstream of ERV	rigid fiberglass	2"
Mixed air and relief air ducts	rigid fiberglass	1"
Exposed supply ducts	rigid fiberglass	1"
Concealed supply ducts	flexible fiberglass	1-½"
Exposed return/transfer ducts and those above office space	rigid fiberglass	1"
Exhaust ducts downstream of motorized backdraft dampers	rigid fiberglass	1"
Exhaust ducts exposed to weather	rigid fiberglass w/ jacket	2"
Supply ducts exposed to weather	rigid fiberglass w/ jacket	3"
Exhaust ducts downstream Of energy recovery units	rigid fiberglass	1"
Kitchen grease ducts (concealed) and heat recovery units	fireproofing	see text
Kitchen Type I hood top	fireproofing	see text

A. Exposed supply main and branch ducts located in the space they are serving do not require insulation.

B. Double wall supply ducts do not require insulation.

C. Provide a protective flexible metal jacketing for all insulated piping and ducts exposed to the weather.

D. Provide a protective metal jacket for all insulated ducts installed at less than 6' AFF in Mechanical rooms.

E. Exposed return ducts located in the space they are serving do not require insulation. Exposed return ducts located in Mechanical rooms shall be insulated as exposed ducts scheduled above. Lined ducts do not require insulation.

END SECTION 23 07 00

SECTION 23 09 23 - DIRECT DIGITAL CONTROL (DDC) SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Section 23 09 54 –Electric Temperature Control System.

C. Section 23 09 93 - Automatic Control Sequences.

1.2 DESCRIPTION OF WORK

A. Work included in this section:
1. General: The control system shall be as indicated on the drawings and described in the specifications.
2. Direct Digital Control (DDC) technology shall be used to provide the functions to control the mechanical systems on this project.
3. The control system shall accommodate simultaneous multiple user operation limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any work-station on the control system and have access to all appropriate data.
4. The control system shall be designed such that each mechanical system will be able to operate under stand-alone control. In the event of a network communication failure, or the loss of any other controller, the control system shall continue to independently operate under control.
5. Communication between the control panels and all work-stations shall be over a high speed peer-to-peer network. Application Specific Controllers shall be constantly scanned by the network controllers to update point information and alarm information.
6. All work and materials are to conform in every detail to the rules and requirements of the Wisconsin Electrical Code and present manufacturing standards. All material shall be new and UL approved. Wiring shall conform to the requirements of Division 26 standards, as minimum.

B. Work not included in this section:
1. Section 23 09 53 (Electric Temperature Control Systems) work will include furnishing and installing all field devices including; electronic sensors, transducers, transmitters, field equipment units, all related field signal wiring, sensor mounting, including all interlock control wiring between equipment and non-DDC equipment.

C. Refer to other Division 23 sections for associated equipment and connections.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's specifications for each control device furnished, including installation instructions and start up instructions. Annotated software program

documentation shall be submitted for system sequences. Submit wiring diagram for each electrical control device. Include Test and Commissioning Reports and Checklists.

B. Maintenance Data: Submit maintenance data and spare parts lists for each type of control device. Include this data in maintenance manual.

1.4 QUALITY ASSURANCE

A. Manufacturer: A firm regularly engaged in manufacture of DDC control equipment, of types and sizes which are similar to required equipment and which have been in satisfactory use for not less than 3 years, in similar service.

B. Acceptable systems are:
1. Johnson Controls (Madison Office) – Base bid
2. Honeywell - Alternate
3. Siemens Building Technologies - Alternate

C. Installer: A local office of one of the above listed manufacturers specializing and experienced in DDC systems interfacing with electric control system installation for not less than 3 years. All work shall be done by qualified mechanics in the direct employ of this temperature control manufacturer or franchised holder with factory-trained mechanics and electricians. Installer response time during the warrantee period shall be four (4) hours or less (24 hours/day, 7 days/week).

D. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.
1. Underwriters Laboratories: Products shall be UL-916-PAZX listed.
2. National Electrical Code — NFPA 70.
3. Federal Communications Commission — Par J.
4. ASHRAE/ANSI 135-2001 (BACnet).
5. NEMA Standards.

E. All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 2 years. Spare parts shall be available for at least 5 years after completion of this contract.

F. DDC Standards: DDC manufacturer shall provide written proof to the Owner that the equipment being provided is in compliance with FCC Rules Governing the Control of Interference Caused by Digital Electronic Equipment to Radio Communications (1979 amendment to Part 15, subpart J). Verification shall be included with shop drawings.

G. Certified performance test reports shall be submitted by the control supplier on all the major control-instrument components such as transmitters, multiplies, and controllers. Testing and reporting procedures similar to the procedures outlined in SAMA Standard PMC 20-1-1973.

H. Commissioning Protocol: Manufacturer shall utilize a commissioning protocol consisting of, as a minimum, a checklist with sign-off for each DDC point and controlling devise indicating;
1. Installed and wired.
2. Tested for proper operation.
3. Graphic display installed.
4. Graphic display correctly representing field conditions.

1.5 DELIVERY, STORAGE AND HANDLING

A. Provide factory shipping cartons for each piece of equipment and control device. Store equipment and materials inside and protected from weather.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. General:

1. Provide a Johnson Controls Application and Data Server, software and PC. The ADS shall network two JCI NAE engines located in the expo building, one at the Coliseum, one in the Administration building and the NCE provided for this project into one system. Provide all software, programming, workstation user views and commissioning for the networked BAS.
2. Provide one JCI network control engine to serve Building 1 and a JCI field equipment controller in Building 2 for control of the specified equipment.
3. Provide DDC control products in sizes and of capacities as required, conforming to manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer and as required for application indicated.
4. System shall be capable of operating with 120 VAC power supply, fully protected with a shutdown-restart circuit and complete with scaling multipliers, arithmetic relays, 3-mode P.I.1/D. or P.I.D. analog controllers, digital display, input keyboard, and associated hardware and software.
5. The DDC system shall be capable of maintaining complete control, including all I/O signaling, upon a power outage until the emergency power is available (15 minute minimum). In addition, the software RAM shall be battery protected for a 24 hour power outage.

B. OPERATOR INTERFACE

1. Operator Interface. Furnish 1 PC based workstation as shown on the system drawings. Each of these workstations shall be able to access all information in the system. These workstations shall reside on the same high-speed network as the building controllers, and also be able to dial into the system.
2. Workstation information access shall use the BACnet Protocol. Communication shall use the Ethernet or ARCNET Physical/Data Link layer protocol. Remote communications shall use the BACnet Point to Point Physical/Data Link Layer Protocol.
3. Hardware. Each operator work-station shall consist of:

    a. Personal Computer. Furnish IBM compatible PCs or Laptops, as well as all required serial, parallel and network communication ports and all cables. The CPU shall operate at a minimum of 1.8 GHz. A minimum of 128 Megabytes of video, 2 Gigabytes of RAM, one CD/DVD drive, and a 160 Gigabit hard disk. A two-button mouse will also be provided. The PC shall have a minimum of a 15" SVGA monitor.

    b. Modems. Furnish auto-dial 56k telephone modems or 10/100 ethernet cards as required for remote access.

    c. Printers. Each work station shall have 1 printer and associated cables.

d. BACnet. The PCWS shall read and write BACnet objects (Analog input, analog output, analog value, binary input, binary output, binary value, device) and allow their use in system applications as described below.

4. System Software

a. Operating System. Furnish a commercially available, concurrent multi-tasking operating system.

b. System Graphics. The Operator Workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on line. An operator with the proper password level shall be able to add, delete, or change dynamic points on a graphic. Dynamic points shall include analog and binary values, dynamic text, static text, and animation files.

i. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system that uses the mouse. The graphics generation package shall provide the capability of capturing or converting graphics from other programs such as Designer, or AutoCAD and to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM.

ii. Graphics Library. Furnish a complete library of standard HVAC equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators as well as standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork.

iii. Engineering Units. Unit selection shall be able to be customized by locality to select the desired units for each measurement. Engineering units on this project shall be: Standard Inch Pound.

5. System Applications. Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation.

a. Automatic System Database Save and Restore. Each workstation shall store on the hard disk a copy of the current database of each building controller, which shall be updated whenever a change is made in any panel in the system.

b. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to archive the database from any system panel and store on magnetic media.

c. System Configuration. The workstation software shall provide a graphical method of configuring the system. The user with proper security shall be able to add new devices, assign modems to devices, and

obtain a visual riser diagram of the system, allowing for future system changes/additions.

d. Context sensitive on-line help to assist the operator in operation and editing of the system.

e. Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall set passwords and security levels for all other operators to restrict the operator's access for viewing and/or changing each system application, full screen editor, and object.

f. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers, annunciating the failure of any device to the operator.

g. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day.

h. Trend Logs. The operator shall be able to define a custom trend log for any data in the system. This definition shall include interval, start-time, and stop-time. Trend intervals of 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, and once a month shall be selectable. Trend data shall be able to be viewed and printed from the operator interface software. They shall also be storable in a tab delimited ASCII format for use by other industry standard word processing and spreadsheet packages.

i. Alarm and Event Log. The operator shall be able to view all logged system alarms and events from any location in the system. All alarms and events that have not been cleared by the operator shall be archived to the hard disk.

j. Object and Property Status and Control shall provide a method for the operator with proper password protection to view, and edit if applicable, the status of any object and property in the system.

k. Clock Synchronization. The real time clocks in all building control panels and workstations shall be synchronized on command of an operator. The system shall automatically adjust for daylight savings and standard time if applicable.

l. Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator

to obtain real time logs of designated lists of objects. Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer.

i. Custom Reports to easily define any system data into a daily, weekly, monthly, or annual report.

ii. Standard Reports. The following standard system reports shall be provided for this project. These reports shall be readily customized to the project by the owner:

iii. Weather Data Report

iv. Tenant Override Reports

6. Workstation Applications Editors. Each PC workstation shall support full screen editing of all system applications.

a. Controller - editor for each type controller and application shall allow the operator with proper password to view and change the configuration, name, control parameters, and system set-points.

b. Scheduling. An editor to provide a monthly calendar for each schedule, clearly showing exception schedules and holidays. Provide a method for allowing several related objects to follow a schedule. The advance and delay time for each object shall be adjustable from this master schedule. Schedules shall be able to be easily copied between objects and/or dates.

c. Equipment Coordination - Provide a full screen editor that allows equipment to be grouped for proper operation as specified in the sequence of operations including the coordination of VAV boxes with their associated Air Handling Equipment.

7. Custom Application Programming. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating.

C. SYSTEM SOFTWARE

1. System Security - User access shall be secured using individual security passwords and user names that restrict the user to only the objects, applications, and system functions as assigned by the system manager.
2. Scheduling. Provide the capability to schedule each object or group of objects in the system including the capability for start, stop, optimal start, optimal stop, and night economizer actions. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of weekly schedules, exception schedules, holiday schedules and optimal start/stop.
3. Alarm Reporting - Alarms shall be routed to the appropriate workstations based on time and other conditions. An alarm shall be able to start programs, be logged in the event log, printed, generate custom messages and display graphics.
4. Remote Communications. The system shall have the ability to dial out in the event of an alarm to receivers including PC Workstations, and Alphanumeric Pagers.

5. Staggered Start. This application shall prevent all controlled equipment from simultaneously restarting after a power outage.
6. System Calculations. Provide software required to perform operations described in Section 23 09 93. Include software to allow instantaneous power (e.g. KW), flow rates (e.g. L/s [GPM]) to be accumulated and converted to energy usage data. Provide an algorithm that calculates a sliding-window KW demand value. Provide an algorithm that calculates energy usage and weather data (heating and cooling degree-days). These items shall all be available for daily, previous day, monthly and the previous month.
7. Anti-Short Cycling - All binary output points shall be protected from short cycling by allowing selectable minimum on and off-time.

D. BUILDING CONTROLLERS

1. General - The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the global strategies described in System software section. Data shall be shared between networked Building Controllers.

    a. The controller shall provide a communications port for connection of the Portable Operators Terminal using Point to Point BACnet physical/data link layer protocol or a connection to the inter-network.
    b. The Building Controller shall be BACnet Class 3 device and perform the following BACnet Functional Group Services: Clock, Reinitialize.

2. Communications. Each Building Controller shall reside on a BACnet inter-network using the Ethernet or ARCNET Physical/Data Link layer protocol. Each Building Controller shall also perform routing to a network of Custom Application and Application Specific Controllers.
3. Memory. The Building Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

E. CUSTOM APPLICATION CONTROLLERS

1. General - The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the local strategies described in System software section. Data shall be shared between networked Controllers. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

    a. Controller hardware shall be suitable for the anticipated ambient conditions. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA Type 4 waterproof enclosures, and shall be rated for operation at -40 F to 150 F. Controller used in conditioned ambient shall be mounted in dust-proof enclosures, and shall be rated for operation at 32 F to 120 F.

F. APPLICATION SPECIFIC CONTROLLERS

1. General - Application specific controllers (ASC) are microprocessor-based DDC controllers which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user programmable, but are customized for operation within the confines of the equipment they are designed

to serve. Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.

2. Environment - Controllers used outdoors and/or in wet ambient shall be mounted within NEMA Type 4 waterproof enclosures, and shall be rated for operation at -40 F to 150 F. Controller used in conditioned ambient shall be mounted in dust-proof enclosures, and shall be rated for operation at 32 F to 120 F.

G. COMMUNICATIONS

1. This project shall comprise a BACnet inter-network. All PC Workstations and Building Controller components shall meet ASHRAE / ANSI Standard 135-1995, BACnet. Each BACnet device shall operate on the BACnet physical/data link protocols specified for that device as defined earlier in this section.
2. All Building Controllers shall have a communications port for connections with the operator interfaces. This may be either an RS-232 port for Point to Point connection or a network interface node for connection to the Ethernet or ARCNET network.
3. Remote operator interface via a 9600 or faster baud modem shall allow for communication with any and all controllers on this network. Communications services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture.
4. The time clocks in all controllers shall be automatically synchronized daily.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install system and materials in accordance with manufacturer's instructions, roughing-in drawings and details on drawings. DDC functions associated with the same system shall be controlled by the same DDC unit. Provide a local control unit for each RTU and its associated equipment sequences.
2. Coordinate the electronic signal requirements with the VFD manufacturer (Section 23 05 14) for setup procedures. Coordinate location and installation of pressure transmitters with HVAC contractor. DDC control manufacturer shall verify that accurate primary signals are obtainable at the transmitter locations.
3. Provide all DDC panels, final wiring of I/O signals of the sequences of Section 23 09 93, software programming, and all field adjustment to meet the intent of the control sequences.
4. The software programming shall include setting up trend logs (i.e. temperature, humidity, and pressure relationships; AHU temperatures and air volumes; EF air volumes; steam and water volumes; steam pressures; CW temperatures; etc.) and auto-call sequences for LEVEL 1 alarms, as determined by the Owner.
5. Temperature Control Contractor is responsible for **ALL** wiring required by the control system whether the control wiring is at low-voltage or at line-voltage. All electrical work performed in the installation of the BAS/ATC system as described in this specification shall be per the National Electrical Code (NEC) and per applicable state and local codes. Where exposed, conduit shall be run parallel to building lines properly supported and sized at a maximum of 40% fill.
6. In no cases shall field-installed conduit smaller than 1/2" trade size be allowed. Where conductors are concealed (tenant spaces), cable rated for use in return air plenums shall be used.

END SECTION 23 09 23

SECTION 23 09 54 - ELECTRIC TEMPERATURE CONTROL SYSTEMS

PART 1 - GENERAL

A. RELATED DOCUMENTS

B. Applicable provisions of Division 1 shall govern work under this section.

C. Section 23 09 23 - DDC Systems.

D. Section 23 09 93 - Automatic Control Sequences.

E. FCC - Regulations, Part 15, for Radio Frequency Emissions.

1.2 DESCRIPTION OF WORK

A. Work included in this section:

1. Includes, but is not necessarily limited to, furnishing and installing a complete, calibrated, tested, adjusted and as intended, electric control system; including all thermostats, controllers, electric actuators, switches, relays, transducers, sensors, transmitters, conduit, wiring and other equipment and accessories necessary to constitute a complete and coordinated automatic electric temperature control system, as described herein and shown on the drawings. Work under this section to be interfaced with other the DDC system sections. Include all field wiring, conduit and all interfacing required to connect to the DDC panel.
2. Control wiring, except for power wiring, necessary for electric or electronic temperature control systems, is work of this section. Electrical work under this section shall be performed in accordance of Division 26 requirements.
3. Automatic Control Dampers shall be furnished by this section and installed as a part of the Division 23 Work.
4. Thermowells (Temperature Sensing Wells), Automatic Control Valves and Actuators, and Separable Sockets shall be furnished by this section and installed as a part of Division 23 Work.
5. All control systems identified in Section 23 09 93 - Automatic Control Sequences is exclusively work of this section[, except for the DDC system as specified under Section 23 09 23.

B. Work not included in this section:

1. Refer to Division 26 sections for power wiring to line voltage devices.
2. Access doors are not included under this section, but are included under Division 23.
3. The installation of automatic control dampers, air flow stations, and air flow control valves is part of the sheetmetal work of Division 23.
4. The installation of thermowells, automatic control valves, sensors, transmitters, etc. is part of the piping work of Division 23.

1.3 QUALITY ASSURANCE

A. Manufacturer: A firm regularly engaged in manufacture of electric temperature control equipment, of types and sizes which are similar to required equipment and which have been in satisfactory use for not less than 5 years, in similar service.

B. Installer: A local office of one of the above listed manufacturers specializing and experienced in electric control system installation for not less than 5 years. All work shall be done by qualified mechanics in the direct employ of this temperature control manufacturer or franchised holder with factory-trained mechanics and electricians. Installer response time during the warrantee period shall be four (4) hours or less (24 hours/day, 7 days/week).

C. Electrical Standards: Provide electrical products that have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's specifications for each control device and compressed air station furnished, including installation instructions and start up instructions. Submit wiring diagram for each electrical control device.

B. Maintenance Data: Submit maintenance data and spare parts lists for each type of control device. Include this data in maintenance manual.

1.5 DELIVERY, STORAGE AND HANDLING

A. Provide factory shipping cartons for each piece of equipment and control device. Provide factory applied plastic end caps on each length of pipe and tube. Maintain cartons and end caps through shipping, storage and handling as required to prevent equipment and pipe end damage and to eliminate dirt and moisture from equipment and inside of pipe and tube. Store equipment and materials inside and protected from weather.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. General:

1. Provide electric temperature control products in sizes and of capacities as required, conforming to manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer and as required for application indicated.
2. All valve and damper operators shall fail safe upon control power failure. All operators shall be electronic type equal to Belimo, size for operation requirements and compatible with DDC system.
3. Heating: to fail to full heating,
4. Cooling: to fail to 0 % cooling,
5. Humidity: to fail to 0 % humidification.
6. The electronic or electric sensors, transmitters, transducers, etc. shall be: Rosemount; Omega; Fisher; Setra; Hy-Cal; Triad; Mamac; TCS; or approved equal.
7. Electronic and electric I/O signals to and from the DDC system shall be 4-20 ma and shall be coordinated between other control sections as required by the control sequences.

B. Dampers:

1. Provide automatic control dampers as indicated. Dampers for modulating or proportioning control, or at velocities exceeding 1800 FPM (discharge of air handling units), shall be opposed blade airfoil type. Control dampers for isolation

or 2 positions may be parallel blade non-airfoil type. Provide mounting holes for enclosed duct mounting. Linkage shall be out of the air stream. All control dampers shall be low leak with blade and jamb seals, rated for leakage less than 7 cfm/sq. ft. of damper area, at differential pressure of 4" w.g. when damper is being held by torque of 50" pounds. Operating Temperature Range: From -20 to 200º F.

2. Control dampers shall be capable of 125% of system differential pressure.
3. Control dampers for supply ducts shall have frames of minimum 16 gage galvanized steel, and blades of minimum 16 gage galvanized steel or extruded aluminum.
4. Intake and Relief Dampers: Motor operated isolation dampers on outside air intakes and exhaust/relief ducts shall be low leakage, insulated type. Construct frame of aluminum channel with minimum .125" wall thickness. Blades shall be airfoil shaped heavy gage extruded aluminum injected with polyurethane foam. R-value = 4.9. Insulated dampers are not required where the building is not heated.
5. NOTE: Access shall be provided to physically inspect the condition and operation of all automatic dampers. Access doors shall be provided under Division 23. Coordinate with ductwork and equipment installer.

C. Electric Operators: Size actuators to operate their appropriate dampers or valves with sufficient reserve power to provide smooth modulating action or 2 position action as specified. Where more than 2 actuators are required to be operated in sequence to each other, provide position feedback positive positioners with adjustable start point and operating range, unless function is provided by DDC system

D. Duct Mounted Carbon Dioxide (CO2) Sensors:
1. Provide carbon dioxide sensors/transmitters for monitoring indoor air quality.
2. Range: 0-2000ppm
3. Accuracy: +/-40ppm +3% of reading @ 72 deg F
4. Stability: <2% full scale over life of sensor, approx. 15 years.

E. Room Thermostats:
1. Provide electronic temperature sensors/transmitters to maintain space temperatures. Include temperature adjustment slide bar or thumb wheel which can be disabled or have a limited range set through the DDC system. Provide an override button with adjustable operating occupied time range through the DDC system. Cover can be plastic, aluminum or nickel plated metal without thermometers.

F. Electronic Temperature Sensors/Transmitters: Provide electronic temperature sensors/transmitters of the following types:
1. All temperature sensors/transmitters shall be 0-20 ma output (RTD, or shielded thermistor where appropriate) to meet the accuracy requirements.
2. Service: RTD
3. 100^{o}F or less: 100 ohms
4. over 100^{o}F: 1000 ohms
5. Duct mounted sensors/transmitters shall be mounted through a hole in the duct and be positioned so as to be easily accessible for repair or replacement. A seal shall be used on the sensor assembly to prevent air leaks.
6. Protective covers shall be provided on room temperature sensors/transmitters to prevent accidental damage.

7. Air sensors/transmitters shall be designed to withstand the environmental conditions to which they will be exposed.
8. Accuracies shall be as follows, including errors associated with sensor, leadwire and transducer, as measured at 70oF.
9. Point Type Accuracy +/-
10. Air Temperature 0.25 %
11. Water Temperature 0.1 %
12. All 4-20 mA output temperature sensors/transmitters shall have individual zero and span adjustment.

G. Pressure Transducers and Transmitters: Capable of 4-20 ma linear output signal with adjustable sensitivity and adjustable zero balance. The output signal (4-20 ma) shall be proportional to the pressure input signal range. Span shall not be greater than 2X the system design pressure at the transmitter. Provide pressure transducers equal to units manufactured by Setra Systems.

H. Accuracy: (*) within 1.00% of span

I. Repeatability: within 0.30% of span

J. Response (max): 1 sec. for full span
1. (*) includes deadband, hysteresis, and linearity.

K. Fire Alarm Interlocks:
1. Provide relays in fan control circuits of air handling units, return fans or exhaust fans which are rated at 5,000 cfm and over. Provide all required relays matching voltage characteristics of alarm panel wiring connection by others. Relays to stop/start fan and close/open appropriate dampers upon alarm panel signal. Switches to match voltage characteristics of alarm panel wiring by others.
2. All signals to be extended to the central fire alarm panel by this contractor. Provide manual remote test switch for each smoke duct detector. Coordinate fire alarm system with Electrical Contractor.

L. Air Flow Control Valves: Refer to section 23 36 17 (Electric Terminal Units) for valves; not work of this section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Install system and materials in accordance with manufacturer's instructions, roughing-in drawings and details on drawings.
2. Electric Control System Work includes furnishing and installing all wiring and field devices necessary for complete systems.

B. Control Wiring: Install control wiring without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with ANSI/NFPA 70, "National Electrical Code" and the Wisconsin Electrical Code.
1. Install circuits over 25 volt with color-coded No. 12 wire in conduit per NEC.
2. Install circuits under 25 volt with color-coded 20 AWG copper with (212^{o}F - 100^{o}C) plastic insulation on each conductor and PVC sheath over all. All DDC I/O signals shall be less than 25 volts.
3. All I/O signal wiring shall be permanently identified and indexed to the control wiring diagram as submitted on shop drawing.

a. Installation of all low voltage circuits and conductors shall be properly supported from structure, and parallel or perpendicular to structure. Splices are not permitted, except at an accessible junction box as follows:

b. When exposed indoors in mechanical rooms, enclose conductors within electrical EMT conduit.

c. Concealed wiring above accessible ceilings may be run as cabling and shall be plenum rated.

d. Wiring located outdoors in parking garages, underground or in aquatic or in wet locations enclose in PVC conduit with water tight joints and sealed covers.

e. Where wiring is exposed outdoors on roof locations use LFMC (Sealtite).

4. Temperature Control Contractor is responsible for **ALL** control wiring whether the control wiring is at low-voltage or at line-voltage to power control components.

C. Installation of Devices:

1. Refer to Division 23 sections for installation of valve bodies, control wells and dampers, not work of this section.
2. Locations and zoning are to be approved by Engineer prior to installation. All room thermostats shall be mounted at 4' height above finished floor. It will be the responsibility of this Contractor to insure that the location of the stat will not be affected by the sun exposure or any other thermal conditions of the space.

D. Final Adjustment of Equipment:

1. After completion of installation, adjust thermostats, control valves, motors and similar equipment provided as work of this section. Calibrate temperature controls to meet factory specifications.
2. All controllers, relays, switches and other devices shall be neatly identified as to function and adjustment (with final set point marked and numerically identified).
3. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

END SECTION 23 09 54

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SECTION 23 09 93 - AUTOMATIC CONTROL SEQUENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Section 23 09 54 - Electric Temperature Control System

C. Section 23 09 23 – Direct Digital Control (DDC) Systems

1.2 DESCRIPTION OF WORK

D. Control sequences are hereby defined as the manner and method by which the automatic controls function. Requirements for each type of operation are specified in this section.

E. Operating equipment, devices and system components required for automatic control systems are specified in other Division 23 Controls and Instrumentation sections of these specifications.

F. All temperature and control signal transportation for the control sequences shall be furnished under Section 23 09 54.

1.3 SUBMITTALS

G. Shop Drawings: Submit shop drawings for each system automatically controlled, containing the following information:
   1. Schematic flow diagram of system showing fans, coils, dampers, valves and control devices. Indicate factory and field wiring.
   2. Label each control device with setting or adjustable range of control.
   3. Indicate each control panel required, with internal and external piping and wiring clearly indicated. Provide detail of panel face, including controls, instruments and labeling.
   4. Include control narrative of the control sequence of each operation and interlocks with other operations.

H. Maintenance Data: Include copy of "as-built" record shop drawings in each maintenance manual. Record drawings shall identify the location of concealed control devices by room number and location description.

PART 2 - PRODUCTS

Not applicable to this section - reference Sections 23 09 54 and 23 09 23.

PART 3 - EXECUTION

3.1 TERMINAL UNITS CONTROL SEQUENCES

I. Gas Fired Unit Heater Control:
   1. Provide electric programmable temperature room thermostat (40º-70º F range) to signal the gas fired heater to stage burners as needed to maintain constant space

temperature. See plans for dual temperature locations where full (both) stage firing is needed for fast recovery capability.

2. Unit heaters to be disabled by overhead door switches or when associated overhead doors are open.
3. Provide single setting low voltage thermostats (pavilions) or 7-day programmable thermostats (maintenance shop) as scheduled.
4. Setback/Setup Temperature Control: Each packaged/programmable thermostat controllers system to have its night setback/setup based on Owner provided schedule. Setback temperature shall be 50°F (adj) during heating.

J. Electric Baseboard and Electric Wall Heater Control:
1. Packaged electric heaters shall be provided with integral unit mounted thermostats. Adjust each thermostat based on installation location:
a. Pre-Function and Pavilion 1 (comfort heating): 68° F

b. Pavilion 2 (space tempering): 60° F.

K. Split System A/C Unit Control
1. Provide with packaged controls to operate compressors, condenser and evaporator fans in sequence to meet space temperature setpoints. Mount direct wired controllers in locations specified.

L. VAV unit control:
1. Provide a DDC space temperature sensor to control, in sequence, a single or two stage electric heating coil and actuator for terminal air flow. When space temperature is below setpoint, the air terminal damper shall modulate toward the minimum flow position. After the air terminal damper is at its minimum flow, stage the heating element on to maintain space temperature. The reverse shall occur when space temperature is above setpoint. Provide a discharge air temperature sensor for monitoring purposes.
2. Provide adjustable minimum and maximum flow setpoints. Flow setpoints shall be set as scheduled on the plans and specifications.
3. Provide zone sensors with push button override for signaling occupancy to the terminal unit. The heating and cooling temperature will be maintained at either the occupied or unoccupied heating or cooling setpoints as defined by the weekly schedule (grouped or individually). If the zone override button is pressed the terminal unit DDC controller shall be indexed to occupied mode for a minimum of 30 minutes (adj.), the minimum flow setpoint shall be obtained and the occupied heating and cooling temperature setpoints shall be maintained regardless of the weekly schedules.

3.2 SAFETY CONTROLS FOR RTUS, ERVS, SUPPLY FANS, MAKE-UP AIR UNITS:

A. System on/off status shall be based on schedule programmed into BAS system.

B. Failure of system to start based on supply fan motor current sensor shall signal alarm.

C. Where applicable, activation of duct smoke detector shall signal fire alarm system.

D. Upon receiving signal from fire alarm system, associated RTU and ERV units shall shut down. FMS contractor shall provide contacts for receiving signal at RTU control panel and subsequent control wiring devices necessary to shut down system.

E. When current switches are used for proving fan status, they shall be set up so that they will detect belt or coupling loss by the reduction in current draw.

3.3 ROOFTOP AIR HANDLING UNIT RTU-1 (VARIABLE AIR VOLUME)

A. RTU consists a variable speed supply fan, multiple stage cooling coil, and a modulating gas heating section serving six VAV terminal units and one large zone (Pre-Function 117) controlled by a modulating damper.

B. Pre-Function 117 Temperature Control: The BAS shall monitor two space temperature sensors in Room 117 and average the readings to maintain space temperature between the heating and cooling setpoints.

1. When the space is occupied and average space temperature is between heating and cooling setpoints, the damper shall be at minimum position corresponding to 30% of design diffuser airflow, final minimum position shall be set by the balancer.
2. When space temperature is above cooling setpoint, damper shall modulate open.
3. When space temperature is below heating setpoint, the BAS shall reset the discharge temperature of RTU-1 from cooling discharge temperature to heating discharge temperature, if space temperature remains below setpoint, the BAS shall modulate the airflow damper open until space temperature setpoint is reached. As heating setpoint is satisfied, the damper shall modulate to maintain setpoint.

C. Discharge Temperature Control: Provide a duct mounted temperature sensor to maintain unit discharge temperature setpoint.

1. BAS shall monitor all zones connected to RTU-1 for cooling zone demands.
2. The BAS shall alternately stage compressors or modulate gas heating to maintain discharge setpoint.
3. Upon a call for cooling from any zone, the discharge air temperature shall be reset to 55° F (adj.). Provide adjustable minimum runtimes and lockouts to prevent short cycling of compressors.
4. A call for heating from Room 117 shall prompt the discharge temperature to be reset gradually up to a maximum discharge temperature of 80° F (adj). At 70° F SA temperature the VAV terminals shall be commanded to minimum position.

D. Supply Fan Control:

1. RTU supply fan shall operate continuously during occupied periods.
2. Provide a duct static pressure sensor in supply duct main, refer to plans for location.
3. The BAS shall modulate the supply fan VFD to maintain a static pressure of 1.0” W.C (adj.). The final static pressure setpoint shall be determined by the balancing contractor to minimize fan operating power.

E. Airside Economizer Control:

1. During normal operation RTU economizer damper shall remain closed.
2. The BAS shall modulate return and outside air dampers to maintain discharge setpoint when conditions allow cooling without the use mechanical cooling.
3. Economizer mode shall be enabled when outside air temperature is below 55° F and RTU is commanded to the cooling discharge setpoint.
4. When economizer is enabled, mechanical cooling shall be locked out.

F. Unoccupied Mode

1. During unoccupied periods, as determined by the owner input schedule or unit overrides, the supply fan shall remain off and outside air damper closed. If any zone falls outside of its unoccupied heating or cooling setpoints, RTU shall be indexed to occupied mode and discharge temperature controlled as specified.

G. Filter Monitoring:
1. Provide differential pressure sensor across the unit filter bank. Provide alarm through BAS if differential pressure exceeds 0.5" W.C. (adj). Provide unit mounted magnahelic differential pressure gauge in parallel with sensor.

3.4 ROOFTOP AIR HANDLING UNIT RTU-2 (SINGLE ZONE VAV)

A. RTU-2 consists a variable speed supply fan, multiple stage cooling coil, and a modulating gas heating section serving a single zone (Mezzanine 202).

B. Discharge Temperature Control: Provide a duct mounted temperature sensor to maintain unit discharge temperature setpoint.
1. BAS shall monitor three zone temperature sensors in room 202 and average to determine zone temperature.
2. The BAS shall stage compressors and modulate gas heating to maintain discharge setpoint.
3. Upon a call for cooling the discharge air temperature shall be reset to 55 deg F (adj.), provide adjustable minimum runtimes and lockouts to prevent short cycling of compressors.
4. A call for heating shall prompt the discharge temperature to be reset gradually up to a maximum discharge temperature of 80deg F (adj).

C. Supply Fan Control:
1. RTU-2 supply fan shall operate continuously during occupied periods.
2. When there is no call for heating or cooling, the supply fan shall operate at minimum speed. The VFD minimum fan speed shall be determined by the balancing contractor to correspond to the scheduled minimum flow.
3. Upon a call for cooling, the discharge temperature shall be reset as described above and the supply fan VFD shall modulate to meet the cooling load.
4. Upon a call for heating the discharge temperature shall be reset as described above and the supply fan VFD shall modulate to meet the heating load.

D. Air Side Economizer Control:
1. During normal operation RTU-2 control damper shall remain closed.
2. The BAS shall modulate return and outside air dampers to maintain discharge setpoint when conditions allow cooling without the use mechanical cooling.
3. Economizer mode shall be enabled when outside air temperature is below 55 deg F and RTU-2 is commanded to the cooling discharge setpoint.
4. When economizer is enabled, mechanical cooling shall be locked out.

E. Unoccupied Mode
1. During unoccupied periods, as determined by the owner input schedule or unit overrides, the supply fan shall remain off and outside air damper closed. If any zone temperature reading falls outside of the unoccupied heating or cooling setpoints, RTU-2 shall be indexed on and heating or cooling .

F. Filter Monitoring:
1. Provide differential pressure sensor across the unit filter bank. Provide alarm through BAS if differential pressure exceeds 0.5" W.C. (adj). Provide unit mounted magnahelic in parallel with sensor.

3.5 PREFUNCTION BUILDING VENTILATION CONTROL (ERV-1&2)

A. Energy recovery ventilators ERV-1 and 2 serve both RTU-1 and 2 to provide code required exhaust and outside air.
   1. ERV-1 consists of individual supply and exhaust fans with a fixed plate enthalpy heat and moisture exchange core. The BAS shall index each fan and associated motor operated isolation damper independently.
   2. ERV-2 consists of individual supply and exhaust fan with an enthalpy heat recovery wheel. The BAS shall index each fan and associated motor operated isolation damper independently and enable wheel rotation.

B. ERV-1 serves restrooms and shall run continuously during occupied periods.
   1. The BAS shall control the supply and exhaust fans independently via contacts provided by the unit manufacturer.

C. ERV-2 provides additional ventilation for events within the pre-function and mezzanine buildings when 200 or more occupants are present.
   1. Provide the operator with a point labeled “Pre-Function Event Ventilation” which indexes ERV-2 on.
   2. Provide a duct mounted CO2 sensor within the return duct common to RTU-1 and 2, upstream of fresh air inlets.
   3. If return air CO2 exceeds 1000 ppm, ERV-2 supply and exhaust fans shall be indexed on until concentration drops below 600 ppm.

D. Economizer Override
   1. The BAS shall monitor the economizer status of RTU-1 and 2.
   2. If both RTU units are operating under economizer mode, the ERV-1 supply fan and ERV-2 supply and exhaust fans shall be indexed off.

3.6 PAVILION BUILDING #1 VENTILATION AND HEATING SYSTEM (SF-1-16, MUA-2A, 2B, GRV/GRH)

A. System consists of sixteen ventilation supply fans, approximately 37,500 cfm each, two direct fired make-up air units and four radiant systems with multiple burner units per system.
   1. The BAS shall monitor space temperature sensors (7) to stage supply fans, and GRV/GRH radiant heaters according to the sequences below and one outside air temperature sensor located in outdoors away from direct sunlight.
   2. The BAS shall monitor runtime on each unit. The supply fans shall be enabled in order from the unit with the shortest runtime to longest. The fan runtimes shall be capable of being reset by the owner.
   3. Upon command to start a supply fan, the BAS shall command the respective motor operated isolation damper open after a 10 sec (adj.) delay.
   4. Maintenance access doors into the supply plenum shall be equipped with contact switches that disable all fans within the plenum upon entry. The system shall be required to be manually reset from outside the plenum.

B. Unoccupied Mode
   1. During unoccupied periods, as determined by the owner input schedule or unit overrides, the supply fans and make-up air unit shall remain off and all supply and relief isolation dampers shall be closed. The radiant heating system zones shall be controlled to their unoccupied mode heating setpoint, 60° F (adj.)

C. The BAS shall be programmed for two occupied operational modes for selection and scheduling by the owner.
   1. Livestock Event:

a. A minimum of two supply fans shall be operating.

2. Non-Livestock Event (intended for trade shows, expos, events with human occupants only)
   a. One MAU-interlocked supply fan shall be operating,

D. Occupied Mode
1. Heating Mode (average zone temperature below 68° F):
   a. The minimum number of supply fans shall be running. MUA units shall operate as described below based on outside air temperature.
   b. Each temperature zone (as indicated on the plans) shall stage its respective GRH burner units to maintain a heating setpoint of 68° F.
   c. When average zone temperature is between heating and cooling setpoints, radiant heaters shall be locked out.
2. Cooling Mode (average zone temperature above 75° F)
   a. As the average space temperature rises, the BAS shall start additional supply fans to maintain a cooling setpoint of 75° F or outside air temperature + 2° F (whichever is greater, adjustable). Supply fans shall be staged on one at a time until 8 (adj) fans are running, after which point 14 total fans shall be staged on and additional fans staged on until all fans are running. Note: Avoid intermediate number of fans to prevent fabric duct fluttering.

E. Make-up Air Unit Operation
1. Each MUA unit shall be interlocked with a supply fan located nearby. (MUA-2A interlocked with SF-1, MUA-2B with SF-16). In the event of failure of the interlocked fan, the next fan in line shall be commanded on and a fan failure alarm generated.
2. MUA shall be disabled when outside air temperature is above 65° F or when the system is operating under cooling mode.
3. MUA units shall modulate their respective direct fired gas burners to maintain a discharge temperature setpoint. The discharge setpoint shall be reset linearly in reference to outside air temperature. At -15° F, DAT=100° F; at 65° F DAT=70° F.

F. Building Pressure Control
1. The BAS shall monitor a building differential pressure sensor (refer to plans for location) to prevent over-pressurization.
2. During occupied modes, the BAS shall command all relief louver isolation dampers open. These louvers are sized for relief at cool weather airflows only. The full system airflow relies on the manual overhead doors being open to allow adequate relief openings.
3. The BAS shall override the supply fan control sequences to limit the number of operating fans to maintain the building differential pressure to less than 0.15 inches W.C. (adj.). An alarm shall be generated in the BAS if the pressure control override is engaged.

G. Supply Fan Staggered Start (overload protection)
1. The BAS shall prevent more than 5 supply fans from starting simultaneously. Fans shall be delayed a minimum of 15 seconds after the previous bank of fans.

3.7 PAVILION BUILDING #2 VENTILATION SYSTEM (SF-17-54)

A. System consists of thirty-eight (38) ventilation supply fans, approximately 36,850 cfm each.
   1. The BAS shall monitor runtime on each unit. The supply fans shall be enabled in order from the unit with the shortest runtime to longest. The fan runtimes shall be capable of being reset by the owner.
   2. Upon command to start a supply fan, the BAS shall command the respective motor operated isolation damper open after a 10 sec (adj.) delay.
   3. Maintenance access doors into the supply plenum shall be equipped with contact switches that disable all fans within the plenum upon entry. The system shall be required to be manually reset from outside the plenum.

B. Unoccupied Mode
   1. During unoccupied periods, as determined by the owner input schedule or system overrides, the supply fans shall remain off and all supply isolation dampers shall be closed.

C. Occupied mode (Any Event)
   1. A minimum of five supply fans shall be running. As the space temperature rises based on the average of zone temperature sensors (as shown on plans) , the BAS shall start additional supply fans to maintain a cooling setpoint of 75° F or outside air temperature + 2° F (whichever is greater, adjustable).
   2. Supply fans shall be staged on one at a time until 19 (adj) fans are running. Further call for cooling shall enable a total of 33 (adj) fans, after which the remaining fans shall be enabled one at a time as needed. Note: Avoid intermediate number of fans to prevent fabric duct fluttering.

D. Building Pressure Control
   1. The BAS shall monitor a building differential pressure sensor (refer to plans for location) to prevent over-pressurization.
   2. The BAS shall override the supply fan control sequences to limit the number of operating fans to maintain the building differential pressure to less than 0.15 inches W.C. (adj.). An alarm shall be generated in the BAS if the pressure control override is engaged.

E. Supply Fan Staggered Start (overload protection)
   1. The BAS shall prevent more than 5 supply fans from starting simultaneously. Fans shall be delayed a minimum of 15 seconds after the previous bank of fans.

3.8 PAVILION RESTROOM AND SHOWER EXHAUST FANS

A. Exhaust fans serving restrooms and showers within Pavilion #1 and #2 shall be interlocked with occupancy sensors, work performed by E.C. not work of this section. T.C.C. shall provide an interlock between exhaust fans and associated motor operated isolation dampers.

3.9 CONCESSION EXHAUST AND MAKE-UP AIR SYSTEMS (EF-4 & SF-24, EF-1 & MUA-1)

A. Exhaust fan EF-4 and supply fan SF-24 shall be interlocked with kitchen hood controls in Room 143, provided by food service contractor to operate when cooking operations are taking place below the hood. SF-24 shall be interlocked with its motor operated isolation damper.

B. Exhaust fan EF-1 and packaged make-up air unit MUA-1 shall be interlocked with kitchen hood controls in Room 116 to operate when cooking operations are taking

place below the hood. MUA-1 shall be provided with packaged discharge air temperature controls, by unit manufacturer. Controls shall maintain MUA-1 discharge air temperature at 65° F.

3.10 ELECTRICAL AND MECHANICAL ROOM VENTILATION (SF-20-22, CEF-1, EF-7A,B)

A. Provide electrical and mechanical room ventilation fans with reverse acting thermostats to provide cooling with outside air upon call for cooling.
   1. Fans shall operate when space temperature exceeds 80° F.
   2. Where shown on drawings, interlock motor operated relief damper within room to open when fan starts.
   3. Mechanical Room 142: Interlock motor operated intake dampers in this room to occupant provided condensing unit which is mounted adjacent to intake louver in addition to room exhaust fans (EF-7A,B).

3.11 FURNACE (F-1) WITH REMOTE DX COOLING CONTROL SEQUENCES

M. General:
   1. F-1 disconnect by EC. F-1 to receive start/stop signal from packaged/ programmable thermostat with 7 day scheduling capability. During hours of occupancy F-1 is a constant volume system.
   2. The programmable controller for F-1 shall also be used to provide the start/stop signal for EV-10 operation and associated fresh air and exhaust motor operated dampers.

N. Furnace (F-1): Office area (CV, DX cooling, gas heating):
   1. Occupied, space temperature ABOVE setpoint, Occupied Cooling: The cooling system shall be operative. The supply fan runs continuously at constant volume.
   2. The DX cooling coil will be energized until the space returns to set point conditions. When the space returns to setpoint the cooling coil will de-energize.
   3. Occupied, space temperature BELOW heating setpoint, Occupied Heating: The heating system shall be operative. The supply fan runs continuously at constant volume. The gas fired heater shall fire until the space returns to setpoint conditions. When the space returns to setpoint the heater shall turn off.
   4. Unoccupied Mode: When the system enters the unoccupied mode, F-1 shall receive a signal from programmable thermostat/controller and it will de-energize. The programmable controller with then default to unoccupied setpoint temperatures. If the space drifts outside of the heating or cooling unoccupied setpoint conditions the programmable controller shall send a signal to F-1 to start. The programmable controller will then cycle the heating or cooling as needed to return the space to unoccupied setpoint conditions. Once the space returns to unoccupied setpoint conditions the programmable thermostat will signal F-1 to de-energize.
   5. The following thermometers and gauges shall be provided and mounted in the air stream of the unit:

Discharge Air Temperature	Outside Air Temperature
Return Air Temperature	Mixed Air Temperature

3.12 MAINTENANCE BUILDING EXHAUST FAN CONTROL

O. EF-8 starters and disconnect by EC. EF-8 to receive start/stop signal from the programmable thermostat with scheduling capability serving GUH-3. EF-8 to run during

hours of occupancy. Interlock the motor operated damper actuation for EF-8 with the signal from GUH-3.

P. EF-9 starters and disconnect by EC. EF-9 to receive start/stop signal from the on/off switch integral to the welding exhaust articulating arm. Interlock the motor operated damper (MOD) actuation for EF-1 with the on/off switch integral to the welding snorkel arm. Provide an end switch to the MOD so EF-9 is not energized until damper is open.

Q. EF-10 starters and disconnect by EC. EF-10 to receive start/stop signal from the programmable thermostat with scheduling capability serving furnace F-1. EF-10 to run during hours of occupancy. Interlock the motor operated damper actuation for EF-10 with the signal from F-1.

3.13 MAKE UP AIR HANDLING UNIT (MAU-3) CONTROL SEQUENCES

R. General:

1. MAU-3 shall utilize packaged electric/electronic controls for unit operations with control contractor tie in for unit start/stop.
2. MAU-3 and the outside air intake motor operated damper shall be energized and de-energized via the occupancy signal provided by the programmable controller serving GUH-3. MAU-3 shall receive the start/stop signal from the duct mounted temperature sensor located in the outside air intake duct leading to MAU-3. The duct mounted temperature sensor initiates unit start when entering outside air temperature falls below 55° (adjustable). The duct mounted temperature sensor shall signal MAU-3 off when the temperature rises above 55°.
3. Provide wall mounted interface for control of discharge air temperature.

S. Safety Controls for Air Handling Units: Manufacturer packaged safeties only. No additional control or contractor wired interfaces required.

T. Make Up Air Unit (MAU-3): Work Area 103 (CV, gas heating):

1. Occupied, OA temperature ABOVE discharge air setpoint: Unit remains energized in standby mode, with fan and gas fired heater off.
2. Occupied, OA/EAT temperature BELOW heating setpoint, Occupied Heating:
3. When the system is in the occupied heating mode, heating system shall be operative. The supply fan runs continuously at constant volume.
4. The gas fired heater shall fire and the packaged unit controls will modulate the gas control valve to maintain a continuous discharge air temperature of 60° (adjustable).
5. Unoccupied Mode (As designated by scheduling function of GUH-3):
6. When the system is in the unoccupied mode, MAU-3 shall receive a signal from GUH-3 and it will de-energize. MAU-3 to remain de-energized while unoccupied.
7. The following thermometers and gauges shall be provided and mounted in the air stream of the unit:

Discharge Air Temperature Outside Air Temperature

8. Provide a remote discharge air temperature controller for ground level manipulation of MAU-3. Set to 60°. (Adjustable)
9. MAU-3 to be disabled via overhead door switches or when identified overhead doors are open.

3.14 FINAL FIELD ADJUSTMENT OF EQUIPMENT

U. After completion of installation of the DDC equipment, calibrate and adjust setpoints of the equipment provided as work of this section. Coordination of the reprogramming of the software as required to meet the intent of the control system as indicated in this Section and 23 09 53.

V. All controllers, relays, sensors/transmitters, wiring leads, and other devices shall be neatly identified as to function and adjustment (with final setpoint marked and numerically identified).

W. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of the control system.

X. Contractor shall provide operational training of the automatic controls to the Owner's maintenance staff. This training shall not be less than (2) 4-hour days.

END SECTION 23 09 93

SECTION 23 11 23 - NATURAL GAS PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK:

A. Extent of natural gas piping system work is indicated on drawings and by requirements of this section.

B. Natural gas piping systems include the following:

1. Provide gas piping system from meter to new gas fired equipment as shown on drawings. Coordinate with utility provide for installation of new service & meter.

1.3 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of natural gas piping products of types, materials and sizes required whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer: A firm with at least 3 years of successful installation experience on projects with natural gas piping system work similar to that required for project.

C. ANSI Code Compliance: Comply with applicable provisions of ANSI B31 "Fuel Gas Piping."

D. National Fuel Gas Code Compliance: Comply with applicable sections of NFPA 54 (ANSI Z223.1) "National Fuel Gas Code" and ANSI Z223.1a "Supplement to National Fuel Gas Code."

E. Local Utility Compliance: Comply with installation requirements of local utility company.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's data for gas piping systems materials and products.

PART 2 - PRODUCTS

2.1 NATURAL GAS PIPING MATERIALS AND PRODUCTS:

A. General: Provide piping materials and factory fabricated piping products of sizes, types, pressure 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. Where applicable use 150% of base pressure rating on natural gas piping system as maximum design pressures with a minimum of 125 psig. Provide sizes and types matching piping and equipment connections; provide fittings of materials that match pipe materials used in natural gas piping systems. Where more than one type of material or product is indicated, selection is installer's option.

2.2 BASIC PIPE, TUBE AND FITTINGS:

A. General: Prior to any welding of metallic pipe Contractor shall prove, upon request, welder has required ASME certifications, and prior to any welding of nonmetallic pipe Contractor shall prove, upon request, welder has been certified in accordance with Federal regulations.

B. Building Distribution Piping (above grade and to 8” below slab):

1. Pipe: Black steel pipe, ASTM 53 (Schedule 40), type E or S.
2. Fittings-2” or smaller: ASTM A197/ANSI B16.9 class 150 black malleable iron threaded.
3. Fittings-larger than 2”: ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless carbon steel welded.

2.3 SPECIAL VALVES:

A. General: Shutoff valves shall be U.L. listed for natural gas systems and shall include the following:

1. Threaded ends 2" and smaller shall be 150 psi WOG, bronze 2 piece body, stainless steel ball, bronze stem, TFE packing and seats, UL listed for N.G. service shut-off.

2. 2-1/2" through 4": Cast iron body, flanged ends, bronze bearings, electroless nickel plated cast iron plug with Hycar resilient plug seal, Buna-N stem seal packing, lever actuator, 175 psi W.O.G., U.L. listed for N.G. service shut-off.

3. Pressure Reducing Valves: Provide gas PRV valves for all equipment that cannot accept the distributed gas pressure of **5** psig. Valves shall be AGA and NFPA compliant for appropriate indoor or outdoor installation, temperature, pressures and sizes required.

B. Manufacturer:

1. Subject to compliance with requirements, provide gas cocks of one of the following: DeZurik; Unit of General Signal; Homestead Industries, Inc., Valve Division; NIBCO, Inc.; Powell Company; Walworth Company; or approved equal.
2. Subject to compliance with requirements, provide Pressure reducing valves of one of the following: Sensus; Fischer; Rockwell Manufacturing Company or

approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Meter will be provided by the local Gas Utility Company. Make arrangements with the Utility company for new or larger meter based on input ratings of gas fired equipment.

3.2 INSTALLATION OF NATURAL GAS PIPING:

A. General: Install natural gas distribution piping in accordance with applicable codes.

B. All gas piping within the building shall be exposed and not concealed within walls or below slabs unless approved by Engineer.

C. Contractor is responsible for field verifying natural gas pressures of existing systems prior to making any new connections. Report any discrepancies to the Engineer.

D. Welded Joints: Welding: Quality welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9 as applicable, for shop and project site welding of piping work. Certify welding of piping work using the Standard Procedure Specifications by and welders tested under supervision of the National Certified Pipe Welding Bureau (NCPWB).

E. Use sealants on metal gas piping threads that are chemically resistant to natural gas. Use sealants sparingly and apply to only male threads of metal joints.

F. Remove cutting and threading burrs before assembling piping. Do not install defective piping or fittings. Do not use pipe with threads that are chipped, stripped or damaged.

G. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping or equipment connections are completed.

H. Ground gas piping electrically and continuously within project and bond to ground connection.

I. Install 4” drip leg, shut-off cock, and union at each equipment connection.

J. Install "Tee" fitting with bottom outlet plugged or capped at bottom of pipe risers.

K. Coordinate installation of gas meter and PRV with local utility company. Coordinate concrete pads by G.C., if required by Utility or if indicated on Drawings.

L. Use dielectric unions where dissimilar metals are joined together.

M. Install piping with 1" drop in 60' pipe run (0.14%) in direction of flow.

N. Install piping parallel to other piping, but maintain minimum of 12" clearance between gas piping and steam or hot water piping above 200ºF. Maintain clearance to other hot surfaces.

3.3 INSTALLATION OF VALVES:

A. Gas Cocks: Provide at connection to gas train for each gas fired equipment item, up stream of each PRV, on risers and branches and where indicated.

B. Locate gas cocks where easily accessible and where they will be protected from possible injury.

C. Pressure Reducing Valves: Install PRV for each gas-fired burner per manufacturer's recommendations. Provide venting per code. Vent regulators provided with equipment. PRV's located outdoors shall be installed to prevent moisture from entering vent.

3.4 EQUIPMENT CONNECTIONS:

A. General: Connect gas piping to each gas fired equipment item with drip leg, shutoff gas cock and union. Comply with equipment manufacturer's instructions. Install gas pressure regulator and upstream strainer at each equipment connection, as required.

B. Verify appropriate gas pressures before initial start-up of any connected equipment.

3.5 PIPING TESTS:

A. Test natural gas piping in accordance with NFPA 31.

1. Test entire piping system with air at 100 psig for 8 hours. Provide temporary equipment for testing including pump and gages. Prior to test protect controls, burners and appliances by temporarily removing the device or closing shutoff valve at the burner and appliance.

2. Purging of lines and recharging of lines shall conform to NFPA 54 or local utility standards.

3. Notify owner's construction supervisor two working days prior to testing and cleaning piping systems. Owner's construction supervisor to witness and approve procedures and results. Provide Owner with written report of test results indicating time, date, pressure, and temperature at the start and conclusion of the test.

END SECTION 23 11 13

SECTION 23 20 01 - PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of piping specialties required by this section is indicated on drawings and/or specified in other Division 23 sections.

B. Types of piping specialties specified in this section include the following:

Pipe Escutcheons
Sleeves Sleeve Seals

C. Piping specialties furnished as part of factory fabricated equipment are specified as part of the equipment assembly in other Division 23 sections.

PART 2 - PRODUCTS

2.1 MANUFACTURED PIPING SPECIALTIES

A. General: Provide factory fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service or if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated and connections which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is Installer's option.

B. Pipe Escutcheons:

1. General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.

2. Pipe Escutcheons for Moist Areas: For waterproof floors and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.

3. Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split

hinged.

C. Fabricated Piping Specialties:

1. Pipe Sleeves: Provide pipe sleeves of one of the following:

a. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams or welded longitudinal joint. Fabricate from the following gages: 3" and smaller, 20 gage; 4" to 6", 16 gage; over 6", 14 gage.

b. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

c. Iron Pipe: Fabricate from cast iron or ductile iron pipe; remove burrs.

2. Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, roof penetrations or in exterior walls of one of the following:

a. Lead and Oakum: Caulked between sleeve and pipe.

b. Mechanical Sleeve Seals: Modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

D. Manufacturer: Subject to compliance with requirements, offering mechanical sleeve seals which may be incorporated in the work include, but are not limited to, the following: Thunderline Corporation or approved equal.

1. Sleeve Seals: Provide sleeve seals for sleeves located in interior walls, floors or other interior construction penetrations of one of the following:

a. Mechanical Sleeve Seals: Modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

b. Mineral Wool and Caulk: Pack space between sleeve and pipe with mineral wool and an expandable fire retardant caulk or putty 1/2" at each end.

PART 3 - EXECUTION

3.1 INSTALLATION OF MANUFACTURED PIPING SPECIALTIES

A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions and ceilings where penetration is exposed to view (except within mechanical equipment room); and on exterior of building. Secure escutcheon to pipe or insulation so

escutcheon covers penetration hole and is flush with adjoining surface.

3.2 INSTALLATION OF FABRICATED PIPING SPECIALTIES

A. Sleeves:

1. Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings and roofs. Do not install sleeves through structural members of work except as detailed on drawings or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve including allowance for thermal expansion; but not less than 2 pipe sizes larger than piping run. Where insulation includes vapor barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated and finish flush to surface; except floor sleeves. Extend floor sleeves 1/4" above level floor finish and 3/4" above floor finish sloped to drain. Provide temporary support of sleeves during placement of concrete and other work around sleeves and provide temporary closure to prevent concrete and other materials from entering sleeves.

    a. Install sheet metal sleeves at interior partitions.
    b. Install steel pipe sleeves at all floor slabs and at all fire rated (1 hour or greater) walls.
    c. Install iron pipe sleeves at exterior penetrations, both above and below grade.

B. Sleeve Seals: Install sleeve seals of type indicated in all pipe sleeves. Interior nonfire-rated nonacoustical partition wall sleeve seals may be deleted.

1. Provide 2-hour fire barrier seals at all 1st floor slabs.
2. Provide 2-hour fire barrier seals at all 2-hour rated walls and floors
3. Provide fire barrier seals at walls to match wall fire rating.
4. Provide mechanical sleeve seals at all below grade sleeves.
5. Provide caulked sleeve seals at all above grade exterior wall sleeves and at all mechanical & electrical equipment room walls (not noted above) and at all floor slabs (not noted above).

END SECTION 23 20 01

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SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of refrigerant piping work is indicated on drawings and schedules and by requirements of this section.

B. Refer to other Division 23 sections for insulation of refrigerant piping and is included as work of this section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of refrigerant piping products, of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with refrigerant piping work similar to that required for project.

C. Codes and Standards:

1. ANSI Compliance: Fabricate and install refrigerant piping in accordance with ANSI B31.5 "Refrigeration Piping."

2. ASHRAE Compliance: Fabricate and install refrigerant piping in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration."

D. Submittals:

1. Product Data: Submit manufacturer's technical product data and installation instructions for refrigerant piping materials and products.

2. Brazing Certification: Certify brazing procedures, brazers and operators in accordance with ASME standards (ANSI B31.5).

3. Record Drawings: At project closeout, submit record drawings of installed refrigerant piping and piping products, in accordance with requirements of Division 1 and Division 23.

4. Maintenance Data: Submit maintenance data and parts lists for refrigerant piping materials and products. Include this data, product data, shop drawings and record

drawings in maintenance manual; in accordance with requirements of Division 1 and Division 23.

PART 2 - PRODUCTS

2.1 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 refrigerant piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials that match pipe materials used in refrigerant piping systems. Where more than one type of materials or products are indicated, selection is installer's option.

2.2 BASIC PIPE AND PIPE FITTINGS

A. General: Provide pipes and pipe fittings in accordance with the following listing:

1. Tube Size 3" and Smaller: Copper tube, Type L, hard drawn temper; mark “ACR”, ANSI B16.22 wrought copper, solder joint fittings; soldered joints.

2. Brazed Joints: Braze joints using American Welding Society (AWS) classification BCuP-4 for brazing filler metal.

3. Provide precleaned and precharged tubing (line sets) by equipment manufacturer at Contractors discretion.

B. Provide piping specialties complying with Section 23 20 01 - Piping Specialties.

C. Provide supports and anchors complying with Section 23 05 29 –Supports and Anchors.

2.3 SPECIAL REFRIGERANT VALVES

A. Globe and Check Valve:

1. Globe Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300ºF temperature rating, 500 psi working pressure.

2. Check Valves: Forged brass, accessible internal parts, soft synthetic seat, fully guided brass piston and stainless steel spring, 250ºF temperature rating, 500 psi working pressure.

3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering globe and check valves which may be incorporated in the work include, but are not limited to, the following: Henry Valve Co.; Sporlan Valve Co.

B. Solenoid Valves:

1. Two-way Solenoid Valves: Forged brass, designed to conform to ARI 760, normally closed, teflon valve seat, NEMA 1 solenoid enclosure, 24 volt, 60 Hz, UL listed, ½" conduit adapter, 250ºF temperature rating, 400 psi working pressure.

2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering solenoid valves which may be incorporated in the work include, but are not limited to, the following: Alco Controls Div., Automatic Switch Co.; Sporlan Valve Co.;

2.4 REFRIGERANT SPECIALTIES

A. Refrigerant Strainers: Brass shell and end connections, brazed joints, monel screen, 100 mesh, UL listed, 350 psi working pressure.

B. Moisture Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections, UL listed, 200ºF temperature rating, 500 psi working pressure.

C. Refrigerant Filter Dryers: Corrosion resistant steel shell, steel flange ring and spring, wrought copper fittings, ductile iron cover plate with steel cap screws, replaceable filter drier core, 500 psi working pressure.

D. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated, UL listed.

E. Available Manufacturers: Subject to compliance with requirements, manufacturers offering refrigeration accessories which may be incorporated in the work include, but are not limited to, the following: Alco Controls Div., Henry Valve Company; Sporlan Valve Company

2.5 BASIC VIBRATION CONTROL

A. General: Provide vibration control products complying with Section 23 05 48 "Vibration Isolation", in accordance with the following listing:

1. Isolation hangers
2. Flexible pipe connectors

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 manner acceptable to installer.

3.2 INSTALLATION OF BASIC IDENTIFICATION

A. General: Install mechanical identification in accordance with Division 23 Basic Mechanical Materials and Methods section "Mechanical Identification."

3.3 INSTALLATION OF REFRIGERANT PIPING

A. General: Install refrigerant piping in accordance with Wisconsin Code Comm 45 and in compliance with equipment manufacturer's recommendations.

B. Install refrigerant piping with ¼" per foot (1%) downward slope in direction of flow for oil return to compressor. Provide oil traps and double risers where indicated and where required to provide oil return.

C. Clean refrigerant piping by swabbing with dry lintless (linen) cloth, followed by refrigerant oil soaked swab. Remove excess oil by swabbing with cloth soaked in high flash point petroleum solvent, squeezed dry.

D. Bleed dry nitrogen through refrigerant piping during brazing operations.

3.4 INSTALLATION OF PIPING SPECIALTIES

A. Install piping specialties in accordance with requirements of Section 23 20 01 -Piping Specialties.

3.5 INSTALLATION OF SUPPORTS AND ANCHORS

A. Install supports and anchors in accordance with requirements of Section 23 05 29 – Supports and Anchors.

3.6 INSTALLATION OF SPECIAL REFRIGERANT VALVES

A. General: Install refrigerant valves where indicated and in accordance with manufacturer's instructions. Remove accessible internal parts before soldering or brazing, replace after joints are completed.

3.7 INSTALLATION OF REFRIGERANT ACCESSORIES

A. Refrigerant Strainers: Install in refrigerant lines as indicated and in accessible location.

B. Moisture Liquid Indicators: Install as indicated on refrigerant liquid lines, in accessible location.

C. Refrigerant Filter Dryers: Install in refrigerant lines as indicated and in accessible location for service.

D. Refrigerant Discharge Line Mufflers: If required by manufacturer, install in horizontal or down flow portion of hot gas lines, immediately after leaving compressor. Do not install in riser.

3.8 EQUIPMENT CONNECTIONS

A. General: Connect refrigerant piping to mechanical equipment as indicated, in accordance

with section 23 05 48 – Vibration Isolation, and comply with equipment manufacturer's instructions where not otherwise indicated.

3.9 FIELD QUALITY CONTROL

A. Refrigerant Piping Leak Test: Prior to initial operation, clean and test refrigerant piping in accordance with ANSI B31.5 "Refrigeration Piping." Perform initial test with dry nitrogen, using soap solution to test all joints. Perform final test with 27" vacuum and then pressurize to 200 psig. Tap joints with a rubber mallet and test for leaks using halide torch. System must be entirely leak free.

B. Repair or replace refrigerant piping as required to eliminate leaks and retest as specified to demonstrate compliance.

3.10 DEHYDRATION AND CHARGING SYSTEM

A. Install core in filter dryer after leak test but before evacuation.

B. Evacuate refrigerant system with high vacuum pump to 500 microns Hg.

C. During evacuation apply heat to pockets, elbows and low spots in piping.

D. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system. Test is to be witnessed by owner's representative.

E. Break vacuum with refrigerant gas; allow pressure to build up to 2 psi.

F. Complete charging of system using new filter dryer core in charging line. Provide full operating charge. Turn spent filter dryer core over to Owner.

G. After the system has been in operation one month, replace filter dryer core and turn over spent filter dryer core to Owner.

END SECTION 23 23 00

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SECTION 23 31 13 – LOW PRESSURE DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. 23 05 29 - Supports and Anchors

C. 23 33 00 – Duct Accessories

1.2 DESCRIPTION OF WORK

A. Extent of low-pressure ductwork is indicated by the requirements of this section. Low pressure ductwork is hereby defined as ductwork subjected to velocities of 2500 fpm or less and operating pressure of 2" w.g. or less, positive or negative. Types of low-pressure ductwork required for project include the following:

1. Supply and return air ductwork.
2. Transfer air systems.
3. Power ventilator exhaust systems
4. Kitchen grease exhaust systems

B. Refer to Section 23 07 00 for external insulation required in conjunction with medium and low pressure ductwork; not work of this section.

1.3 SUBMITTALS

A. Product Data:

1. Submit schedule of materials, proposed joints, reinforcement and sealants to be used for shop fabricated ductwork use for work of this section.

2. Submit manufacturer's specifications on manufactured products and factory fabricated ductwork, used for work of this section.

B. Record Drawings: At project closeout submit record drawings of installed ductwork, duct accessories and outlets and inlets; in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE

A. SMACNA Standards: Comply with SMACNA "Duct Construction Standards", latest editions, for fabrication, installation, and testing of medium and low pressure ductwork.

B. NFPA Compliance: Comply with ANSI/NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" and ANSI/NFPA 90B "Standard for the

Installation of Warm Air Heating and Air Conditioning Systems."

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect shop fabricated and factory fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping. Lined ducts shall not be stored outside.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, and seam marks, roller marks, oil canning, stains and discolorations and other imperfections including those which would impair painting. Duct metal will serve as final finish. Refrain from making field markings or notes on duct.

B. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 653, lock forming quality, galvanized coating 1.20 ounces per square foot or greater, both sides, G90 per ASTM A90; MINIMUM 26 GAGE; mill phosphatized for exposed locations. Provide paint grip finish on exterior ductwork. Where welded black steel sheet is indicated, use first quality, soft steel sheet capable of welding or double seaming without fracture.

C. Kitchen Grease Exhaust Ductwork: Where ductwork is located in concealed locations, fabricate using minimum 16 gauge black steel or minimum 18 gauge stainless steel with all joints welded liquid tight or prefabricated grease duct with Underwriters Laboratory, Inc listing and labeled for use as commercial grease duct assembly utilizing an aluminized steel shell. Where ductwork is exposed, use 18 gauge or heavier stainless steel with a number 3 finish, with all joints welded liquid tight or prefabricated Underwriters Laboratory, Inc listed duct with stainless steel shell. Grind and polish all welded joints and seams to a number 3 finish.

D. Flexible Ductwork: Factory fabricated flexible ductwork may be used in lieu of above sheet metal in concealed accessible ceiling spaces for 4' maximum upstream of supply diffusers only. Flexible duct shall be factory made insulated round air duct with a reinforced outer vapor barrier jacket enclosing 1-1/2" thick fiberglass insulation wrapped around a continuous vapor barrier film reinforced with a steel wire helix. Duct shall meet 25/50 flame spread/smoke developed rating and have a "K" factor of .30/inch at 75°F. Duct shall bear UL Class I air duct label as tested by UL 181. Duct shall be rated for 4" w.g. static pressure and 3000-FPM velocity.

E. Aluminum Ductwork: ANSI/ASTM B209 aluminum sheet, alloy 3003H-14 double lockforming quality.

F. Acoustic Lined Ductwork: Apply a 1” or 2” thick insulation sound lining where indicated on the drawings. Liner material shall be glass fiber material with mat face. Maximum thermal conductivity of 0.26 Btu-inch per hour-square foot – degree F at 75°F mean temperature, 2.0 PCF density, and air friction correction factor shall not exceed 1.15 at 2000 FPM air velocity. Lining adhesive to suitable for air velocities to 5000 FPM and temperatures to 250°F. Knauf Liner EM, Owens Corning Aeroflex, Schuller Linacoustic, Certainteed Ultralite, or equal.

G. Double Wall Duct (Supply air): Cover lined supply ductwork with a perforated inner of 24 gauge galvanized sheetmetal with 3/16” perforations on ½” centers anchored to the primary duct casing to protect the insulation from erosion. Use solid 26 gauge galvanized cover at humidifier manifolds. Install sheetmetal nosing at leading edge of each lined ductwork section.

2.2 MISCELLANEOUS DUCTWORK MATERIALS

A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

B. Duct Sealant: Nonhardening, nonmigrating mastic or liquid elastic sealant (type applicable for fabrication/installation detail) as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork.

C. Duct Cement: Nonhardening migrating mastic or liquid neoprene based cement (type applicable for fabrication/installation detail) as compounded and recommended by manufacturer specifically for cementing fitting components or longitudinal seams in ductwork.

D. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.

2.3 FABRICATION

A. Shop-fabricate ductwork of gages and reinforcement complying with SMACNA "HVAC Duct Construction Standards.” Galvanized ducts shall be used unless otherwise indicated.

B. Fabricate duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with centerline radius equal to associated duct width. Fabricate turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30° for contracting tapers and 20° for expanding tapers. Use high efficiency 45 degree take-offs for branch ducts. Use bell mouth take-offs at plenum connections.

C. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Section 23 33 00 "Duct Accessories" for accessory requirements.

D. Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive and fasten with mechanical fasteners. Fasten perforated metal liner

on supply ducts where indicated, and fasten solid metal liner a minimum of 12” upstream and 36” downstream of humidifier manifolds.

2.4 FACTORY FABRICATED DUCTWORK

A. General: At installer's option, provide factory-fabricated duct and fittings, in lieu of shop fabricated duct and fittings.

B. Materials and gages as specified in section 2.1.

C. Elbows: One-piece construction for 90° and 45° elbows 14" and smaller. Provide multiple core construction for larger diameters with standing seam circumferential joint.

D. Divided Flow Fittings: 90° tees, constructed with saddle tap spot welded and bonded to duct fitting body.

E. Manufacturer: Subject to compliance with requirements for application, provide factory fabricated ductwork of one of the following: United Sheet Metal Div., United McGill Corp.; Semco Mfg., Inc.; Steelcraft Corp.; or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTWORK

A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve airtight and noiseless (no objectionable noise) systems capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type that will hold ducts true to shape and to prevent buckling, oil-canning, and tinning.

B. Seal ductwork after installation to SMACNA Class "B" for low pressure and Class “A” for medium pressure systems, as described in SMACNA "Duct Standards". Spiral round standing seams do not require sealing.

C. Install concrete inserts or mechanical fasteners in concrete construction for support of ductwork. Install mechanical fasteners on structural steel prior to structural fireproofing.

D. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns and other structural and permanent enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces conceal ductwork from view by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

E. Provide lined ductwork where indicated on drawings.

F. Use aluminum sheet ducts for all branch exhaust ducts serving shower rooms, high humidity areas, similar wet spaces, and other ducts as indicated on the Drawings. Seal all joints, latitudinal and longitudinal with silicone sealant. Pitch aluminum branch ducts serving wet spaces to drain back to inlet grilles.

G. Grease Duct Installation:

1. Where welded joints are used with black steel duct, coat all external welded joints and seams with high temperature paint. Grind and polish to #3 finish all exposed stainless steel joints and seams.

2. Apply bracing and reinforcement to the outside of the duct to prevent breathing, rattling, vibration or sagging of duct.

3. Factory-built grease duct assemblies shall be listed and labeled for use as commercial kitchen grease duct assemblies in accordance with UL approvals. Such assemblies shall be installed in accordance with the listing and manufacturers' installation instructions. Complete installation shall follow code requirements for pitch, access doors etc.

4. Install without forming dips, sag or undrain able traps which might collect residue by supporting at not greater than 5 foot intervals; fasteners at hangers shall not penetrate the duct. Do not use sheet metal screws on supports; use bolted, riveted or welded connections. Where ductwork is listed, install in accordance with listing.

5. Construct grease tight access doors with high temperature gasket to cover the entire door plate. Door plate shall be of the same material and thickness as the duct and as large as possible, up to maximum 24 inches in any dimension or provide manufactured UL approved doors. Locate on side of duct at intervals as required by current code for ease of inspection and cleaning and at each change in direction, and where shown on plans, including risers, and not less than 1-1/2 inches from the bottom of the duct.

6. Fire protection enclosure or wrap shall be easily removable and replaceable at each duct access door and clean out or provide rated manufactured access doors approved for the fireproofing application.

7. Pitch horizontal ducts at 1/8 inch per foot to hood and/or drainable traps in the direction of air flow.

8. Provide residue trap at the base of each vertical rise with provisions for cleanout to access the bottom of the trap for cleaning.

H. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and their electrical equipment clear spaces and enclosures. Where ductwork serves the electrical space, all ductwork shall have a watertight drip pan with soldered joints and shall have a 1" bottom drain every 10' of pan length with a 1" galvanized steel line routed to a floor

drain. Pan shall equal duct width plus 6” (3” beyond each side) and shall be 2” deep.

I. Where ducts pass through an exposed interior partition or wall conceal space between construction opening and duct or duct plus insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2".

J. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

K. Support ductwork in manner complying with SMACNA hangers and supports section.

L. Louvers:

1. Provide 2” rigid fiberglass insulation sandwiched between two layers of galvanized sheet metal on back side of unused portions of louver. Paint louver side of close off sheet flat black.

2. Pitch bottom of duct and or plenum to drain out bottom of louver.

3. Where pitching of duct or plenum to drain out louver is not possible, provide sloped drain pans with soldered seams at bottom plenum and provide a 1” trapped drain pipe extending to floor drain or building exterior.

3.2 CLEANING

A. Clean ductwork internally, unit by unit as it is installed of dust and debris. Clean external surfaces of foreign substances that might cause corrosive deterioration of metal or where ductwork is to be painted, might interfere with painting or cause paint deterioration.

3.3 BALANCING

A. Refer to Section 23 05 93 "Testing, Adjusting and Balancing" for air distribution balancing of medium and low-pressure ductwork; not work of this section. Seal any leaks in ductwork that become apparent in balancing process.

END SECTION 23 31 13

SECTION 23 31 14 - HIGH PRESSURE DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of high-pressure ductwork is indicated on drawings and by requirements of this section. High pressure ductwork is hereby defined as ductwork subjected to velocities over 3500 fpm or operating pressure of over 4" w.g., positive or negative, but not greater than 6" w.g.

B. Types of high-pressure ductwork required for project include the following:

1. Exhaust ductwork serving welding station.

1.3 QUALITY ASSURANCE:

A. SMACNA Standards: Comply with SMACNA "High Pressure Duct Construction Standards" for fabrication and installation of high-pressure ductwork.

B. NFPA Compliance: Comply with ANSI/NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" and ANSI/NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's specifications on manufactured products and factory fabricated ductwork, used for work of this section.

B. Record Drawings: At project closeout submit record drawings of installed ductwork, duct accessories and outlets and inlets; in accordance with requirements of Division 1.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect shop fabricated and factory fabricated ductwork accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Where possible store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains and discolorations and other imperfections including those which would impair painting.

B. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ANSI/ASTM A653, lockforming quality, with ANSI/ASTM A90, G90 zinc coating; Provide mill phosphatized paint grip finish for exposed locations.

2.2 MISCELLANEOUS DUCTWORK MATERIALS

A. General: Provide miscellaneous materials and products of types and sizes indicated and where not otherwise indicated provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

B. Duct Sealant: Nonhardening, nonmigrating mastic or liquid elastic sealant (type applicable for fabrication/installation detail) as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork.

C. Duct Cement: Nonhardening, migrating mastic or liquid neoprene based cement (type applicable for fabrication/installation detail) as compounded and recommended by manufacturer specifically for cementing fitting components or longitudinal seams in ductwork.

D. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.

2.3 FABRICATION

A. Shop-fabricate ductwork of gages and reinforcement complying with SMACNA "High Pressure Duct Standards - 3rd Edition."

B. Fabricate duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with centerline radius equal to associated duct width. Limit angular tapers to 30o for contracting tapers and 20o for expanding tapers.

C. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Section 23 33 00 "Duct Accessories" for accessory requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTWORK

A. General: Assemble and install ductwork in accordance with recognized industry practices

which will achieve airtight (1% leakage) and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type that will hold ducts true to shape and to prevent buckling.

B. Seal ductwork after installation in accordance with recommendations of SMACNA "High Pressure Duct Standards - 3rd Edition, Chapter 5 - Sealants."

C. Install concrete inserts or mechanical fasteners in concrete construction for support of suspended ductwork. Install mechanical fasteners on structural steel prior to structural fireproofing. Provide structural steel members for floor supported ductwork.

D. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

E. Support ductwork in manner complying with SMACNA "High Pressure Duct Standards - 3rd Edition" hanging and supporting systems chapter.

3.2 CLEANING

A. Clean ductwork internally unit by unit, as it is installed, of dust and debris. Clean external surfaces of foreign substances that might cause corrosive deterioration of metal or where ductwork is to be painted, might interfere with painting or cause paint deterioration.

3.3 BALANCING

A. Refer to Section 23 05 93 "Testing, Adjusting and Balancing" for air distribution balancing of high pressure ductwork; not work of this section.

END SECTION 23 31 14

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SECTION 23 31 16 – FABRIC AIR DISTRIBUTION DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section

B. 23 05 29 - Supports and Anchors

C. 23 33 00 – Duct Accessories

1.2 DESCRIPTION OF WORK

A. Extent of fabric air distribution ductwork is indicated on drawings and by the requirements of this section.

B. Types of fabric ductwork required for this project include the following:

C. Non-permeable fabric duct with orifice type air diffusers

1.3 SUBMITTALS

A. Product Data:
   1. Submit manufacturer's design shop drawings including materials, dimensions, and air distribution performance as required to meet design criteria as shown on drawings and details.
   2. Submit physical samples of fabric ductwork material in colors specified for approval prior to ordering or fabrication.

B. Record Drawings: At project closeout submit record drawings of installed ductwork, duct accessories and outlets and inlets; in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE

A. Product shall be classified by Underwriter's Laboratories under AJIJ "Distribution Device, Air". It shall also be in compliance with ICC-ES AC167 Acceptance Criteria for Fabric Duct Air Dispersion Systems. It shall meet the latest revision NFPA 90A requirement, generating flame spread and smoke developed index less than 25/50 respectively when evaluated in accordance to UL723

B. Design & Quality Control
   1. Manufacturer must have documented design support information including duct sizing, vent and orifice location, vent and orifice sizing, length, and suspension. Parameters for design, including maximum air temperature, velocity, pressure and fabric permeability, shall be considered and documented.
   2. Provide an Engineering Guarantee of performance showing the throw area and velocity that will be delivered.

1.5 WARRANTY

1. Manufacturer must provide a 10 year product warranty for products supplied.

2. Manufacturer must provide a site visit after all systems are installed and balanced to verify velocity performance of the fabric duct system. This test must be done using NEBB calibrated equipment to collect airflow readings throughout the facility. Airflow shall be within +/-10 feet per minute velocity of design requirement. Minimum grid at 10' centers. This information must then be provided to the owner for verification of system performance.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protect fabric air distribution ductwork products from damage during shipping, storage and handling.

B. Where possible, store ductwork inside and protect from weather. Prevent dirt and moisture from entering packaging.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

A. Subject to compliance with requirements, provide product manufactured by one of the following:
1. Air Distribution Concepts, Inc;
2. DuctSox Corporation
3. DurkeeSox Fabric Air Dispersion System Ltd.

2.2 FABRIC AIR DISPERSION SYSTEM:

A. Air diffusers shall be constructed of a coated woven fire retardant fabric complying with the following physical characteristics:
1. Fabric Construction: 100% Polyethylene/ Polyester
2. Coating: Non-air permeable coating
3. Color: Custom color to be selected by architect.
4. Air Permeability: 0 cfm/ft2 per ASTM D737, Frazier
5. Temperature Range: 0 degrees F to 180 degrees F

2.3 SYSTEM FABRICATION REQUIREMENTS:

A. Dispersion orifice sizing, up to 6 inch diameter (design dependant).

B. Size, quantity, and location of orifices to be specified and approved by manufacturer.

C. Inlet connection to metal duct via wormgear band as supplied by manufacturer.

D. Lengths to include required zippers as specified by manufacturer.

E. Fabric system shall include connectors to accommodate suspension system listed below.

F. Any deviation from a straight run shall be made using a gored elbow or a take-off port. Normal 90 degree elbows are 6 gores and a radius of 2 to 2.5 times the diameter of the diffuser.

2.4 DESIGN PARAMETERS:

A. Fabric air diffusers shall be designed from 0.25" water gage minimum to 3" maximum, with 0.5" as the standard.

B. Fabric air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F (-17.8 degrees C and 82 degrees C).

C. Design CFM, static pressure and diffuser length shall be designed or approved by the manufacturer. (1000 to 1500 cfm recommended).

D. Use fabric diffusers only for positive pressure air distribution components of the mechanical ventilation system.

2.5 SUSPENSION HARDWARE:

A. Cable: System shall be installed using a cable system including a single (1 Row) or double strands (2 Row) of cable located 2.5" above top-dead-center (1 Row) or 2.5" above the 10 and 2 o'clock locations of the diffuser system. 2 Row supports are required for systems of 30" diameter and larger. Hardware to include cable, eye bolts, cable clamps and turnbuckle(s) as required. System attachment shall be made using plastic snap clips spaced 36 inches. Component options include:
1. Galvanized Steel Cable

PART 3 - EXECUTION

3.1 INSTALLATION OF FABRIC AIR DISPERSION SYSTEM:

A. Install chosen suspension system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with product.

3.2 CLEANING AND PROTECTION:

A. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.

B. If diffuser systems become soiled during installation, they should be removed and cleaned following the manufacturers standard terms of laundry.

3.3 ATTIC STOCK

A. Provide owner with one complete set of fabric distribution duct runs, consisting of one north and one south branch complete with zippers, orifices and hanger clips.

END SECTION 23 31 13

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SECTION 23 33 00 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. 23 31 13 – Low and Medium Pressure Ductwork

C. 23 31 14 – High Pressure Ductwork

1.2 DESCRIPTION OF WORK

A. Extent of duct accessories work is indicated on drawings and in schedules and by requirements of this section. Equipment included herein includes the following:

dampers	turning vanes
duct hardware	smoke detectors
duct access doors	flashings
sound attenuators	louvers
kitchen grease duct access doors	fire dampers

B. Refer to Division 10 of specifications for exterior louvers. Louvers are furnished and installed under Division 10, but all ductwork connection work is included under this section.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's specifications for each type of duct accessory including dimensions, capacities, materials of construction and installation instructions.

B. Shop Drawings: Submit assembly type shop drawings for each type of duct accessory showing interfacing requirements with ductwork and method of fastening or support.

C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory; include this data in Maintenance Manual.

1.4 QUALITY ASSURANCE

A. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) "HVAC Duct Construction Standards, Metal and Flexible-Second Edition, 1995"

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." Flexible connections and similar materials to be fire retardant and UL 214 listed.

D. NFPA Compliance: Comply with applicable provisions of ANSI/NFPA 90A "Air Conditioning and Ventilating Systems" pertaining to installation of duct accessories.

PART 2 - PRODUCTS

2.1 DAMPERS

A. Volume Dampers: Provide dampers constructed in accordance with SMACNA Fig. 2-12, Fig. 2-13, and associated notes. Provide continuous rod on single blade dampers as indicated in fig. 2-12. All volume dampers shall be provided with lockable quadrants and stand-off brackets on insulated ducts. Dampers shall be constructed of same material as the ductwork served i.e.; galvanized, aluminum, stainless steel or PVC, etc.

B. Control Dampers: Control dampers are furnished by the Temperature Control Contractor. Reference Section 23 09 53.

C. Counterbalanced Economizer Relief Dampers: Provide dampers with parallel blades, counterbalanced and factory set to relieve at indicated static pressure. Construct blades of 16-gage aluminum, provide 1/2" diameter ball bearings, 1/2" diameter steel axles spaced on 9" centers. Construct frame of 2" x 1.2" x 1/8" steel channel for face areas 25 square feet and under; 4" x 1-1/4" x 16 gage channel for face areas over 25 square feet. Provide galvanized steel finish on frame with aluminum touch up.

D. Manufacturer: Subject to compliance with requirements, provide dampers of one of the following: Air Balance, Inc.; Airguide Corp.; Air Balance; Arrow Louver and Damper; Greenheck, Penn Ventilator Co.; Ruskin Manufacturing Co.; Vent Products; Sheet Metal Connectors or approved equal.

2.2 TURNING VANES

A. Manufactured Turning Vanes: Provide air foil turning vanes constructed of 1-1/2" wide curved blades set at 1-1/2" o.c., supported with bars perpendicular to blades set at 2" o.c., and set into side strips suitable for mounting in medium pressure ducts, or for ducts 18” or wider. Provide single width type turning vanes in square elbows less than 18” wide in low pressure ducts. Constructed of same material as the ductwork served i.e.; galvanized, stainless steel or PVC, etc.

2.3 DUCT HARDWARE

A. General: Provide duct hardware manufactured by one manufacturer for all items on project for the following:

1. Test Holes: Provide in ductwork at fan inlet and outlet and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.

2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering duct hardware which may be incorporated in the work include, but are not limited to, the following: Ventfabrics, Inc.; Young Regulator Company; or approved equal.

2.4 DUCT ACCESS DOORS

A. General: Provide where indicated and where required for service or cleaning of duct enclosed equipment. Examples include motorized damper, control valves, and actuators. Provide duct access doors of size required for intended service, 12" x 3/4 duct dimension minimum or 18” x 24” where head and shoulder access is required.

B. Construction: Construct of same or greater gage as ductwork served and of same material i.e.; galvanized, stainless steel or PVC. Provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged other side with one handle type latch for doors 12" high and smaller, two handle type latches for larger doors.

C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering duct access doors which may be incorporated in the work include, but are not limited to, the following: Air Balance, Inc.; Duro Dyne Corporation; Ruskin Manufacturing Company; Ventfabrics, Inc.; Ward Industries, Inc.

2.5 SOUND ATTENUATORS

A. Manufacturers: Industrial Acoustics Company, Environmental Elements Corporation, Semco, Dynasonics, Rink, VibroAcoustics, Price or approved equal.

B. Construct of a 22 gauge galvanized steel outer casing, and 26 gauge galvanized, perforated steel inner liner. Seams and joints of outer casing to be air tight.

C. Fill annular space between outer casing and inner liner with acoustic fill that is inert, inorganic, and of a density sufficient to obtain the specified acoustic performance. Material must meet requirements of NFPA 90A with a flame spread index of 25 or less and smoke developed rating of 50 or less.

D. Acoustical and aerodynamic performance is indicated on schedules on the drawings.

2.6 FLASHINGS

A. Provide flashing to completely weatherproof connection of ductwork to louvers. Flashing to be constructed of material similar to louver material.

B. Flashing and counterflashing for roof curbs will be provided by others.

C. Flashing and curbs for duct and pipe penetrations of roof assemblies to be in accordance

with details.

2.7 SMOKE DETECTORS

A. Smoke detectors are furnished and installed by the Electrical Contractor.

2.8 LOUVERS

A. Louvers are provided by the General contractor and specified in the architectural section of these specifications.

2.9 KITCHEN GREASE DUCT ACCESS DOORS

A. General: Where indicated and where required per code for cleaning the interior of the duct. Examples include at each change in direction, at each floor penetration and every 20 feet in straight runs. Provide duct access doors 12" x 3/4 duct dimension but no smaller than 12”x 12” minimum size.

B. Construction: Factory manufactured UL rated grease duct doors.Assembly shall meet NFPA-96 requirements and constructed of 14 GA black iron or 16 GA stainless steel to match duct construction. Provide 2”x 2”x 1/8” angle neck extension with ½” protrusion into duct on doors mounted on bottom of duct. Stud bolts to with wing nuts to secure access door and fireproofing wrap shall be minimum 3/8” diameter and 6” on center. Provide high temperature gasket all around perimeter of opening between door and flange.

C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering duct access doors which may be incorporated in the work include, but are not limited to, the following: Kees; Flame Gard, Morgan Thermal Ceramics: Fastdoor XL, Ductmate Industries.

2.10 FIRE DAMPERS

A. Furnish and install, at locations shown on plans, fire dampers of the interlocking blade curtain type, or multi-blade type, constructed and dynamically tested in accordance with UL Safety Standard 555. All fire dampers shall have a 1-1/2 hour fire protection rating, unless noted otherwise. Provide 165°F fusible link and a UL label in accordance with established UL labeling procedures. Damper manufacturer's literature submitted for approval prior to installation shall include comprehensive performance data developed from testing in accordance with AMCA Standard 500 and shall illustrate pressure drops for all sizes of dampers required at all anticipated air flow rates. Provide style “B” dampers, with open blades out of the airstream, unless noted otherwise, to provide free area opening equal to duct size.

PART 3 - EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION OF ACCESSORIES

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 sound attenuators in locations indicated on the drawings. Where modular installation is required, install units in a galvanized steel frame equipped with gaskets or seals between modules to prevent bypass of air.

C. Louvers are furnished and installed by others. Connect outside air intake duct to the louver, sealing all connections air and water tight. Provide screen on inside of active louver area where none is provided with louvers. Install insulated metal panel on unused portion of louver. Mechanical contractor is responsible for coordinating the sizes and locations of all the exterior louvers with the General Contractor.

D. Install access doors adjacent to damper operators or motors, fire dampers, damper quadrants, plenums, filters, AFCV's, coils, fan motors, valves, traps, bearings, inlet and outlet of fan in air handling units, oiling devices, and other devices which require attention and are not accessible through other means and elsewhere as indicated.

E. Provide balancing damper upstream of each outlet and inlet. Damper shall be at take off, or as far upstream as possible to minimize air dampering noise.

F. Coordinate with other work including ductwork as necessary to interface installation of duct accessories properly with other work.

G. Install control dampers in ductwork as required by Temperature Control Sections 23 09 53 and 23 09 93.

H. Install kitchen grease duct access doors per NFPA-96, access door manufacturers' instructions and fire wrap manufacturers ESR installation instructions for proper access. Provide liquid tight construction. Extend throat of access door into duct where mounted on bottom of duct to keep grease from collecting on access door.

I. 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 leak-proof performance.

J. Fire dampers shall be installed in wall and floor openings utilizing steel sleeves, angles, other materials, and practices required to provide an installation equivalent to that utilized by the manufacturer when dampers were tested at UL. Installation shall be in accordance with the damper manufacturer's instructions, NFPA 90A and appropriate SMACNA Standards.

END SECTION 23 33 00

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SECTION 23 34 13 - AXIAL FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Section 23 05 48 – Vibration Isolation

1.2 DESCRIPTION OF WORK

A. Provide air distribution equipment as indicated on drawings or on specifications including centrifugal fans. Types of equipment included herein includes the following:

Sidewall Propeller Fans

B. Where air distribution equipment is noted as "return" fans or "exhaust/return" fans, specification requirements shall be same as "exhaust" fans.

C. Refer to Section 23 05 48 Vibration Isolation.

D. 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 fan motor. Include starters, disconnects and required electrical devices, except where specified as furnished or factory installed, by manufacturer.

2. Interlock wiring between fan units; and between fans and field installed control devices.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's specifications for air distribution equipment showing dimensions, certified capacities, ratings, total-range fan performance curves with operating point clearly indicated, inlet and outlet octave band sound power data, materials, gages, finishes, weights, accessories and installation instructions. Single point operating curves are not acceptable.

B. Maintenance Data: Submit maintenance instructions including lubrication instructions, motor and drive replacement and spare parts lists. Include this data in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an

AMCA accredited laboratory. Fans shall be certified to bear the AMCA seal for air and sound performance.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver air distribution equipment with factory installed shipping skids and lifting lugs; pack components in factory fabricated protective containers.

B. Handle air distribution equipment carefully. Do not install damaged components; replace and return damaged components to manufacturer.

C. Store air distribution equipment in clean dry place and protect from weather and construction traffic. Comply with manufacturer's rigging and installation instructions.

PART 2 - PRODUCTS

2.1 SIDEWALL PROPELLER FANS

A. Manufacturers: Cook (Loren) Co.; Greenheck Fan Corporation; New York Blower Co.; Twin City Fan and Blower Co.; or approved equal.

B. Constructed of steel with angle iron reinforcing and motor support frame, die formed propeller blades with a welded reinforcing gusset on the backside for added rigidity, belt or drive as scheduled, pneumatically operated control damper with blade edge and jamb seals, damper operator, bird screen, and screened inlet/fan guard. Unless a special coating is scheduled, paint fans with a prime coat after metal cleaning and surface preparation; apply a second coat of paint to all exterior surfaces.

C. Provide factory fabricated wall sleeves and integral motor operated isolation dampers where scheduled.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install air distribution equipment where indicated, in accordance with manufacturer's installation instructions and with recognized industry practices, to ensure that equipment complies with requirements and serve intended purposes.

B. Access: Provide access and service space around and over air distribution equipment as indicated, but in no case less than that recommended by manufacturer.

C. Isolation: Set on vibration isolators, fasten in accordance with manufacturer's installation instructions.

D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

E. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Ensure that rotation is in direction

indicated and intended for proper performance. Do not proceed with centrifugal fan start-up until wiring installation is acceptable to centrifugal fan Installer.

F. Ductwork Connections: Refer to Division 23 "Ductwork" sections. Provide flexible connections on inlet and outlet duct connections.

G. Exhaust Systems: Provide automatic dampers at each fan and interlock with motor to serve as a back-draft damper. Reference Section 23 09 53

3.2 FIELD QUALITY CONTROL

A. Upon completion of installation of centrifugal 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 that cannot be satisfactorily corrected.

3.3 EXTRA STOCK

A. Provide one spare set of belts for each fan. Obtain receipt from owner that belts have been received.

B. Provide fixed sheave to replace adjustable pitch pulley. Sheave shall be sized by balancing contractor.

END SECTION 23 34 13

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SECTION 23 34 16 - CENTRIFUGAL FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Section 23 05 48 – Vibration Isolation

1.2 DESCRIPTION OF WORK

A. Provide air distribution equipment as indicated on drawings or on specifications including centrifugal fans. Types of equipment included herein includes the following:

Centrifugal fans	Airfoil Plenum Fans
Tubular centrifugal fans	Inline centrifugal fans
Kitchen exhaust fans	Upblast kitchen exhaust fans

B. Where air distribution equipment is noted as "return" fans or "exhaust/return" fans, specification requirements shall be same as "exhaust" fans.

C. Refer to Section 23 05 48 Vibration Isolation.

D. 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 fan motor. Include starters, disconnects and required electrical devices, except where specified as furnished or factory installed, by manufacturer.

2. Interlock wiring between fan units; and between fans and field installed control devices.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's specifications for air distribution equipment showing dimensions, certified capacities, ratings, total-range fan performance curves with operating point clearly indicated, sound data, materials, gages, finishes, weights, accessories and installation instructions. Single point operating curves are not acceptable.

B. Maintenance Data: Submit maintenance instructions including lubrication instructions, motor and drive replacement and spare parts lists. Include this data in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Provide equipment with AMCA Certified Ratings and UL listed and labeled electrical

components. Sound rate in accordance with AMCA 300.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver air distribution equipment with factory installed shipping skids and lifting lugs; pack components in factory fabricated protective containers.

B. Handle air distribution equipment carefully. Do not install damaged components; replace and return damaged components to manufacturer.

C. Store air distribution equipment in clean dry place and protect from weather and construction traffic. Comply with manufacturer's rigging and installation instructions.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL FANS

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

B. Fan Units: Provide factory assembled and tested fan units consisting of housing, wheel, fan shaft, bearings and side support structure. Clean, condition and prime paint sheet metal parts prior to final assembly. Apply final coat of enamel to exterior surfaces after assembly.

C. Housings: Provide curved scroll housings; lock seam construction for sizes 24" to 40". Provide spun inlet cones and duct connections.

D. Wheels: Provide backward inclined type blades for sizes 22" and smaller, air foil blades for sizes 24" and larger. Weld blades to wheel rim and hub plate. Key wheels to shafts. True and dynamically balance wheels after assembly.

E. Shafts: Constructs of AISI 1040 or 1045 solid hot rolled steel, turned and polished.

F. Bearings: Provide heavy-duty, grease lubricated, precision antifriction ball or roller, self-aligning, pillow block type bearings selected for minimum average life (AFBMA L50) of 200,000 hours.

G. Motors: Provide energy efficient variable frequency motors in accordance with Division 23 section "Electrical Provisions of Mechanical Work." Include manufacturer provided disconnects and motor starters where scheduled.

H. Drive: Provide V-belt drive with adjustable pitch sheave, selected for midpoint at design conditions.

I. Access Doors: Provide access door in scroll housing, with latch type handles, flush mounted for uninsulated housings, and raised mounted for insulated housings.

J. Drain Connections: Provide 3/4" threaded coupling drain connection at lowest point of housing.

K. Extended Grease Lines: Extend grease lines from bearings to outside of inlet duct flange. Terminate with grease fitting.

L. Install piping with proper depth trap from each cooling coil condensate drain to the nearest drain location.

M. Manufacturer: Subject to compliance with requirements, provide centrifugal fans of one of the following: Cook (Loren) Co.; Greenheck Fan Corporation; New York Blower Co.; Twin City Fan and Blower Co.

2.2 AIRFOIL PLENUM FANS

A. General: Provide centrifugal single width, single inlet backward inclined centrifugal airfoil, belt driven plenum blower of capacities and having accessories as scheduled.

B. Fan Units: Provide factory assembled and tested fan units consisting of housing, wheel, fan shaft, bearings and support structure. Clean, condition and prime paint sheet metal parts prior to final assembly. Apply final coat of enamel to exterior surfaces after assembly.

C. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The inlet panel shall be constructed from heavy gauge reinforced steel with an integral rectangular formed duct connection. High performance airflow baffle shall be standard to reduce under-unit turbulence and improve efficiency. Integral lifting points shall be standard.

D. Wheels: Provide aluminum centrifugal wheel with twelve air foil blades. Weld blades to wheel rim and hub plate. Key wheels to shafts. True and dynamically balance wheels after assembly. Wheel shall overlap an aerodynamic aluminum inlet cone

E. Shafts: Constructs of AISI 1040 or 1045 solid hot rolled steel, turned and polished.

F. Bearings: Provide heavy-duty, grease lubricated, precision antifriction ball or roller, self-aligning, pillow block type bearings selected for minimum average life (AFBMA L50) of 200,000 hours. Provide extended grease lines fore

G. Motors: Provide energy efficient variable frequency motors in accordance with Division 23 section "Electrical Provisions of Mechanical Work." Include manufacturer provided disconnects and motor starters where scheduled.

H. Drive: Provide V-belt drive with adjustable pitch sheave, selected for midpoint at design conditions. Drives shall be sized for 150% of the installed motor horsepower.

I. Extended Grease Lines: Extend grease lines from bearings and terminate with grease fitting.

J. Manufacturer: Subject to compliance with requirements, provide centrifugal fans of one of the following: Cook (Loren) Co.; Greenheck Fan Corporation; New York Blower Co.; Twin City Fan and Blower Co.

2.3 TUBULAR CENTRIFUGAL KITCHEN GREASE FANS

A. General: Provide tubular centrifugal fans of sizes and arrangement as indicated and of capacities and having accessories as scheduled. Fan performance shall be based on tests conducted in accordance with AMCA Standard 210 test code for air moving devices, and licensed to bear the AMCA Certified Ratings Seal. Fan shall be selected for grease removal meeting UL 762 and built in accordance to NFPA 96.

B. Fan Units: Provide factory assembled and tested fan units consisting of housing, wheel, fan shaft, bearings, straightening vanes and motor support. Clean, condition and prime paint sheet metal parts prior to final assembly. Apply final coat of enamel to exterior surfaces after assembly.

C. Housings: Construct housings of low carbon steel with continuous weld construction, braced to prevent vibration or pulsation. Provide streamlined inlet and outlet configurations.

1. Include bolted access door for cleaning.
2. Grease trap with drain connection.

D. Wheels: Provide airfoil type blades and welded construction. Statically and dynamically balance wheels before assembly and balance again in assemble unit at design rpm.

E. Shafts: Construct of solid hot rolled steel, turned and polished. Design to operate at no more than 70% of first critical speed at top of speed range of the fan's class.

A. Bearings: Bearings: Provide self-aligning, grease lubricated, pillow block type bearings, selected for minimum average life (AFBMA L50) of 100,000 hours. Include extended lubrication lines.

F. Drive: Provide V-belt drive, selected for 1.4 service factor. Provide adjustable pitch sheaves, selected for midpoint at design conditions.

G. Arrangement: Provide arrangement 1 for floor mounted fans and arrangement 9 for ceiling mounted fans.

H. Motor: Provide open drip proof energy efficient motor fastened to adjustable motor base.

I. Vibration Control: Provide spring vibration isolators with number and size of isolators selected by manufacturer.

J. Accessories: Provide the following accessories as indicated and/or scheduled.

1. Companion Flanges: Provide flanges on inlet and outlet to accommodate slip connection for ductwork.

2. Belt Guard: Provide protective enclosure over moving parts with opening for tachometer.

3. Extended Grease Lines: Extend grease lines from bearings to outside of inlet duct flange. Terminate with grease fitting.

K. Manufacturer: Subject to compliance with requirements, manufacturers offering tubular centrifugal fans which may be incorporated in the work include, but are not limited to, the following: Cook (Loren) Co.; Greenheck Fan Corporation; New York Blower Co.; Twin City Fan and Blower Co.

2.1 UPBLAST KITCHEN EXHAUST FANS

A. General: Provide utility fans of sizes and arrangement as indicated and of capacities and having accessories as scheduled and listed below. Fan performance shall be based on tests conducted in accordance with AMCA Standard 210 test code for air moving devices, and licensed to bear the AMCA Certified Ratings Seal. Fan shall be selected for grease removal meeting UL 762 and built in accordance to NFPA 96.

B. 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.

C. Housings:

1. Construct of heavy gage steel with side sheets fastened to scroll sheets by means of welded scroll construction. Provide flanged round inlet for grease duct connection and flanged discharge duct connection.

2. Vibration isolators.

3. Provide adjustable motor supports.

4. Include bolted access door for cleaning.

5. Grease trap with drain connection.

D. Wheels: Provide backward inclined wheels as scheduled. Provide swaged hubs. Balance wheels statically and dynamically.

E. Shafts: Construct of AISC 1040 ground and polished steel. Apply rust preventive coating.

F. Bearings: Provide self-aligning, grease lubricated, pillow block type bearings, selected for minimum average life (AFBMA L50) of 100,000 hours. Include extended lubrication lines.

G. Extended Grease Lines: Extend grease lines from bearings to outside of inlet duct flange. Terminate with grease fitting.

H. Motors: Provide open drip proof energy efficient 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. Provide weatherproof cover with ventilation slots to fit over motor and drive for outdoor installations.

I. Drives: Provide adjustable pitch sheave, selected for midpoint at design conditions.

J. Manufacturer: Subject to compliance with requirements, provide utility fans of one of the following: Cook (Loren) Co.; Greenheck Fan Corporation; New York Blower Co.; Twin City Fan and Blower Co.

2.4 INLINE CENTRIFUGAL FANS

A. General: Provide inline centrifugal fans of sizes and arrangement as indicated, and of

capacities and having accessories as scheduled.

B. Housing: Aluminum split housing, constructed of spun aluminum, with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct Drive Units: Provide ball bearing motor encased in housing so as to be out of air stream. Provide factory wiring to disconnect located on outside of fan housing.
1. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications for the purpose of final airflow balancing.
2. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
3. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by speed switch mounted to fan housing.

D. Belt Drive Units: Provide ball bearing motor mounted on adjustable base, with adjustable sheaves. Provide enclosure around belts. Provide lubricating tubes from fan bearings to outside of fan housing.

E. Wheel: Provide aluminum air foil blades on aluminum hub.

F. Vibration Control: Provide spring vibration isolators with number and size of isolators selected by manufacturer.

G. Accessories: Provide the following accessories as indicated and/or scheduled:

1. Companion Flanges: Provide matching flanges on inlet and outlet to connect ductwork to fan.

2. Fan Guards: Provide guards on inlets and outlets that are not connected to ductwork.

3. Extended Grease Lines: Extend grease lines from bearings to outside of inlet duct flange. Terminate with grease fitting.

H. Manufacturer: Subject to compliance with requirements, manufacturers offering inline centrifugal fans which may be incorporated in the work include, but are not limited to, one of the following: Cook (Loren) Co.; Greenheck Fan Corporation; New York Blower Co.; Twin City Fan and Blower Co.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install air distribution equipment where indicated, in accordance with manufacturer's installation instructions and with recognized industry practices, to ensure that equipment complies with requirements and serve intended purposes.

B. Access: Provide access and service space around and over air distribution equipment as indicated, but in no case less than that recommended by manufacturer.

C. Isolation: Set on vibration isolators, fasten in accordance with manufacturer's installation instructions.

D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

E. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Ensure that rotation is in direction indicated and intended for proper performance. Do not proceed with centrifugal fan start-up until wiring installation is acceptable to centrifugal fan Installer.

F. Ductwork Connections: Refer to Division 23 "Ductwork" sections. Provide flexible connections on inlet and outlet duct connections.

G. Exhaust Systems: Provide automatic dampers at each fan and interlock with motor to serve as a back-draft damper. Reference Section 23 09 53

3.2 FIELD QUALITY CONTROL

A. Upon completion of installation of centrifugal 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 that cannot be satisfactorily corrected.

3.3 EXTRA STOCK

A. Provide one spare set of belts for each fan. Obtain receipt from owner that belts have been received.

B. Provide fixed sheave to replace adjustable pitch pulley. Sheave shall be sized by balancing contractor.

END SECTION 23 34 16

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SECTION 23 34 23 - POWER AND GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of power ventilator work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of power ventilators specified in this section include the following:

1. Power Ventilators:

a. Centrifugal roof ventilators

2. Ceiling Ventilators:

a. Ceiling exhausters

3. Prefabricated roof curbs.

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 fan motor. Include starters, disconnects and required electrical devices, except where specified as furnished or factory installed, by manufacturer.

2. Interlock wiring between fan units; and between fans and field installed control devices.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for power and gravity ventilators, including specifications, capacity ratings, dimensions, weights, materials, accessories furnished, and installation instructions. Single point operating curves are **NOT** acceptable.

B. Shop Drawings: Submit assembly type shop drawings showing unit dimensions, construction details, methods of assembly of components, and field connection detail.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to power ventilators. 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 of each type of power and gravity ventilator, accessory, and control. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE

A. Provide equipment with AMCA Certified Ratings and UL listed and labeled electrical components. Sound rate in accordance with AMCA 300.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver ventilation equipment with factory installed shipping skids and lifting lugs; pack components in factory fabricated protective containers.

B. Handle ventilation equipment carefully. Do not install damaged components; replace and return damaged components to manufacturer.

C. Store ventilation equipment in clean dry place and protect from weather and construction traffic. Comply with manufacturer's rigging and installation instructions.

PART 2 - PRODUCTS

2.1 POWER VENTILATORS

A. General: Except as otherwise indicated, provide standard prefabricated power ventilator units of type and size indicated, modified as necessary to comply with requirements, and as required for complete installation.

B. Centrifugal Roof Ventilators: Provide centrifugal roof type, curb mounted, power ventilators of type, size, and capacity as scheduled, and as specified herein.

1. Type: Centrifugal backward inclined fan wheel, direct driven as scheduled. Provide with spun aluminum weatherproof housings. Provide square base to suit roof curb. Provide permanently lubricated, capacitor-start, induction-run type motor. Housing design to be as scheduled: Downblast or Upblast type. Fan shall bear AMCA certified rating seal for sound and air performance.

2. Electrical: Provide factory-wired nonfusible type disconnect switch at motor in fan housing. Provide thermal overload protection in fan motor. Provide conduit chase within unit for electrical connection. Provide solid state fan speed controller for each direct drive fan as scheduled.

3. Grease-Laden Exhaust: Where scheduled, in addition to above, provide centrifugal roof ventilators conforming to UL 762 (Power Ventilator for Restaurant Appliances). Include a factory provided fan housing drain with grease trap.

4. Bird Screens: Provide removable bird screens, ½" mesh, 16-gage aluminum or brass wire.

5. Provide minimum 18” high roof curb of size to match unit dimensions constructed of galvanized metal with 1 ½” thick fiberglass insulation and wood nailing block around entire perimeter.

6. Dampers: Motor-operated dampers at inlets, by Temperature Control, not work of this Section.

7. Manufacturer: Subject to compliance with requirements, provide centrifugal roof ventilators of one of the following: Carnes Co; Cook (Loren) Co.; Greenheck; Penn Ventilator.

2.2 CEILING VENTILATORS

A. Ceiling Exhausters:

1. Provide ceiling exhausters, designed for ceiling or wall mounting, of type, size and capacity as scheduled.

2. Provide AMCA Certified Rating Seal.

3. Type: Provide galvanized steel housing lined with acoustical insulation, adaptable for ceiling installation. Provide impeller type wheel fan wheels mounted on motor shaft with fan shrouds, all removable for service. Provide integral backdraft damper fan discharge.

4. Grille: Provide white finished grille with thumbscrew attachment to fan housing.

5. Motor: Provide permanent split-capacitor motor, permanently lubricate, with grounded cord and plug.

6. Discharge: Provide metal roof or wall cap with back draft damper and bird screen as scheduled or otherwise indicated on Drawings. Rust-resistant finish or as indicated on Drawings.

7. Electrical: Provide junction box for electrical connection on housing, and receptacle for motor plug-in.

   Furnish remote fan speed control, solid state, capable of controlling fan speed from full speed to approximately half speed, where scheduled.

8. Manufacturer: Subject to compliance with requirements, provide impeller type ceiling exhausters of one of the following: Acme; Air Control Products; Broan; Carnes; Cook (Loren) Co.; Dayton Electric; ILG Industries; JennFan; Power Line.

2.3 GRAVITY VENTILATORS

A. General: Except as otherwise indicated, provide standard prefabricated gravity ventilator

units of type and size indicated, modified as necessary to comply with requirements, and as required for complete installation.

2.4 PREFABRICATED ROOF CURBS

A. General: Provide manufacturer's standard shop fabricated units, modified if necessary to comply with requirements.

B. Fabricate structural framing for units of structural quality sheet steel (ASTM A 570, Grade 40), formed to profiles indicated or, if not indicated, to manufacturer's standard profiles for coordination with roofing, insulation and deck construction. Include 45º cant strips and deck flanges with offsets to accommodate roof insulation. Weld corners and seams to form watertight units. Delete 45º cant strips where not required or acceptable with roofing type. Coordinate with roofing contractor.

1. Fabricate units from zinc coated steel, ASTM A 446, Grade C, designation G90 hot-dip coating, mill phosphatized.

C. Reinforce continuous runs of over 3'-0" length by inserting welded stiffeners of heavy gage with flanges as required to provide sufficient rigidity and strength to withstand maximum lateral forces in addition to superimposed vertical loads.

D. Sloping Roof Decks: For deck slopes of ¼" per foot and more, fabricate support units for form level top edge.

E. Gage and Height: Fabricate units of zinc coated steel, gage and to height above roof surface as indicated. Where gage or height are not indicated, fabricate units of 18-gage steel, and nominal height of 12” above the top of the roof.

F. Provide pressure treated wood nailer, not less than 1-1/2" thick and of width indicated, but not less than width of support wall assembly. Anchor nailer securely to top of metal frame unit.

G. Fabricate exterior support profile to receive insulation of thickness indicated or, if not indicated, of 1" thickness.

H. Insulate units inside structural support wall with rigid glass fiber insulation board of approximately 3-lb. density and 1-1/2" minimum thickness, except as otherwise indicated.

I. Provide support liners where shown, formed of 22 gage galvanized sheet metal, mill phosphatized, flanged at lower edges.

1. Extend support liners through deck construction to coordinate with ductwork below as indicated.

2. Use perforated metal for support liners, with approximately 1000, 3/32" diameter holes per sq. ft., to provide sound absorbing surfaces.

3. Provide sound insulation insert for curbs so indicated. Construct of 1" thick rigid fiberglass panels secured in galvanized steel framework, with rounded edges to

minimize airflow resistance.

J. Metal Deck Reinforcement: Where indicated as integral part of support units. Provide channel shaped metal deck closure strips to reinforce opening through metal decking. Fabricate strips from 14-gage metal to match metal and finish of curb units, except as otherwise indicated.

K. Manufacturer: Subject to compliance with requirements, provide prefabricated roof curbs of one of the following: Custom Curb; Pate; S & L Manufacturing; ThyCurb; or approved equals.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Examine areas and conditions under which power ventilators are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF POWER AND GRAVITY VENTILATORS

A. General: Except as otherwise indicated or specified, install ventilators in accordance with manufacturer's installation instructions and recognized industry practices to insure that ventilators serve their intended function.

B. Coordinate ventilator work with work of roofing, and ceilings, as necessary for proper interfacing.

C. Ductwork: Refer to Section 23 31 13 "Medium and Low Pressure Ductwork". Connect ducts to ventilators in accordance with manufacturer's installation instructions.

1. Provide access door in duct below ventilator to service damper.

2. Solder bottom joints and up 2" of side joints of duct under roof ventilator to retain any moisture entering ventilator.

D. Roof Curbs: Coordinate with General Contractor. Not work of this Section.

E. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

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

F. Remove shipping bolts and temporary supports within ventilators. Attach units securely to roof curbs with galvanized or aluminum fasteners.

3.3 FIELD QUALITY CONTROL

A. Testing: After installation of ventilators has been completed, test each ventilator to demonstrate proper operation of units at performance requirements specified. When possible, field-correct malfunctioning units, then retest to demonstrate compliance. Replace units that cannot be satisfactorily corrected.

3.4 ADJUSTING AND CLEANING

A. Cleaning: Clean factory finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch up paint.

END SECTION 23 34 23

SECTION 23 36 17 - ELECTRIC TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of heating terminal work is indicated by drawings and schedules.

B. Types of electrical heating terminals in this section include the following:

Baseboard radiation
Heating coils
Fan Forced Heaters
VAV Terminals (VAV)

C. Refer to Division 26 sections for electrical wiring work required in conjunction with heating terminals; not work of this section.

D. Refer to other Division 23 sections for ductwork and duct accessories required in conjunction with heating terminals.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data on heating terminals, including dimensions, capacities, ratings, performance characteristics, gages and finishes of materials and installation instructions.

B. Shop Drawings: Submit assembly type shop drawings showing unit dimensions, construction details and field electrical connection details.

C. Maintenance Data: Submit maintenance instructions, including cleaning instructions and spare parts lists. Include this data in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electrical heating terminal units, of types, ratings and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer: Qualified with at least 3 years of successful installation experience on projects with electrical heating terminal installation work similar to that required for project.

C. NEC Compliance: Comply with applicable heating terminal installation requirements of

NEC pertaining to installation of space heating equipment and appliances.

D. UL Compliance: Comply with applicable requirements of UL 1042, "Electric Baseboard Heating Equipment." Provide heating terminals that are UL listed and labeled.

E. SMACNA Compliance: Comply with applicable requirements of SMACNA's "Ducted Electric Heat Guide for Air Handling Systems."

F. NFPA Compliance: Comply with applicable requirements of NFPA 90A pertaining to installation of A-C systems.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver heating terminals in factory fabricated type containers. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store heating terminals in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 ELECTRIC BASEBOARD RADIATION

A. General: Except as otherwise indicated, provide manufacturer's standard electric baseboard radiation materials and components as indicated by published product information and as required for a complete installation.

B. Heating Elements: Except as otherwise indicated, provide manufacturer's standard elements for indicated duty and rated for the indicated capacity, consisting of electric resistance elements inside aluminum tubes mechanically expanded into aluminum fins and equipped with a capacity type automatic reject thermal overheat cutout.

C. Heating Capacity: Size elements based on ratings of the required output (Btu or watts) and electrical input (watts, voltage, phase).

D. Temperature Controls: Temperature controls are specified in other Division 23 sections.

E. Cabinets: Provide cabinets braced and reinforced to provide required stiffness, with adjustable heating element supports and expansion compensating brackets. Phosphate and paint cabinet inside and out with one coat of baked-on primer. Provide one piece, 22 gage, bottom, back and top panels and 18 gage removable front panels and end caps. Baked enamel finish selected from manufacturer's standard colors.

F. Manufacturers: Subject to compliance with requirements, provide units of one of the following: Fasco; and Square D; Q-Mark (Marley Engineered Products); Vulcan (Mestek) or approved equal.

2.2 ELECTRIC DUCT HEATING COILS

A. General: Provide electric duct heating coils with automatic reset thermal cutouts for primary over temperature protection and with load carrying manual reset thermal cutouts, factory wired in series with each heater stage, for secondary protection. Include over-current cutouts and sub-circuit fusing in the assembly and construct with the following additional construction features:

1. Open Coil Electric Element: Construct coils with resistance wire of 80% nickel/20% chromium, insulated by floated ceramic bushings. Recess bushings into casing openings and secure on supporting brackets, spaced 4" o.c. maximum, vertical, slip-in type.

2. Heating Capacity: Size coils based on the ratings of the required output (Btu), electrical input (watts, voltage, phase) and CFM.

B. Coil to be provided with built-in door disconnect switch, fuses and fuse blocks, air-flow switch to lock out heater on NO FLOW, mercury contactors for each stage, step controller, transformer, fan relay, pilot light (indicating functional operation including stage energized), all within a totally enclosed terminal box.

C. Manufacturers: Subject to compliance with requirements, provide units of one of the following: Indeeco; Brasch; Tutco; Lenox; or approved equal.

2.3 FAN-FORCED HEATERS

A. Provide cabinet unit heaters in locations as indicated and of capacities, styles and having accessories as scheduled.

B. Casings: Back box to be designed for duty as a recessed rough-in box or surface mounting on finished walls. Completely wired steel inner frame shall support all components, including heating element, fan motor and blade, thermostat, fan control and thermal cutout. Louvered front cover shall be finished in white baked enamel, suitable for field painting.

C. Fans: Construct of aluminum, factory balanced propeller type.

D. Heating Element: Provide manufacturer's standard elements for indicated duty and rated for the indicated capacity, consisting of electric resistance elements. Units to be factory wired with unit mounted heat switch, magnetic contactors, high temperature cut out safety control, and fan override thermostat.

E. Motors: Provide totally enclosed motors, with built-in overload protection, having electrical characteristics as scheduled.

F. Temperature Controls: Provide integral temperature control with thermal overheat protection. Snap action switch shall be activated after heating element reaches operating temperature and continue until after heated air has been discharged. Provide a plug button for replacing thermostat for providing optional tamper-resistant controls.

G. Manufacturer: Subject to compliance with requirements, provide unit heaters of one of the following: Airtherm; Q-Mark; Markel Co; Vulcan (Mestek).

2.4 VARIABLE AIR VOLUME TERMINALS (VAV)

A. Acceptable Manufacturers: Anemostat; Carrier; Krueger; Titus; Trane; Tuttle & Bailey; or approved equal.

B. VAV Control Units: Units shall be pressure independent, completely factory assembled, consisting of an insulated plenum with air inlet and outlet collars, multipoint flow probe, air volume damper, electronic controller, hot water booster coil (where scheduled) and removable access panel.

C. Casing: Unit casing shall be galvanized sheet steel lined with minimum ½" of 1-1/2 lb./cu. ft. density thermal/acoustic glass fiber insulation not to exceed NFPA 90A smoke and flame spread rating recommendations and to meet UL 181 anti-erosion requirements. Secure lining to prevent de-lamination or sagging. Provide sound attenuator or lined duct section downstream of box when needed to comply with scheduled NC ratings.

D. Identification: Provide label on each unit indicating manufacturer, model number, cfm range, and plan tag number.

E. Air Dampers: Construct of materials that cannot corrode, do not require lubrication nor periodic servicing. Provide mechanism to vary air volume through damper from minimum to maximum in response to signal from the BAS. Damper leakage not to exceed 2% at 3" wg inlet static pressure.

F. Flow Sensor: The velocity probe shall consist of a multiple point averaging flow sensor with integral flow taps and calibration chart for field balancing.

G. Valve Actuator: Actuator shall be furnished and installed by Temperature Control contractor. Electronic actuator shall include 24-volt motor providing forward, null, and reverse operation. Electronic pressure-independent control shall have heating and cooling setpoints adjustable from the BAS and at the terminal unit.

H. The air pressure drop through the units shall not exceed scheduled values. The unit manufacturer shall furnish certified sound data for both casing radiated and discharge sound levels as tested in an ADC certified laboratory in strict accordance with ARI 880-98 Test Standard and shall include 2nd through 7th octave band data for all unit sizes. Both discharge and radiated NC levels shall be based on a 10dB sound absorption as determined by subtracting the highest point on the power level curve. Sound performance based on other standards or methods will not be accepted.

I. Room temperature controls shall be furnished by the Temperature Control Contractor.

J. See schedule for electric duct heating coil requirements. Provide as specified for Electric Duct Heating coils.

PART 3 - EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION OF HEATING TERMINALS

A. Install heating terminals as indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices to ensure that heating terminal equipment fulfills requirements. Comply with applicable installation requirements of NEC and NECA's "Standard of Installation."

B. Coordinate with electrical work, including wiring/cabling work, as necessary to interface installation of heating terminals with other work.

C. Clean dust and debris from each heating terminal as it is installed to ensure cleanliness.

D. Comb out damaged fins where bent or crushed before covering elements with enclosures.

E. Touch up scratched or marred heating terminal enclosure surfaces to match original finishes.

3.3 TESTING

A. Upon completion of installation of heating terminals and after building circuitry has been energized, test heating terminals to demonstrate capability and compliance with requirements. Where possible, field-correct malfunctioning units, then retest to demonstrate compliance.

END SECTION 23 36 17

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SECTION 23 37 13 – DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Section 23 31 13 - Medium and Low Pressure Ductwork

C. Section 23 33 00 - Duct Accessories

D. Section 23 05 93 -Testing, Adjusting and Balancing

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's data on outlets and inlets including the following:

1. Schedule of Diffusers, Registers and Grilles indicating drawing designation, room location, number furnished, model number, size and accessories furnished.

2. Data sheet for each type of Diffusers, Registers and Grilles and accessory furnished; indicating construction, finish and mounting details.

3. Performance data for each type of Diffusers, Registers and Grilles furnished including: throw at 150/100/50 fpm, total and velocity pressure drop, and noise criteria ratings. Indicate selections on data.

B. Maintenance Data: Submit maintenance instructions including cleaning instructions for finishes and spare parts lists. Include this data in maintenance manuals.

1.3 QUALITY ASSURANCE

A. ASHRAE Standards: Comply with American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE) Standard 70 "Methods of Testing for Rating the Air Flow Performance of Outlets and Inlets."

B. ADC Test Code: Comply with Air Diffusion Council (ADC) Equipment Test Code 1062R4 "Certification, Rating and Test Manual."

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver Diffusers, Registers and Grilles wrapped in factory fabricated fiberboard type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store Diffusers, Registers and Grilles in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering diffusers which may be incorporated in the work include, but are not limited to, the following: Anemostat; Carnes; Carrier; Krueger; Metal Aire; Nailor; Price Industries; Titus; United McGill, or approved equal.

B. General: Provide diffusers, registers, and grilles where shown; of size, shape, capacity and type indicated; constructed of materials, finishes, components, and accessories as indicated, scheduled, and as required for complete installation.

C. Performance: Provide performance data for each type of outlet and inlet furnished including: throw at 150/100/50 fpm, total and velocity pressure drop at vertical throw, and noise criteria ratings at vertical throw.

D. Finish: White baked enamel standard. Color and finish indicated is for submittal to Architect for final approval.

E. Accessories: Round neck on supply diffusers. Adjustable opposed blade damper assembly where indicated. Damper may be integral with slot diffuser throw pattern blades. Insulated supply plenum on linear diffusers as indicated.

F. Mountings:

1. Lay-In: Housing sized to fit between ceiling exposed suspension tee bars and rest on top surface of tee bars. Tee bar required on each side.

2. Surface-mounted: Furnish flanged or beveled border for wall or ceiling installation. Flanged borders with gasket and screw holes.

3. Duct-mounted: Diffuser or grille housing and frame designed for installation on exposed duct branch.

2.2 DIFFUSERS, GRILLES, AND REGISTERS

Manufacturer's model numbers are provided to indicate quality and performance specified. Any manufacturer indicated above may submit equivalent models.

Ceiling Diffuser CD-1,2:
Surface mounted: Steel construction with anti-smudge beveled frame, square concentric louvers, round duct connection, baked enamel finish, each throw direction manual adjustable for horizontal to vertical airflow, throw directions to be 4-way unless otherwise indicated. Baked white enamel finish. Diffuser louver sizes and round neck sizes indicated on drawings. Carnes SKSJ, or approved equal.

Supply Grille SR-1:
Round duct flush mounted: Aluminum construction, vertical and horizontal straight double deflection adjustable hemmed or teardrop blades at manufacturer's standard spacing, approximately 3/4" on center. Flanges shall be curved with radius matching spiral duct size as shown on plans with foam gasket. Drawings indicate grille dimensions. Provide with natural aluminum finish with factory clear coat to protect finish. Provide with adjustable air scoop damper. Carnes RDDMH or approved equal.

Supply Grille SG-1:
Duct mounted: Aluminum construction, vertical and horizontal straight double deflection adjustable hemmed or teardrop blades at manufacturer's standard spacing, approximately 3/4" on center. 1" flange without screw holes. Clear anodize finish. Grille size indicated on drawings. Carnes RADMH, or approved equal.

Supply Grille SG-2:
Surface mounted: Steel construction, vertical and horizontal straight double deflection adjustable hemmed or teardrop blades at manufacturer's standard spacing, approximately 3/4" on center. 1" flange with screw holes and gasket. Baked white enamel finish. Grille size indicated on drawings. Carnes RSDBH, or approved equal.

Return Grille RG-1, Transfer Grille TG-1, Exhaust Grille EG-1:
Surface mounted: Aluminum construction, 1/2"x1/2"x1/2" eggcrate, 90% free area, 1" flange with screw holes. Baked white enamel finish. Size indicated on drawings. Carnes RAPAF, or approved equal.

Return Grille RG-2, Transfer Grille TG-2, Exhaust Grille EG-2:
Lay-in: Aluminum construction, 1/2"x1/2"x1/2" eggcrate, 90% free area,1" flange with no screw holes, 22"x22" nominal neck size, 23-3/4"x23-3/4" nominal frame dimensions. Baked white enamel finish. Carnes RAPAF, or approved equal.

Open Ended Duct with screen OED: Shop fabricated galvanized sheet metal frame with welded wire fabric constructied of 0.063 gauge wire, ½" x ½" spacing and hot dipped galvanized finish equal to McNichols Co. Weldmesh.

2.3 SLOT DIFFUSERS

Provide all materials and components for a complete slot air distribution system, installed in ceiling type indicated on the architectural drawings. Components include, but not limited to, diffusers, insulated plenums, blank-offs, end caps, spacer clips, hanger clips, and support clips. Pattern controllers shall be capable of throws parallel (horizontal) to ceiling. Finish shall be white baked enamel.

Plenum Slot Diffuser PSD-1,2:
Lay-in mounted: Plenum slot diffuser: Steel construction, adjustable pattern high induction air pattern with factory provided center T-bars compatible with ceiling components and color. Vane air pattern and flow rate adjustment with air pattern having full 180 degree adjustment. Drawings indicate diffuser length and number of slots. Provide insulated plenum with interior, vanes and frame painted flat black. Provide round or oval inlet collar to plenum to match duct size serving unit, as indicated on Drawings. Provide 4 foot long diffusers with center notches for 2'x2' ceiling

grids. Donco DCD, Kees K or approved equal.

PART 3 - EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

A. General: Install outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions. Provide transition at diffuser to match plan duct size with inlet size.

B. Support all duct ceiling inlets and outlet from structure. Provide minimum 28 gage 3/4" angle supports on 2 sides for non-ducted outlets installed in ceiling tiles. Extend angles to T-bar supports.

C. Locate diffusers, registers and grilles as indicated on plans. Unless otherwise indicated on the reflected ceiling plans, locate diffusers, registers and grilles in center of acoustical ceiling modules. Locate slot diffusers on T-bar. Locate lay-in linear diffusers beside T-bar and install additional support bar as required. Install louvered return and exhaust inlets with blade orientation to minimize see through.

D. Where diffusers are located under obstacles prohibiting standard elbow connection, remove round neck and provide square plenum inlet as tall as possible with side connection. Transition duct as required.

E. Security grilles and diffusers shall have steel angle back plates, welded or bolted at backside of wall or ceiling. Support ceiling-mounted units from structure above.

3.3 BALANCING

A. Balancing damper shall be installed in duct leading to each outlet and inlet. Refer to Section 23 05 93 "Testing, Adjusting and Balancing" for balancing of outlets and inlets; not work of this section.

END SECTION 23 37 13

SECTION 23 41 00 - AIR TREATMENT EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of work required by this section is indicated on drawings and schedules and/or specified in other Division 23 sections. Equipment specified herein includes the following:

panel filter media	25-30% efficient filter media
housings for panel filters	housings for 25-30% efficient filter media
side access filter housings	

B. This section contains specifications for filters used in all central station air handling units, fan coil units, cabinet unit heaters, special filter housings, and field erected units, whether located indoors, or outdoors.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data concerning dimensions, materials, efficiencies, installation instructions and appropriate identification. Use UL Class 1 or Class 2 filters unless noted otherwise. Efficiencies indicated in this section are based on ASHRAE Standard 52. Fan motors have been selected to operate against the resistance of dirty filters as specified in this section.

B. Shop Drawings: Submit shop drawings for filter rack assemblies showing dimensions, materials and methods of assembly.

C. Maintenance Data: Submit maintenance data and spare parts lists for each type of filter, filter gage and rack required. Include this data in maintenance manual.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air filtering equipment with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. ASHRAE Compliance: ASHRAE Standard 52
2. UL Compliance: UL181, UL 586

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS: Subject to compliance with requirements, provide filters and frames of one of the following: American Air Filter; Barnebey-Cheney; Cambridge; Continental; Flanders; Farr; Mine Safety Appliances; Research Products; or approved equal.

2.2 MERV 6 PANEL FILTER MEDIA (FARR 20-20, cabinet unit heaters, fan coil units, unit ventilators, residential furnaces)

A. Use 1" thick fiber blanket in a cardboard frame with perforated metal retainer. Coat media with flameproof, non- volatile adhesive.

B. Media nominal rating to be 500 FPM face velocity, 0.15 inch WG initial resistance, 0.50 inches WG recommended final resistance. Average arrestance of filter media shall be 80%.

C. Provide filter holding frame.

2.3 MERV 7 EFFICIENT FILTER MEDIA

A. Use 2" or 4" thick as scheduled, pleated, lofted, non-woven, reinforced fabric, supported and bonded to a welded wire grid, and enclosed in cardboard frame.

B. Media nominal rating to be 500 FPM face velocity, 0.30 inch WG initial resistance, 0.9 inches WG recommended final resistance. Efficiency to be 25-30% dust spot, 90-92% weight arrestance.

C. Furnish a side-access housing or holding frame as scheduled or specified. Top access housing or holding frame is required for evaporative coolers.

2.4 MERV 11 EFFICIENT FILTER MEDIA

A. Media nominal rating to be 500 FPM face velocity, 0.40 inch WG initial resistance, 1.0 inches WG recommended final resistance, 95% dust spot efficiency.

B. Furnish a side-access filter housing or holding frame as scheduled.

2.5 HOUSINGS FOR PANEL FILTERS

A. Manufactured by air handling unit manufacturer, filter media manufacturer, or contractor fabricated. Casing and tracks constructed of galvanized or enameled steel or aluminum.

B. Provide access to the media tracks from outside the casing so media and be readily changed.

2.6 HOUSINGS FOR MERV 7 EFFICIENT FILTER MEDIA

A. Housing or holding frame to be of the same manufacturer as filter media or provided by the air handling unit manufacturer. Contractor fabricated housings or filter racks will not be accepted. Casing and tracks constructed of galvanized or enameled steel or aluminum.

B. Provide access to the media tracks from outside the casing so media and be readily changed.

2.7 SIDE ACCESS FILTER HOUSINGS

A. Galvanized steel housing with aluminum or galvanized steel filter mounting tracks. Mounting tracks and access doors to have gaskets to minimize air bypass around the filters. Housing assembly to be suitable for use in duct systems with 2 inches of water static pressure.

B. Standard filter sections provided by air handling unit manufacturers may be used for MERV 11 efficient.

C. Insulate housings where adjacent duct or air handling apparatus is insulated. Insulation to be contained within a double wall steel panel and meet the requirements specified for adjacent duct or apparatus.

D. Furnish a door on each end of the housing to facilitate filter changing. Doors to be hinged and provided with lever handle latches to secure the door. Doors shall not be secured with nuts, bolts, wing nuts, or sheet metal screws.

E. Furnish housings for MERV 11 with a lever action sealing mechanism to secure media in tracks.

F. Include an integral prefilter track for installation of MERV 7 efficient prefilters.

2.8 FILTER GAUGES

A. Manufacturers: Dwyer; or approved equal.

B. Direct reading, 3-1/2 inch dial type, diaphragm actuated, in a metal case. Lettering shall be black figures on white background. Provide front recalibration adjustment.

C. Provide gauges with the following ranges:

Filter Type	Scale Range (inch W.G.)
Panel filters	0.0 to 0.5
MERV 7 efficient filters	0.0 to 1.0
MERV 11 efficient filters	0.0 to 2.0

D. Provide one gauge for each filter bank, suitable for flush or surface mounting. Include an air filter gauge accessory package consisting of mounting bracket, aluminum tubing, two static pressure tips, and vent valves for each gauge

PART 3 - EXECUTION

3.1 INSTALLATION

A. Where air handling equipment is to be used for temporary heating or ventilation of a facility, do not operate the equipment until specified filter media has been installed.

Contractor shall be responsible for maintaining the cleanliness of air handling apparatus and air distribution systems during construction through regular inspection and changing of filter media throughout the construction period.

B. Where air handling apparatus is used during the construction period, install new filter media prior to start of air balancing. Additionally, deliver one new set of media to the owner prior to substantial completion.

C. Install units as shown on drawings and details according to manufacturer's instructions.

D. Reinforce filter holding frames per manufacturer's instructions.

E. Maintain necessary clearance for changing filters.

3.2 FILTER GAUGES

A. Install filter gauge static pressure tips upstream and downstream of filters.

B. Mount gauge on outside of filter housing or filter plenum in accessible position; install tubing and gauge valves between gauge and sensor tips. Adjust and level each gauge.

END SECTION 23 41 00

SECTION 23 51 00 - BREECHINGS, CHIMNEYS AND STACKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Section 23 07 00 - Mechanical Insulation.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's specifications including materials, dimensions, weights, accessories, approvals and installation instructions.

B. Shop Drawings: Submit assembly type shop drawings including materials, dimensions, weights, accessories, and required clearances.

C. Maintenance Data: Include product data in maintenance manual.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of prefabricated breeching of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. NFPA Compliance: Comply with the most current edition of NFPA 211 "Chimneys," Fireplaces, Vents and Solid Fuel Burning Appliances" and the most current edition of NFPA 54 National Fuel Gas Code (ANSI Z223.1).

C. UL Compliance and Labeling: Comply with applicable portions of UL safety standards pertaining to breeching; provide products that have been UL listed and labeled.

D. SMACNA Compliance: Comply with SMACNA Low Pressure Duct Standards for fabricated breeching.

PART 2 – PRODUCTS

2.1 SINGLE WALL METAL BREECHINGS AND STACKS

A. All Steel, Positive Pressure, Single Wall Vents:

1. Manufacturers: Subject to compliance with requirements, provide all steel, positive pressure single wall vents of one of the following: Selkirk - Heat Fab; Stacks, Inc.; Hart & Cooley; or approved equal.

2. Description: Factory fabricated Gas Vent Connector tested and listed by

Underwriters Laboratories to UL 1738/ ULC S636 for use with Listed natural gas or propane equipment that produce flue-gas temperatures not above 550°F.

3. Construction: Fabricate from AL 29-4C Stainless Steel suited for use with high efficiency gas burning equipment which produce condensation in the vent. All joints to be fastened with factory applied seal tested to be gas tight at 2.5 times the listed pressure rating of 8" water column.

2.2 DOUBLE WALL METAL BREECHINGS AND STACKS

A. Type B Gas Vents:

1. Available Manufacturers: Subject to compliance with requirements, provide Type B double wall gas vents of one of the following: American Metal Products Co., Div. of Masco Corp.; General Products Co., Inc.; Hart & Cooley Mfg. Co.; Selkirk Metalbestos; or approved equal.

2. Description: Double wall gas vents, UL listed for Type B, consisting of an inner pipe of sheet aluminum, and outer pipe of galvanized sheet steel, with the following minimum thicknesses:

Size	Inner Pipe	Outer Pipe
Round, up to 6"	0.012"	28 gage
Round, 7" to 18"	0.014"	28 gage
Round, 20" to 24"	0.018"	26 gage
Oval, up to 4"	0.012"	28 gage
Oval, 5" to 6"	0.014"	28 gage

3. Accessories: UL labeled tees, elbows, increasers, draft hood connectors, metal cap with bird barrier, adjustable roof flashing, storm collar, support assembly, thimbles, fire stop spacers, and fasteners, fabricated of similar materials and designs as vent pipe straight sections.

2.3 DIRECT DUCTED COMBUSTION AIR INTAKE

A. Provide galvanized sheet metal, or PVC piping.

1. Galvanized sheet metal shall be equivalent to 2" pressure class ductwork. See Section 23 31 13 for construction and seal class.

2. PVC piping shall be schedule 40 DWV and fittings. Joints to be made using PVC cleaner and cement.

B. See Section 23 07 00 Mechanical Insulation for requirements of concealed intake ducts.

2.4 SINGLE WALL POLYPROPYLENE FLUE/VENT FOR CONDENSING HEATING EQUIPMENT

A. Provide rigid and flexible polypropylene piping with concentric assemblies where indicated.

1. Manufacturers: Subject to compliance with requirements, provide all polypropylene positive pressure single wall vents of the following: Innoflue; or approved equal.

2. Designed for use with Category II or IV condensing gas, propane, or oil fired equipment as **APPROVED BY THE HEATING EQUIPMENT MANUFACTURER**.

3. Maximum continuous flue gas temperature shall not exceed 248 degrees F (120 degrees C).

4. Vent shall be listed for maximum positive pressure rating of 20" W.C.

5. Vent shall be constructed from Flame Resistant Polypropylene rated for this application.

6. System components to have factory installed gasket in female end connections for push-together installation and water tight fit. Zero clearance to combustibles where indicated.

7. All polypropylene piping and products furnished under this product line to be UL-1738 and ULC-S636 rated for gas burning appliance venting systems.

B. See Section 23 07 00 Mechanical Insulation for requirements of concealed intake ducts.

PART 3 - EXECUTION

3.1 INSTALLATION OF SINGLE WALL BREECHINGS AND STACKS

A. Install all steel, positive pressure, single wall vents in accordance with manufacturer's installation instructions, NFPA and UL listings. Use single manufacturer for all components including adapters to boiler, thimbles through building construction, flashings and termination kits.

B. Seal joints between sections of positive pressure vents in accordance with manufacturer's installation instructions, and using only sealants recommended by manufacturer.

C. Install vents parallel to building components maintaining minimum clearances from combustibles as specified in UL listing and pitch as required by manufacturer.

D. Support vents at intervals recommended by the manufacturer to support the weight of the vent and all accessories, without exceeding loading of boilers.

3.2 INSTALLATION OF DOUBLE WALL BREECHINGS AND STACKS

A. Install all steel, positive pressure, double wall vents in accordance with manufacturer's installation instructions and UL listing. Maintain minimum clearances from combustibles specified in UL listing.

B. Seal joints between sections of positive pressure vents in accordance with manufacturer's installation instructions, and using only sealants recommended by manufacturer.

C. Support vents at intervals recommended by the manufacturer to support the weight of the vent and all accessories, without exceeding loading of boilers.

D. Install Type B gas vents in accordance with manufacturer's installation instructions and UL listing. Maintain minimum clearances from combustibles specified in UL listing.

3.3 INSTALLATION DIRECT DUCTED COMBUSTION AIR INTAKE

A. Seal joints in accordance with manufacturer's installation instructions, and using only sealants recommended by manufacturer.

B. Install intake piping parallel to building components maintaining minimum clearances from combustibles and maximum equivalent lengths as specified in UL listing and pitch as required by manufacturer.

C. Support piping at intervals recommended by the manufacturer to support the weight of the vent and all accessories.

3.4 INSTALLATION OF SINGLE WALL POLYPROPYLENE FLUE/VENT

A. Vent installation shall conform to the manufacturer’s installation instructions, its UL listing and state/local codes.

B. The vent system shall be routed for zero clearance to combustibles where indicated and as specified by the manufacturer.

C. Support piping at intervals recommended by the manufacturer to support the weight of the vent and all accessories.

D. The vent system and breeching shall be inspected and cleaned before the final connection to the appliances.

3.5 CLEANING AND PROTECTION

A. Clean breechings internally during installation to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth.

B. Temporary Closure: At ends of breechings and chimneys that are not completed or connected to equipment, provide temporary closure which will prevent entrance of dust and debris until installations are completed.

END SECTION 23 51 00

SECTION 23 54 00 – FURNACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 and Division 23 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of furnaces work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of packaged heating and cooling units specified in this section include the following:

1. Gas-Fired Furnaces, Condensing

C. Refer to other Division 15 sections for automatic temperature controls not factory installed, and required for conjunction with packaged heating and cooling units; not work of this section.

D. Accessories: Refer to other Division 23 sections for Furnace Accessories not factory installed, including air filters and cleaners, humidifiers, condensing units, DX cooling coils, refrigeration piping, and fuel gas piping.

E. Electrical Work: Refer to Division 23 section "Electrical Provisions of Mechanical Work" for requirements.

F. Electrical Work: Provide the following wiring as work of this section, in accordance with requirements of Division 26:

1. Provide control wiring between unit mounted control panel and thermostats, remote control panels, and any other control device furnished as work of this section.

2. Provide factory mounted and wired controls and electrical devices as specified in this section.

G. Refer to Division 26 sections for other electrical work including motor starters, disconnects, wires/cables, raceways, and other required electrical devices; not work of this section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of packaged heating and cooling units, of types and capacities required, whose products have been in

satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. ARI Compliance: Provide capacity ratings for packaged heating and cooling units in accordance with ARI Standard 360 "Standard for Commercial and Industrial Unitary Air Conditioning Equipment".

2. ASHRAE Compliance: Construct refrigerating system of packaged heating and cooling units in accordance with ASHRAE Standard 15 "Safety Code for Mechanical Refrigeration".

3. UL Compliance: Provide packaged heating and cooling units that are UL listed and labeled.

4. UL Compliance: Provide packaged heating and cooling units that are designed, manufactured, and tested in accordance with UL requirements.

5. NFPA Compliance: Provide packaged heating and cooling units that are in compliance with NFPA 70.

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 to packaged heating and cooling units. Submit manufacturer's ladder type wiring diagrams for interlock and control wiring required for final installation of packaged heating and cooling units and controls. 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 packaged heating and cooling unit, control, and accessory; including "trouble shooting" maintenance guide. Include this data with requirements of Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle packaged heating and cooling units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged packaged heating and cooling units or components; replace with new.

B. Store packaged heating and cooling 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 packaged

heating and cooling units, and moving units to final location for installation.

1.6 WARRANTY

A. Warranty on Heat Exchanger: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, heat exchangers with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

1. Warranty Period: 5 years from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 Gas-Fired Furnaces, Condensing

A. General: Provide factory assembled, piped, wired, and tested packaged units as indicated, consisting of casing, heat exchangers, burners, fans, filters, and unit controls that comply with ANSI Z21.47, "Gas-Fired Central Furnaces," and NFPA 54, "National Fuel Gas Code"; and bearing label of the American Gas Association. Provide capacities and electrical characteristics as scheduled.

B. Cabinet: Steel, with interior insulation around the heat exchanger. Lift-out panels expose burners and all other items requiring access for maintenance.

1. Interior Insulation: Mineral-fiber board thermal insulation manufactured with glass fibers a minimum of ½ inch (13 mm) thick, bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, with aluminum foil jacket.

C. Finish of External Casings and Cabinets: Factory painted, manufacturer's standard color.

D. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.

E. Fan Motors: Energy-efficient type as specified in Section 23 05 13 on motors. Open drip proof, with internal thermal protection and permanent lubrication.

F. Type of fuel: Natural Gas

G. Heat Exchanger: Stamped and welded.

1. Primary: Aluminized steel.
2. Secondary: Polyethylene-coated steel.

H. Burner Controls: Solid state; Control gas valve and ignition.

1. Gas Valve" 24 V, 100 percent safety gas shutoff, pressure regulator, and manual shutoff.
2. Ignition: Electric pilot ignition, with electric spark igniter.

I. Automatic Controls: Solid-state board delays fan start and shutdown.

J. Accessories:

1. Combination Combustion-Air Intake and Vent: PVC plastic fitting to combine combustion-air inlet and vent through outside wall.
2. Ventilation Air Heat Exchanger: Polyethylene air-to-air heat exchanger.

K. Manufacturer: Bryant, Carrier, Trane, Ruud.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Examine areas and conditions under which packaged heating and cooling 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 FURNACES

A. General: Install furnaces in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.

C. Base-Mounted Units: Secure units to G.C. provided concrete equipment curb. Provide optional bottom closure base, equipment stand, or specialty return assembly if required by installation conditions.

D. Electrical Wiring: Install electrical devices furnished by manufacturer's wiring diagram submittal to electrical installer.

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.

E. Ductwork: Refer to Division 23 sections on Ductwork. Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.

1. Connect outside air duct to unit with flexible connection, provide manual damper, quadrant and lock.

2. Connect condenser supply and exhaust ducts to unit with flexible connections.

F. Air Cooled Condenser Piping: Refer to Section 23 23 00, “Refrigeration Piping Systems”. Connect liquid and hot gas piping to unit as indicated.

H. Drain Piping: Connect unit drain to nearest indirect waste connection. Provide trap at drain pan; construct at least 1" deeper than fan pressure in inches of water.

G. Install piping adjacent to machine to allow service and maintenance.

H. Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: connect plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.

3.3 FIELD QUALITY CONTROL

A. General: Start-up packaged heating and cooling units, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.4 CLOSEOUT PROCEDURES

A. Training: Provide services of manufacturer's technical representative for 1-half day to instruct Owner's personnel in operation and maintenance of packaged heating and cooling units.

1. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

3.5 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts for each packaged heating and cooling unit:

1. One set of matched fan belts for each belt driven fan.
2. One set filters for each unit.

END SECTION 23 54 00

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SECTION 23 55 00 - FUEL-FIRED HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of fuel-fired heater work required by this section is indicated on drawings and schedules and by requirements of this section.

B. Types of fuel-fired heaters specified in this section include the following:
1. Tubular infrared heaters
2. Indoor direct fired gas makeup air units
3. Direct fired gas rooftop makeup air units
4. Gas fired separate combustion make up air units
5. Gas-fired propeller unit heaters

C. Refer to appropriate Division 23 sections for fuel piping; controls, ductwork; breechings; and testing, adjusting, and balancing in connection with fuel-fired heaters; not work of this section.

D. Refer to Division 26 sections for the following; not work of this section.

E. Power supply wiring from power source to power connection and fuel-fired heaters. Include disconnects and required electrical devices, except where specified as furnished or factory installed by manufacturer.

F. Refer to other Division 23 sections for automatic temperature controls not factory installed, required in conjunction with fuel-fired units; not work of this section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fuel-fired heaters, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
1. ANSI Compliance: Construct and install gas-fired unit heaters in accordance with ANSI Z83.8 "Gas Unit Heaters."
2.
3. ANSI Compliance: Construct and install gas-fired duct heaters in accordance with ANSI Z83.9 "Gas-Fired Duct Furnaces."
4.
5. 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 fuel-fired heaters. Submit manufacturer's ladder-type wiring diagrams or interlock and control wiring. Clearly differentiate between portions or wiring that are factory-installed and portions to be field-installed.

D. Maintenance Data: Submit maintenance data and parts list for each type of fuel-fired heater, control, and accessory; including "trouble-shooting" maintenance guide. Include this data and product data in maintenance guide. Include this data and product data in maintenance manual; in accordance with requirements of Division 1.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Handle fuel-fired heaters and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged fuel-fired heaters or components; replace with new.

B. Store fuel-fired 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 fuel-fired heaters, and moving them to final location.

PART 2 - PRODUCTS

2.1 TUBULAR INFRARED HEATERS (MULTIPLE-BURNER ENGINEERED VACUUM SYSTEM TYPE)

A. Subject to compliance with requirements, provide a complete engineered negative pressure radiant systems from one of the following: Detroit Radiant Products Company; Ambi-Rad; Solaronics, Schwank Inc.; Calcana, Inc. Fuel type: burner shall be designed for natural gas having characteristics same as those of gas available at project site.

B. Gas control: operation shall include a defined input differential. Heater must be CSA Design Certified to operate at an input differential of at least 20% between the low and nominal rated input modes.

C. Combustion chamber: shall be 4 inch O.D. 16ga. Titanium stabilized aluminized steel to allow for the operating temperature to exceed the 1030F as set forth in the ANSI Z83.20 standard, finished with a high emissivity rated, corrosion resistant, black coating with an emissivity level documented at .92 or higher.

D. Emitter tube: shall be 4 inch O.D. 16ga. aluminized steel finished with a high emissivity rated, corrosion resistant, black coating with an emissivity level documented at .92 or higher

E. Condensate tail pipe: shall be 4 inch O.D. 16ga. 304 stainless steel. Pipe shall be able to be cut to any length without having raw carbon steel exposed at the edges. Glass lined, porcelain lined, or other material prone to chipping and cracking shall not be permitted.

F. Burner type: units shall operate under a negative pressure with exhaust gasses pulled through the exchanger pipe to a common exhauster pump. Each burner shall receive its combustion air independently. Burners that have exhaust gases from upstream burners passing over them shall not be permitted. Burners shall operate at a minimum of 3.5" W.C. manifold pressure to achieve proper air-gas mixing. Burners that require air filters shall not be permitted.

G. Burner: stainless-steel venturi burner. The flame anchoring screen shall have a minimum temperature rating equivalent to 304 grade stainless steel. Non stainless steel burners shall not be permitted.

H. Tube connections: the heater's combustion chamber and radiant emitter tube shall incorporate a 4 inch slip-fit, interlocking connection in which the upstream tube slides into the next tube and is held by a bolted clamp. A butted tube connection system shall not be permitted.

I. Exhauster Pumps:

1. Systems designed for condensing shall have a cast aluminum housing for corrosion resistance. Cast iron housings shall not be permitted.
2. Motors ½ hp and higher shall be TEFC type standard efficiency. Motors shall be equipped with thermal protection and capacitor starters.

J. Ignition system: Hot surface silicon carbide composition. Igniter shall be readily accessible and serviceable without having to remove the burner. Spark ignition systems shall not be permitted.

K. Reflectors: Shall be .025 polished aluminum with a multi-faceted design which includes reflector end caps. Reflector shall have a polished bright finish with clear visual reflection ability. (A sample will be required at time of submittal). Reflector shall have a minimum of 7 sheet metal bends in its fabrication to optimize downward radiation. Reflectors shall be rotatable from 0 to 45 degrees when required. The heater's reflector hanging system shall be designed to permit expansion while minimizing noise and/or rattles.

L. Control box: Heater's exterior control chassis shall be constructed of corrosion resistant enameled steel.

1. Air intake: An air intake collar shall be supplied as part of the burner control assembly to accept a 4 inch O.D. supply duct.

M. Heaters shall be equipped with a sight glass allowing a visual inspection of igniter and burner operation from the floor. Sight glass visible only at a appliance level shall not be permitted. Heater shall be supplied with a stainless steel flexible gas connector.

N. System Operation and Safety Controls:

1. Each burner assembly shall include a safety differential pressure switch to monitor combustion air flow, as to provide complete burner shutdown due to

insufficient combustion air or flue blockage. A single differential pressure switch at the exhauster assembly shall not be permitted.

2. The system exhauster shall have a minimum of a 90-second post purge to aid in the removal of exhaust gases and condensate in the exchanger pipes.
3. The heater shall incorporate a self-diagnostic ignition module, and recycle the heater after an inadvertent shutdown.
4. The heater's control system shall be designed to shut off the gas flow to the main burner in the event either a gas supply or power supply interruption occurs.
5. Heater control assembly shall include three indicator lights that define the units operating input ranges. One indicator shall validate air flow. Two indicator lights shall indicate low and high stages.

O. Thermostat control shall be two-stage operating on 24 volts.

P. Venting: shall be per manufacturer approval and specifications.

Q. Thermostat: devices and wiring are specified in Division 23 Section "Instrumentation and Control for HVAC."

2.2 INDOOR DIRECT FIRED GAS MAKEUP AIR UNIT

A. Provide self-contained, packaged heater which shall include; casing; modulating burner; non-overloading fan; motor, and automatic controls.

B. Construction shall consist of a minimum 18-gauge unpainted galvanized steel designed for indoor installation. The burner section shall be insulated with 1 inch, 1-1/2 lb density acoustical and thermal rigid glass fiber insulation with fire resistant acrylic coating.

C. Provide hinged service access doors to access burners, controls and blower.

D. Provide a gas burner which shall be specifically designed to burn natural gas or propane (as scheduled) below the maximum non-contaminating levels required by OSHA and the ACGIH. Burner shall be cast aluminum with non-clogging, stainless steel baffles attached to gas train supply section which has no moving parts. The burner shall have a 30-to-1 turndown ratio and be designed for 100% thermal efficiency for the life of the equipment

E. Provide outdoor air velocity across the burner which shall be constant and at an air velocity necessary for ANSI certification. The burner velocity shall be constant at all times throughout the operation of the heater. No air from the indoor space shall be allowed to re-circulate across the burner at any time. Service access to the burner igniter, UV Scanner and/or flame rod shall be accomplished through an access door panel.

F. The burner pilot system shall consist of a Direct Spark Ignition module, spark igniter and a flame rod to verify burner low fire ignition before allowing the gas valve to fully open.

G. Supply Fan(s) shall be a forward curved DWDI centrifugal type, belt or direct driven for the required air capacity. The motor shall be standard NEMA frame, Open Drip Proof (ODP), mounted on an adjustable slide base with a single adjustment screw (for belt drive fans). The motor shall have a 1.15 service factor, suitable for continuous service at 120 degree F ambient temperature, and shall be wired for the specified voltage. Blower, motor and drive shall be factory tested to ensure the specified air delivery (per ANSI standards) at the design total static pressure. Fan shall be connected to the motor by a V belt drive, capacity designed for 30% over the motor nameplate horsepower, if applicable. Fan shaft shall be a turned, ground and polished solid shaft.

H. Fan shall have greasable heavy duty pillow block ball bearings, and shall be designed for a minimum L10 for 100,000.hour. Bearings shall have extended lubrication lines, which shall terminate at the unit exterior.

I. Manufacturer: Subject to compliance with requirements, provide make-up air furnace units of one of the following: AbsolutAire, Huntaire; Johnson Marcraft; Reznor; Modine; or pre-approved equal.

2.3 DIRECT FIRED GAS ROOFTOP MAKEUP AIR UNIT

A. General: Provide factory fabricated and factory-tested units as indicated, of sizes and capacities as scheduled, and as specified herein.

B. Casings: Construct unit exterior casings of heavy (16) gage 1-1/2-inch insulated steel throughout, with steel framework with baked enamel or mill galvanized finish. Furnish casings with removable hinge-mounted panels to provide access to all internal parts. Construct units air tight, water tight, and rust inhibited. Unit casings including filter boxes, access plenum sections and burner shall be thermally insulated with fiberglass insulation securely fastened to the casing. Provide insulation with fire retarding characteristics, complying with NFPA 90A.

C. Burner: The unit burner shall be designed for direct firing in the air stream. Burner shall be fully modulating 25 to 1 turn down ratio and shall have stainless steel combustion baffles for complete combustion and uniform temperature distribution. Burner operation shall be programmed through a flame safeguard with timed prepurge and flame sensor or scanner. Burner shall be approved for operation with natural gas at a maximum of 5 psi inlet gas pressure. All controls shall be furnished by unit manufacturer and factory prewired including motor starters. Include prepurge of unit prior of ignition cycle.

D. Burner Controls: Include gas train with 120 volt solenoid gas valves, main gas regulator, modulating electric gas valve, air flow switch, high limit and operating thermostats, electric ignition, electric flame safeguards, and control transformer. Burner shall be modulated by discharge air controller set at 65°F (adjustable). Gas train approval shall be Factory Mutual (FM).

E. Fans: Fans shall be double width, double inlet, centrifugal-type statically and dynamically balanced in the unit fan section. Fasten fans securely to solid or hollow steel shafts and design for continuous operation at the maximum rated static pressure. Mount bearings externally, or if internally mounted, provide with an extended grease line and fitting to allow servicing without dismantling of the unit. Provide fan section with hinged access door.

1. Provide fans with variable pitch V-belt drives for purposes of system balancing. Fixed pitch drives are acceptable for drives 10 HP and larger, provided system balancing is accomplished by either trial of different fixed pitch sheave or use of temporary adjustable pitch sheaves. After system is balanced, fixed pitch sheaves shall replace the variable pitch sheaves for all motors using multiple belt drives. All V-belt drives shall be designed for 150% of motor rating.

F. Dampers: Furnish motorized inlet shutoff damper with built-in end switch and linkage. Dampers shall be low leakage type with edge and side seals.

1. Filters: Provide V-bank filter section with 18 gauge casing, to match unit
2. Filter box section shall be suitable for installation of filters as indicated in Section 23 41 00 of this specification.

3. Inlet Hood: Provide 18 gauge steel inlet hood with 18 gauge galvanized 1" mesh bird screen, to match unit.
4. 115-Volt Duplex Receptacle: Provide transformer, disconnect switch and weatherproof GFI electrical receptacle, per State requirements for rooftop units.
5. Vibration Isolation: Provide internal blower/motor isolation.
6. Roof Curb: Provide 12: high 12 gauge galvanized steel roof curb to match unit. Provide curb gasket. Coordinate installer to provide 1" roof insulation on the sides of the curb and a 1"x4" wood nailer around the top perimeter of the curb.
7. Manufacturer: Subject to compliance with requirements, provide gas-fired, direct fired makeup air units of one of the following: Greenheck Fan Corporation; Hastings Industries, Inc; Reznor; Lennox Industries, Inc; Modine Manufacturing Co; or approved equal.

2.4 GAS-FIRED, SEPARATED COMBUSTION MAKE UP AIR UNIT

A. General: Provide gas-fired, separated combustion make up air unit as indicated, of type and minimum capacity as scheduled, and as specified herein.

B. Construct casing of welded galvanized steel, with enamel finish. Construct interior casing, to contain airflow, of aluminized steel. Provide removable drain pan, and duct flanges on inlet and outlet of casing.

C. Construct heat exchanger of welded aluminized or stainless steel with separated combustion feature. Provide combustion air inlet fan and motor, provide duct collars for flue and combustion air inlet.

D. Construct burner of aluminized steel, and include integral burner crossover. Design burner to be suitable for natural gas.

E. Provide the following controls, factory-piped and prewired to electrical junction box mounted on unit.
1. Limit control.
   a. 120 volt to 24 volt control transformer.
   b. Time delay relay.
   c. Differential switch.
   d. Combination redundant gas valve consisting of:
   e. Combination pilot solenoid valve.
   f. Automatic electric gas valve.
   g. Pilot filter.
   h. Pressure regulator.
   i. Pilot shutoff.
   j. Manual shutoff.

F. Provide terminal vent assembly consisting of individual intake and exhaust vents or concentric exhaust and inlet terminals, and concentric adapter assembly for connection of flue exhaust pipe and combustion air pipe. (Manufacturer approval dependent.)

G. Provide units that are certified to be in conformance with AGA applicable regulations.

H. Provide the following accessories, factory-mounted, and prewired to electrical junction box:
1. Solid-state modulating gas valve providing modulated control from 100% to approximately 50% of full unit rating.

2. Horizontal louvers to control vertical pattern of discharge air and louver fin diffuser to control horizontal spread of discharge air.

I. Temperature controls for makeup air unit are specified in other Division 23 Sections, and are not work of this section.

J. Manufacturer: Subject to compliance with requirements, provide gas-fired, separated combustion duct heaters of the following: Modine, Airedale, ITT Reznor; or approved equal.

2.5 GAS-FIRED PROPELLER UNIT HEATERS

A. General: Provide gas fired propeller unit heaters as indicated of type and minimum capacity as scheduled, and as specified herein.

B. Construct casing of galvanized steel, with baked enamel finish. Provide integral inserts for hanger rods.

C. Construct heat exchanger of welded aluminized, or stainless steel. Provide integral power exhauster, construct integral to each heat exchanger section. Provide intake and exhaust venting per manufacturer recommendations.

D. Construct burner of same material as heat exchanger, and include integral burner crossover. Design burner to be suitable for propane or natural gas.

E. Construct fan of aluminum, direct drive propeller type, and factory-balance.

F. Provide motor, totally enclosed sleeve or ball-bearing type, with built-in thermal overload protection, designed for 115 volts, 60 cycle, single phase. Mount motor on resilient mount and provide heavy-duty fan guard.

G. Provide the following controls, factory-piped and prewired to electrical junction box mounted on unit:
1. 115 or 24-volt automatic gas valve.
2. Safety pilot with 100% shutoff.
3. Pressure regulator with leak limiting device.
4. Manual main and adjustable pilot valves.
5. High Limit switch.
6. Certify units are in conformance with AGA applicable regulations.

H. Provide the following accessories, factory-mounted, and prewired to electrical junction box:
1. 2-stage gas valve providing 2-stage control of 100% or approximately 55% of full unit rating.
2. Electric spark ignition.
3. Louver fin diffusers to control horizontal spread of discharge air stream.

I. Provide temperature controls consisting of line or low voltage room thermostat with locking cover and thermostat guard.

J. Manufacturer: Subject to compliance with requirements, provide gas-fired propeller unit heaters of one of the following: BDP Co; Hastings Industries, Inc; ITT Reznor; Lennox Industries, Inc; Modine Manufacturing Co; Trane Co; or approved equal

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which fuel-fired heaters are to be installed. Do not proceed with work unit unsatisfactory conditions have been corrected in manner acceptable to installer.

3.2 INSTALLATION OF GAS-FIRED RADIANT HEATERS

A. General: Units shall be mounted and installed as detailed and per manufacturer's requirements. Mount tubing with 1" in 10' slope towards exhauster. Adjust angle of reflectors as indicated on drawings and as required for best performance of equipment in application. Install continuous radiant shields and verify required clearances to combustibles and other materials. Modify length of radiant heating tubes, at the discharge end of the tubes, as required to fit packaged units in space available, and in accordance with manufacturer's recommendations.

B. Mount tubing with 1" in 10' slope towards exhauster. Mount reflector continuous on tubing.

C. Connection of gas piping is specified in other Division 23 fuel piping sections, not work of this section.

D. Electrical wiring is specified in Division 26, not work of this section.

E. Install terminal vent assembly at indicated locations. Install gas vent through roof per radiant heater manufacturer's requirements, with vent cap, as specified in Section 23 51 00.

3.3 INSTALLATION OF GAS-FIRED, DIRECT FIRED MAKEUP AIR UNITS

A. General: Install units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure the units comply with requirements and serve intended purposes.

B. Coordination: Coordinate with other work including ductwork, floor construction, roof decking and piping as necessary to interface installation of air handling units with other work.

C. Access: Provide access space within and around units for service as indicated but in no case less than recommended by manufacturer.

D. Support: Provide roof curb to general construction contractor and coordinate installation. Provide equipment supports as indicated on substrate, secure units to supports. Mount on vibration isolators. Set so unit is plumb and level.

E. Duct Connections: Refer to Division 23 Air Distribution sections. Provide ductwork, accessories, and flexible connections as indicated. Connect ductwork to unit inlet and outlet duct collars, use transitions no greater than 15^{o} in any direction for exact fit to collars.

F. Piping Connections: Refer to Division 23 HVAC sections. Provide piping, valves, accessories, gages, supports, and flexible connectors as indicated.

G. Provide PVC condensate drain piping at exhauster discharge as indicated.

H. Electrical wiring is specified in Division 26, not work of this section. Provide positive equipment ground for unit components.

3.4 INSTALLATION OF GAS-FIRED, SEPARATED COMBUSTION MAKEUP AIR UNIT

A. General: Install gas-fired, separated combustion makeup air unit as indicated, an in accordance with manufacturer's published installation instructions.

B. Hang units form substrate using threaded rods and building attachments, secure rods to unit hanger attachments. Adjust hangers so unit is plumb and level. Provide vibration isolators if unit is not internally isolated.

C. Connect ductwork to unit inlet and outlet duct collars, use transitions no greater than 15^{o} in any direction for exact fit to collars.

D. Extend gas piping to within 5' from unit, provide drop with manual gas shutoff valve, 1/8" NPT plugged test connection, tee, and dirt pocket. Locate piping drop so as not to interfere with service of unit. Extend gas piping runout, full size of gas train inlet, from tee to gas train connection, provide union with sufficient clearance for unit removal and service.

E. Connection of gas piping is specified in Division 23 fuel piping sections, not work of this section.

F. Extend power wiring form fused disconnect to electrical junction box on unit. Install thermostat and control sensors in indicated locations, provide low voltage wiring from thermostat to electrical junction box on unit. Comply with requirements of Division 26 for wiring.

G. Electrical wiring is specified in Division 26, not work of this section.

H. Install terminal vent assembly at indicated location, provide minimum 24-gage exhaust duct and combustion air duct between vent assembly and unit. Refer to Section 23 07 00 "Insulation" for insulation of exhaust and combustion air ducts, not work of this section.

3.5 INSTALLATION OF GAS-FIRED PROPELLER UNIT HEATERS

A. General: Install gas-fired propeller unit heaters as indicated, and in accordance with manufacturer's published installation instructions.

B. Hang units from substrate using threaded rods and building attachments, secure rods to unit hanger attachments. Adjust hangers so unit is plumb and level.

C. Extend gas piping to within 5' from unit, provide drop with manual gas shutoff valve, 1/8" NPT plugged test connection, tee, and drip pocket. Locate piping drop so as to not interfere with service of unit. Extend gas piping runout, full size of gas train inlet, from tee to gas train connection, provide union with sufficient clearance for unit removal and service.

D. Connection of gas piping is specified in other Division 23 fuel piping section, not work of his section.

E. Extend power wiring from fused disconnect to electrical junction box on unit. Install thermostat in indicated location, provide line or low voltage wiring as required from thermostat to electrical junction box on unit. Comply with requirements of Division 26 for wiring.

F. Electrical wiring is specified in Division 26, not work of this section.

G. Extend breeching from flue to unit heater, make gas tight connection. Comply with requirements of Section 23 51 00 Breechings.

H. Connection of breeching is specified in Section 23 51 00 Breechings, not work of this section.

3.6 START-UP

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

3.7 SPARE PARTS

A. Provide one complete extra set of filters for each make-up air furnace unit. Install new filters at completion of air handling system work, and prior to testing, adjusting, and balancing work. Obtain receipt from Owner that new filters have been installed.

B. Provide one spare set of belts for each belt-driven unit, obtain receipt from Owner that belts have been received.

C. Provide fixed sheave to replace adjustable pitch pulley. Sheave shall be sized by balancing contractor.

END SECTION 23 55 00

SECTION 23 63 13 - AIR COOLED CONDENSERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Division 23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.2 SUMMARY

Section Includes: Air Cooled Condensers

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights (shipping, installed and operating), dimensions, required clearances and methods of assembly of components, furnished specialties and accessories; and installation and start-up instructions.

B. Wiring Diagrams: Submit ladder type wiring diagrams for power and control wiring required for final installation of condensing units and controls. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

C. Operation and Maintenance Data: Submit maintenance data and parts list for each air cooled condenser, control and accessory; including "trouble shooting" maintenance guide; plus servicing and preventative maintenance procedures and schedule. Include this data and product data in maintenance manual; in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of condensers, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. Capacity ratings for air cooled condensers shall be in accordance with ARI Standard 360 "Standard for Unitary Air Conditioning Equipment."

2. Refrigeration system of air cooled condensers shall be constructed in accordance with ASHRAE Standard ASHRAE 15 "Safety Code for Mechanical Refrigeration."

3. Air cooled condensers shall meet or exceed the minimum COP/Efficiency levels as prescribed in ASHRAE 90A "Energy Conservation in New Building Design."

4. Air cooled condensers shall be listed by UL and have UL label affixed.

1.5 DELIVERY, STORAGE AND HANDLING

A. Handle air cooled condensers and components carefully to prevent damage. Follow manufacturer's written instructions for rigging. Replace damaged air cooled condensers or components.

B. Store air cooled condensers and components in clean, dry place off the ground. Protect from weather, water and physical damage.

PART 2 - PRODUCTS

2.1 AIR COOLED CONDENSERS

A. Available Manufacturers: Subject to compliance with requirements, provide air cooled condensers from one of the following:

Carrier Air Conditioning; Div of Carrier Corp.
McQuay Air Conditioning Group; McQuay Inc.
Trane Co; Div American Standard Inc.
York; Div of York International.
Ruud Industries Inc.

B. General: factory assembled and tested, air cooled condensers, consisting of casing, condenser coils, condenser fans and motors, and unit controls. Capacities and electrical characteristics are scheduled at the end of this Section.

C. Unit Casings: designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to controls, condenser fans, motors, and drives. Additional features include:

1. Steel, galvanized or zinc coated, for exposed casing surfaces, treated and finished with manufacturer's standard paint coating.

2. Lifting lugs to facilitate rigging of units.

3. Factory installed metal grilles, for protection of condenser coil during shipping, installation, and operation.

4. Hinged and gasketed control panel door.

D. Controls: Operating and safety controls shall include condenser fan motors thermal and overload cutouts. Control transformer if required shall be 115v. Provide magnetic contactors for condenser fan motors, and an unfused disconnect switch which is factory mounted and wired for single external electrical power connection.

E. Condensing Section: Condenser coil shall be seamless copper tubing mechanically bonded to heavy-duty, configurated aluminum fins. Units shall include liquid accumulator and subcooling circuit, and back-seating liquid line service access valve. Condenser coils shall be factory tested at 450 psig, vacuum dehydrate, and filled with a holding charge of nitrogen.

F. Condenser fans and drives: propeller type condenser fans for vertical air discharge; either direct drive or belt drive. Additional features include:

Permanent lubricated ball bearing condenser fan motors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install condensing 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. Support:
1. Install ground mounted units on 4" thick reinforced concrete pad, 4" larger on each side than condensing unit. Concrete is specified in Division 3. Coordinate installation of anchoring devices.
2. Connect precharged refrigerant tubing to unit's quick connect fittings. Run tubing so as not to interfere with access to unit.

3.2 FIELD QUALITY CONTROL

Testing: Charge systems with refrigerant and oil and test for leaks. Repair leaks and replace lost refrigerant and oil.

3.3 DEMONSTRATION

A. Provide services of manufacturer's authorized service representative to provide start-up service and to instruct Owner's personnel in operation and maintenance of condensing units.

B. Start-up condensing units in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

C. Train Owner's personnel on start-up and shut-down procedures, trouble shooting procedures, servicing and preventative maintenance schedule and procedures. Review with the Owner's personnel the data contained in the Operating and Maintenance Manuals specified in Division 1.

Schedule training with Owner, provide at least 7 days prior notice to Architect/Engineer.

END SECTION 23 63 13

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SECTION 23 72 23 – ENERGY RECOVERY UNIT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 govern work under this section.

B. Division 23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.2 DESCRIPTION OF WORK

A. Extent of energy reclaim work required by this section is indicated on drawings and schedules and by requirements of this section.

B. Types of unit specified in this section include the following:

Enthalpy exchange device

C. Refer to other Division 23 sections for insulation of heat reclaim ducts; not work of this section.

D. Refer to other Division 23 sections for hangers, specialties and controls required in conjunction with energy recovery ventilators; not work of this section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of heat reclaim devises, of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Sensible and latent recovery efficiencies must be clearly documented through a certification program conducted in accordance with ARI 1060 standards. Unit shall be UL listed and rated for plenum installation complying with NFPA 90A for flame/smoke rating.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for energy recovery ventilators including performance data, materials, dimensions, weights and installation data. Independent wheel testing to document that the desiccant material utilized does not transfer pollutants typically encountered in the indoor air environment shall be provided from a credible test laboratory. The cross-contamination and performance certification reports must be provided for engineering review as part of the submittals for this project.

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 the energy recovery ventilator. Include this data in maintenance manual.

1.5 PRODUCTS DELIVERY, STORAGE AND HANDLING

A. Handle energy recovery ventilators carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.

B. Store energy recovery ventilators in clean dry place. Protect from weather, dirt, fumes, water and construction debris and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading energy recovery ventilators and moving them to final location.

PART 2 - PRODUCTS

2.1 ROOF MOUNTED FIXED PLATE ENTHALPY ENERGY RECOVERY UNIT

A. Energy Transfer: The ERV shall be capable of transferring both sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one air stream to the other, without exposing transfer media in succeeding cycles directly to the exhaust air and then to the fresh air.

1. Passive Frost Control: The ERV core shall perform without condensing or frosting under normal operating conditions (defined as outside temperatures above -10°F and inside relative humidity below 40%). Occasional more extreme conditions shall not affect the usual function, performance or durability of the core. No condensate drains will be allowed.

2. Positive Airstream Separation: Water vapor transfer shall be through molecular transport by hydroscopic resin and shall not be accomplished by “porous plate” mechanisms. Exhaust and fresh airstreams shall travel at all times in separate passages, and airstreams shall not mix.

B. Construction: The energy recovery component shall be of fixed-plate cross-flow construction, with no moving parts. No condensate drain pans or drains shall be allowed and unit shall be capable of operating in both winter and summer conditions without generating condensate.
1. The unit case shall be constructed of G90 galvanized, 20-gauge steel, with lapped corners and zinc plated screw fasteners. The unit roof shall be one piece or have watertight standing seam joints and shall overlap wall panels and doors in order to positively shed water.
2. Access doors shall provide easy access to blowers, ERV cores, and filters. Doors shall have an airtight compression seal using closed cell foam gaskets rated for outdoor exposure. Pressure taps, with captive plugs, shall be provided allowing cross-core pressure measurement allowing for accurate airflow measurement.
3. Weatherhoods shall be screened to exclude birds and animals. Inlet weatherhoods shall be sized to maintain inlet velocities below 500 fpm, and equipped with rain excluder

baffles.

4. Case walls and doors shall be insulated with 1 inch, 4 pound density, foil/scrim faced, high-density fiberglass board insulation, providing a cleanable surface and eliminating the possibility of exposing the fresh air to glass fibers, and with minimum R-value of 4.3 (hr·ft2·°F/BTU).

C. The ERV cores shall be protected by a MERV-8 rated, 2" nominal, pleated, disposable filter in both airstreams.
D. Unit shall have single-point power connection and a single-point 24 VAC contactor control connection
E. Blower motors shall be EISA compliant for energy efficiency with open drip proof design and integral thermal protection.
F. Blowers shall be quiet running, forward curve type and be direct drive..
G. The unit electrical box shall include a factory installed, non-fused disconnect switch and a 24 VAC, Class II transformer/relay package.
H. Provide unit and duct connection orientation per project schedule.
I. Units are available single or three phase at a full range of operating voltages. See project schedule.
J. Provide motor horsepower as specified in project schedule.
K. Provide factory installed disconnect fuses.
L. Provide factory installed filter monitors for each airstream.
M. Provide 14 inch high, non-pitched roof curbs as available from the factory.
N. Manufacturer: Subject to compliance with requirements, provide centrifugal fans of one of the following: RenewAire; or approved equal.

2.2 ROOF MOUNTED ENTHALPY WHEEL ENERGY RECOVERY UNIT

A. CASING - Standard panels shall be 20 gauge galvanized solid exterior skins, lined with 1/2-inch thick synthetic rubber insulation. The housing shall be supported by structural base that forms a pan to ensure weather tight construction. Lifting holes shall be provided at the unit base. Units shall have a one piece weatherproof sheet metal roof. A galvanized steel sheet metal weather hood shall protect the outdoor air intake opening. The exhaust air discharge shall be covered with a gravity backdraft damper and a galvanized steel sheet metal weather hood. The exhaust air discharge shall be covered with a gravity backdraft damper and a galvanized steel sheet metal weather hood. The exterior of the unit shall be coated with a two-part epoxy painting system for corrosion protection. Indoor unit casing less intake and exhaust weather hoods.

B. ACCESS - Access to components shall be provided through a large, tightly sealed and easily removable access panel. Access panels shall be constructed of the same materials as the unit casing and use manufacturer's standard hardware. The wheel cassette shall be easily removable for access.

C. UNIT CONFIGURATION - The supply air inlet and exhaust air outlet must be oriented to maximize the distance between the two airstreams in order to minimize the risk of short circuiting the exhaust air into the supply air intake.

D. TOTAL ENERGY WHEEL - The energy recovery wheel shall be manufactured by SEMCO. The media shall be a fluted, honeycomb design to provide for laminar flow, to prevent the leakage of the exhaust air to the supply air through the media, and to allow for the use of a purge section to minimize contaminant carry-over. The rotor media shall

be made of aluminum that is coated with a non-migrating, 4A molecular sieve desiccant, specifically developed for the selective transfer of water vapor. Verification in writing shall be presented from the desiccant manufacturer confirming that the internal pore diameter distribution inherent in the desiccant being provided limits adsorption to materials having kinetic diameter of 4 angstroms or less. All media surfaces shall be coated with a non-migrating solid adsorbent layer prior to being formed into the honeycomb media structure to insure that all surfaces are coated and that adequate latent capacity is provided. Desiccant coatings that are sprayed on or dip coated, or desiccants that must be reapplied over time are not acceptable. Equal sensible and latent recovery efficiencies shall be provided, and clearly documented through a certification program conducted in accordance with ASHRAE 84 and ARI 1060 standards. The media shall be cleanable with low temperature steam, hot water or light detergent, without degrading the latent recovery. (USE 3A SEIVE IF GAS REMOVAL REQUIRED)

Wheel media shall be independently tested to document a flame spread of less than 25 and a smoke generation rating of less than 50 when tested in accordance with ASTM E-84. This independent wheel test data shall be provided as part of the submittal.

E. ROTOR HOUSING: The rotor housing shall be a structural framework that limits the deflection of the rotor due to air pressure. The housing shall be made of galvanized steel to prevent corrosion. The rotor cassette shall be a structural framework, which limits the deflection of the rotor due to air pressure. The housing shall be made of galvanized steel to prevent corrosion. The rotor cassette shall be easily removable from the Energy Recovery Unit to facilitate rigging (if necessary) and case of service. The wheel cassette design shall use flange bearings for long life. The casing design shall also incorporate a purge to limit contaminant carry-over.

F. FANS- Fan ratings are based on tests made in accordance with AMCA Standard 210. Fans shall be DWDI, designed with a scroll type housing. Fan blades shall be statically and dynamically balanced and tested prior to shipment. Fans shall be driven by multiple speed direct drive motors located at the fan inlet or by fixed speed motors using belts and sheaves.

G. PRE-FILTERS - The filter media shall be an average efficiency of 25-30% based upon the ASHRAE Test Standard. The filters shall be listed by Underwriters Laboratories as class 2.

H. ELECTRICAL - Unit shall require a single point power connection with a voltage as listed on the schedule. The electrical panel shall include the necessary components and contactors to start and stop the system from a remote location if desired. The wheel may also be stopped from a remote location for economizer operation, independent of the supply and exhaust fans.

I. ACCEPTABLE MANUFACTURERS: The ventilation recovery unit shall be a packaged ventilation unit as scheduled by listed manufacturer or approved equal. The energy recovery/ventilation system shall be a complete factory package. Where they are connected each other, minimal ductwork or transitions shall be required between the rooftop unit and the recovery device. The energy recovery ventilation unit shall perform as specified or demonstrate similar energy performance, latent and sensible. Energy Recovery units shall be outdoor air pre-conditioner with components indicated. Silica gel media is not acceptable.

PART 3 - EXECUTION

3.1 INSPECTION

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

B. Install reclaim wheel into system per manufacturer's recommendations. Provide vibration isolation at suspension rods and duct connections.

3.2 ADJUSTING AND CLEANING

A. Cleaning: Clean factory finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch up paint.

3.3 INSTALLATION OF ENERGY RECOVERY UNITS

A. General: Attach units to associated air handling units or mount independently on roof or in building as indicated on drawings.

B. Support: Install and secure energy recovery units on curbs or from structure, as indicated on drawings. Provide for manufacturer’s recommended clearance for maintenance and inspection.

C. Electrical Connections: Refer to Division 16 sections for electrical connections for equipment for final connections to equipment and installation of loose shipped electrical components.

END SECTION 23 72 23

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SECTION 23 74 14 – LARGE PACKAGED ROOFTOP UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 & Division 23 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Extent of air handling unit work is indicated by drawings and schedules and by requirements of this section. Each unit is defined to include (but not by way of limitation) casing, fan, high efficiency motor, cooling and heating coils, gas furnace section, operating and safety controls, drip pan, humidifiers, thermal insulation, filter, access sections and access doors. Refer to schedule on drawings.

B. Refer to other Division 23 sections for gas piping required in connection with packaged air handling units; not work of this section.

C. Refer to other Division 23 control systems sections for control work required in conjunction with air distribution equipment; not work of this section.

D. 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 fan motor. Include starters, disconnects and required electrical devices, except where specified as furnished or factory installed, by manufacturer.
2. Interlock wiring between fan units; and between fans and field installed control devices.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's specifications for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, gages and finishes of materials and installation instructions. Include sound data where specified.

B. Shop Drawings: Submit shop drawings detailing the manufacturer's electrical requirements for power supply wiring for rooftop units. 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. Provide manufacturer’s standard color chart for color selection by Architect.

C. Operation and Maintenance Data: Submit maintenance data and parts list for each rooftop units, including "trouble shooting" maintenance guide, servicing guide and preventative maintenance in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of rooftop air handling units and other specified equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. AMCA Compliance: Test and rate air handling units in accordance with AMCA standards.
   2. ASHRAE Compliance: Construct and install refrigerant system and coils in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration". Energy Efficiency Ratio (EER) of rooftop units shall be equal to or greater than prescribed by ASHRAE 90A "Energy Conservation in New Building Design".
   3. ARI Compliance: Test and rate air handling units in accordance with ARI 430 "Standard for Central Station Air Handling Units", display certification symbol on units of certified models.
      a. Testing and rating of rooftop units of 135,000 BTU/hour capacity or over shall be in accordance with ARI 360 "Standard for Commercial and Industrial Unitary Air Conditioning Equipment".
      b. Testing and rating of rooftop units under 135,000 BTU/hour capacity shall be in accordance with ARI 210 "Standard for Unitary Air Conditioning Equipment", and provide Certified Rating Seal.
      c. Sound testing and rating of units shall be in accordance with ARI 270 "Standard for Sound Rating of Outdoor Unitary Equipment". Units shall bear Certified Rating Seal.
   4. NFPA Compliance: Provide air handling unit internal insulation having flame spread rating not over 25 and smoke developed rating no higher than 50; and complying with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".
   5. UL and NEMA Compliance: Provide electrical components required as part of air handling units, which have been listed and labeled by UL and comply with NEMA Standards. Rooftop units shall be designed, manufactured, and tested in accordance with UL requirements. Rooftop units shall be listed by UL and have UL label as a unit.
   6. NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of air handling units.
   7. AGA Compliance: Gas fired furnace section construction shall be in accordance with AGA safety standards. Furnace section shall bear the AGA label.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle rooftop units and components carefully. Replace damaged rooftop units or components with new.

B. Store rooftop units and components in clean dry place, off the ground, and protect from weather, water, and physical damage.

C. Rig rooftop units to comply with manufacturer's rigging and installation instructions for unloading rooftop units, and moving them to final location.

1.6 SCHEDULING AND SEQUENCING

A. Coordinate installation of roof mounting curb or framing with roof structure.

B. Coordinate roof opening locations, structural requirements, and for mechanical and electrical connections.

1.7 WARRANTY

A. Warranty on Parts (1 year), Compressor (5 year) and Heat Exchanger (10 year): Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors and heat exchangers with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

Warranty Period: Starts on date of substantial completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide units of one of the following: AAON; Carrier Air Conditioning; McQuay Inc.; Johnson Controls; Lennox; Trane Co; or approved equal.

2.2 ROOFTOP UNITS

A. General: Provide factory fabricated and factory-tested air handling units as indicated, of sizes and capacities as scheduled, and as specified herein. Unit shall be completely factory assembled and tested and shipped in one piece. Refer to schedules on drawings for capacities and additional control and accessory requirements specific to this project.

B. Casings:
1. Unit casing shall be double wall construction with minimum 1" -1 ½ pound density batt-faced insulation. Exterior wall panel shall be minimum 16-gauge galvanized steel having corrosion protection coating and exterior finish. [Interior wall panel shall be minimum of 22-gage galvanized steel with corrosion resistant coating.
2. Casing roof shall be insulated, galvanized, pitched for drainage and gasketed to wall. Unit floor shall be insulated, galvanized, and sloped under the fan/motor assembly, draining into a double-pitched insulated galvanized drain pan under the coils.
3. Provide inlet and exhaust hoods at exterior of unit with bird screens, sized to prevent moisture carryover into unit at specified operating conditions.
4. Casings shall have double wall hinged and gasketed access doors for inspection

and access to internal parts, knockouts for electrical and piping connections and an exterior condensate drain connection and lifting lugs.

5. Provide additional casing sections or extensions as indicated on drawings or as required for proper installation and operating clearances for specified coils, dampers, filters, and other unit devices.

C. Coils:

1. General: Aluminum plate fin and seamless copper tube type. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall have a galvanized steel casing. Coils shall be mounted in the coil casing with same end connections accessible for service. Coils shall be removable from the unit through the roof or through the piping enclosure. Coil section shall be completely insulated.
2. Refrigerant Cooling Coils: Coils shall be minimum (4) row construction with an equalizing type vertical distributor to ensure each coil circuit receives the same amount of refrigerant. Coils shall be proof (450 psig) and leak (300 psig) tested with air pressure under water, then cleaned, dehydrated, and sealed with a holding charge of nitrogen.

D. Dampers:

1. Low leak outside and return air dampers with modulating control shall be provided to adjust airflow. Dampers shall be of parallel blade airfoil design set in a rigid galvanized steel frame with compressible metal jamb seals and vinyl blade edge seals. Outside and return air dampers be provided with independent linkages and actuators.
2. Low leak exhaust discharge damper with gravity relief w/o fan shall be provided to control building pressure during economizer operation.

E. Refrigeration System:

1. Compressor shall be industrial grade, energy efficient direct drive 3600 RPM maximum speed scroll type. The motor shall of a suction gas cooled hermetic design. Compressor shall have centrifugal oil pump with dirt separator, oil sight glass, and oil charging valve.
2. Provide factory installed compressor lockout thermostat to prevent compressor operation at low ambient conditions.
3. Provide coil frost protection compressor unloading based on refrigerant circuit suction temperature to prevent coil frosting with minimum energy usage. As an alternate, factory installed hot gas bypass shall be required on all VAV units to prevent coil frosting

F. Centrifugal Fans:

1. General: Provide centrifugal fans of sizes and arrangements as indicated. Fans shall be double width, double inlet, multiblade type. Fan and motor assembly shall be internally isolated from unit casing with spring isolators furnished and installed by unit manufacturer. Provide 2” vibration isolation springs on supply fans.
2. Wheels: Provide airfoil blades or forward curved blades as scheduled and as required for stable operation.
3. Motors: Provide energy efficient variable frequency motors in accordance with Section 23 05 13 "Electrical Provisions".

4. Drive: Provide V-belt drive with adjustable pitch sheave, selected for midpoint at design conditions. Provide with factory wired variable frequency drives where scheduled.

G. Air Filters:
1. Provide replaceable air filters with holding frames.
2. Provide filters with rated face velocity of 500 fpm, as scheduled. Refer to Section 23 41 00.

H. Gas Heating Section:
1. Provide a complete modulating furnace section with corrosion resistant Stainless steel heat exchanger, forced combustion blower, hot surface ignition system, pre-purge cycle, safety and operating controls.
2. Manual reset at the thermostat shall be required after three unsuccessful ignition attempts. Refer to schedules for fuel type and heating stages required.

I. Temperature Control:
1. Provide terminal strips to allow unit to be controlled by BAS specified in Section 23 09 93 - Automatic Controls Sequences.
2. Control devices shall consist of manufacturer' standard or optional equipment as required to perform specified operations. All control devices shall comply with temperature controls specifications presented in Section 23 09 54 Electric Temperature Control Systems.

J. Electrical:
1. Units shall have a 115 VAC convenience outlet, separately fused, for unit service. Unit power connection shall be through unit cabinet.

K. Roof Curb:
1. Provide an insulated galvanized steel curb with wood nailing strips and gasketing. Curb shall be designed for level installation of the air handling unit.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which air handling 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 AIR HANDLING UNITS

A. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated. Maintain manufacturer's recommended clearances.

B. Support: Install and secure rooftop units on curbs and coordinate structural support, roof penetrations and flashing. Curb installed by general contractor.

C. Controls: Controls system devices and interface wiring to accomplish controls sequence of operations presented in Section 23 09 xx shall be installed by unit manufacturer. All

control devices shall comply with requirements of Section 23 09 xx.

D. Electrical Connections: Refer to Division 26 sections for electrical connections for equipment for final connections to equipment and installation of loose shipped electrical components.

3.3 DEMONSTRATION

A. Start-Up Services: Provide the services of a factory authorized service representative to start-up units in accordance with manufacturer's written instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Operating and Maintenance Training: Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall include start-up and shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. Review operating and maintenance data contained in the Operating and Maintenance Manuals specified in Division 1. Schedule training with Owner, provide at least 7-days prior notice to the Architect/Engineer.

C. Piping Connections: Refer to Division 23 HVAC sections. Provide piping, valves, accessories, gages, supports, and flexible connectors as indicated.

D. Duct Connections: Refer to Division 23 air distribution section. Provide ductwork, accessories, and flexible connections as indicated.

E. Grounding: Provide positive equipment ground for air handling equipment components.

3.4 FIELD QUALITY CONTROL

A. Testing: Upon completion of installation of air handling units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, than retest to demonstrate compliance.

3.5 EXTRA STOCK

A. Provide one complete extra set of filters for each air handling unit. Install new filters at completion of air handling system work, and prior to testing, adjusting, and balancing work. Obtain receipt form Owner that new filters have been installed.

B. Provide one spare set of belts for each belt-driven air handling unit, obtain receipt from Owner that belts have been received.

C. Provide fixed sheave to replace adjustable pitch pulley. Sheave shall be sized by balancing contractor.

END SECTION 23 74 14

DIVISION 23 -HVAC
SECTION 23 81 26 – PACKAGED AIR CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 and Division 23 shall govern work under this section.

1.2 DESCRIPTION OF WORK

A. Provide air distribution equipment as indicated on drawings or on specifications including centrifugal fans. Types of equipment included herein includes the following:

Split System Air Conditioners Through Wall Packaged Air Conditioners

B. Extent of split system HVAC equipment work is indicated by drawings and schedules and by requirements of this section. Each packaged split system is defined to include (but not by way of limitation) air-cooled condensing unit, evaporator unit, casings, fans, motors, coils, condensate drain/pump, thermal insulation, filter, internal vibration isolation, condensate and refrigerant piping, controls, and accessories. Refer to schedule on Drawings.

C. Through wall packaged air conditioning units consists of hermetic compressor, an air-cooled coil, propeller-type condenser fan, and control box.

D. Refer to Division 26 sections for the following work; not work of this section. Power supply wiring from power source to power connections on units. Include starters, disconnects and required electrical devices, except where specified as furnished or factory installed, by manufacturer.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of packaged air handling units with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
1. AMCA Compliance: Test and rate units in accordance with AMCA standards.
2. ARI Compliance: Unit will be rated in accordance with the latest edition of ARI Standard 210/240 and 310.
3. ASHRAE Compliance: Construct and install refrigerant coils in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
4. NFPA Compliance: Provide unit internal insulation having flame spread rating not over 25 and smoke developed rating no higher than 50; and complying with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating

Systems".

5. UL and NEMA Compliance: Provide electrical components required as part of air handling units, which have been listed and labeled by UL and comply with NEMA Standards.
6. NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of air handling units.

C. Warranty: The units shall have manufacturer's parts and defects warranty for a period of one year from date of installation. The compressor shall have a warranty of 5 years minimum from date of installation not including labor.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's specifications for units showing dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, finishes of materials and installation instructions, including all accessories. Provide sound data where specified.

B. Shop Drawings: Submit assembly type shop drawings showing unit dimensions, construction details and field connection details.

C. Maintenance Data: Submit maintenance instructions, including lubrication instructions, motor and drive replacement and spare parts lists. Include this data in maintenance manuals.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver units in factory fabricated protective containers.

B. Handle units carefully to avoid damage to components, enclosures and finish. Do not install damaged components; replace and return damaged components to unit manufacturer.

C. Store units in a clean, dry place and protect from weather and construction traffic.

PART 2 - PRODUCTS

2.1 PACKAGED SPLIT SYSTEM HVAC UNITS

A. Manufacturer: Subject to compliance with requirements, provide units of one of the following: Carrier; Mitsubishi; Sanyo; or approved equal.

B. General: Provide factory fabricated and factory tested units as indicated, of sizes and capacities as scheduled, and as specified herein. Minimum SEER to be 13.0 for system.

C. Compressor/Condensing Unit: Hermetically sealed using R-410a or R-134a, with built-in overloads and vibration isolation. Pre-charged unit weatherproof construction, motor, fan, copper-aluminum condenser coil, compressor, accumulator, crank case heater, and microprocessor. Provide baked-enamel finish in manufacturer's standard color.

D. Evaporator Unit: Pre-charged unit of capacity indicated on Drawings with multi-speed centrifugal fan/motor, copper tube / aluminum fin evaporator coil, and adjustable air discharge outlets. Include 1" disposable filter and drain pump with integral reservoir and level sensor capable of lifting condensate 20". Cabinet of heavy gauge galvanized steel with sound and thermal insulation. Removable panels for access. Provide suspended, wall, ceiling, or floor, mounted as indicated on Drawings. Provide baked-enamel finish in manufacturer's standard color.

E. Refrigerant Piping: Precharged (pre-insulated) piping set with valves, insulation, and accessories, piping sized to match capacity of system and length of run.

F. Controls: Provide wall mounted temperature sensor with LED display and microprocessor controller to cycle the system to maintain setpoint, display diagnostic functions, and control head pressure during low ambient conditions.

2.2 THROUGH WALL PACKAGED AIR CONDITIONERS

A. Manufacturer: Subject to compliance with requirements, provide units of one of the following: GE, Freidrich, LG; or approved equal.

B. Air Conditioner: Factory assembled, single piece, air-cooled air conditioner unit. Contained within the unit enclosure is all factory wiring, piping, controls, compressor, refrigerant charge (R-410A) and special features required prior to field start up.

C. Unit Cabinet: Wall sleeve shall be constructed of 18-gauge galvanized zinc-coated steel. Provide condenser wall grille integral to the unit.

D. Indoor section shall consist of a tangential blower wheel direct driven by a totally enclosed motor, 1-phase type with class B insulation and permanently lubricated bearings.

E. Include an electric resistance heater element for space heating, sequenced by the packaged unit thermostat.

F. The front cover shall incorporate air filters conveniently mounted in the front of the unit. The filters shall be made of anti-microbial material. The filters shall be washable and reusable.

5. Compressor will be hermetically sealed and compressor will be mounted on rubber vibration isolators.

6. Condenser coil will be air cooled and coil will be constructed of aluminum fins mechanically bonded to copper tubes which are then cleaned, dehydrated, and sealed.

7. Refrigeration Components: Refrigeration circuit components will be included liquid-line front-seating shutoff valve with sweat connections, vapor-line front-seating shutoff valve with sweat connections, system charge of R-410A refrigerant, and compressor oil and unit will be equipped with high-pressure switch, low pressure switch and filter drier.

8. Controls: The unit shall be controlled by a unit mounted thermostat.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which 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 PACKAGED SPLIT SYSTEM HVAC UNITS

A. General: Install units and refrigerant piping where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure the units comply with requirements and serve intended purposes.

B. Coordination: Coordinate with other work including ductwork, floor construction, roof decking and piping as necessary to interface installation of units with other work.

C. Access: Provide access space within and around units for service as indicated but in no case less than recommended by manufacturer.

D. Support: Install condensing units on curb or pad, as indicated on Drawings

E. Mounting: Mount evaporator units on ceiling grid, on wall, on floor, or suspended in space, as indicated on Drawings. Maintain required access to unit.

F. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical Installer.

G. 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.

H. Piping Connections: Install piping, valves, accessories, gages, supports, and flexible connectors as indicated and recommended by manufacturer.

I. Grounding: Provide positive equipment ground for unit components.

3.3 INSTALLATION OF THROUGH WALL PACKAGED AIR CONDITIONERS

J. General: Install units and refrigerant piping where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure the units comply with requirements and serve intended purposes.

K. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical Installer.

L. 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.

M. Grounding: Provide positive equipment ground for unit components.

3.4 FIELD QUALITY CONTROL

A. Testing: Upon completion of installation of units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, than retest to demonstrate compliance. Verify that clean filters have been installed in unit prior to system balancing.

END SECTION 23 82 26

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DIVISION 26 - ELECTRICAL
SECTION 26 00 00 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

B. Refer to Division 7 – Through-Penetration Fire Stop Systems, for sealing requirements at penetrations of fire rated surfaces.

1.2 CODES AND PERMITS

A. Perform all work in strict accordance with the requirements of the State of Wisconsin Electrical Code and State of Wisconsin Energy Code. Requirements outlined therein shall be minimum as related to this work.

B. Arrange for Code required inspections and pay for same if not covered by permit costs. Include costs and submittal for required reviews of the fire alarm and detection systems as required by the authority having jurisdiction (AHJ).

C. Arrange and pay for required meter deposits and utility extension costs.

1.3 WORK PRIORITY AND COORDINATION

A. Contractor, his mechanics and subcontractors shall cooperate with all others so construction may proceed without hindrances and in all cases to the best interests of the Owner. Confer with others regarding any work that may affect this work and arrange piping, ductwork, equipment, etc. in proper relation to that of others. Coordinate prior to installation the arrangement of electrical work as related to plumbing, HVAC and general construction work.

B. Electrical Contractor shall be responsible for any coordination required with the utility for any of the services described above and any coordination required with the Telephone Company for telephone services both temporary and permanent. Madison Gas and Electric Company (MG&E) will be providing power for this project. All work shall be done in compliance with all utility requirements.

1.4 DEMOLITION WORK

A. Demolition of all existing equipment, light fixtures, conduit, etc. is a part of the work for this project. Contractor shall visit the site and thoroughly examine all existing conditions of all buildings, structures and other miscellaneous electrical equipment on the site of the new construction for this project. This demolition work shall include the removal of existing light fixtures (type F1) that are being reused for this project. Remove fixtures and store in a dry, protected location until they are ready for reinstallation. Turn over to

Owner all fixtures that are not needed for this project. Provide all required work necessary for removal of existing services and removal of all existing unused components. Contact MG&E and coordinate the removal of all existing electric services that are presently on site that will not be reused.

B. Contractors shall notify the Architect at least 10 days prior to the bid closing date of any deviations or required changes that are noticed. No allowance for additional costs for work related to existing conditions will be permitted after bidding unless proof of hidden work, breakage or damage could not be determined by inspection or examination by the Contractor.

1.5 TEMPORARY ELECTRIC SERVICE

A. Include in project scope a temporary electric service to serve the tent pavilions that will be used during the construction period. Service shall be a 480/277 volt three phase, four wire, 400 amp service shall that will terminate with a weather head on a 30 foot pole at a location determined by Owner. Include metering equipment as required by MG&E. Verify locations and other requirements with the Owner on the site. Weather head and pole can be used to serve the permanent service required by this project.

1.6 DRAWINGS

A. The drawings are schematic in nature indicating the general location of all electrical equipment and devices. While the sizes and locations have been indicated, the Contractor shall properly adjust his work to meet conditions as they actually exist on the premises. Equipment and devices shall provide adequate and acceptable clearance for entry, servicing and maintenance. Minor adjustments shall be discussed with the Engineer with the view to convenience of operation and noninterference with other work. The Engineer reserves the right to change the location of any conduit, device or piece of equipment to suit conditions, with no added cost to the Owner if the requested change does not modify the scope of work. Should the particular equipment which any contractor proposes to install require other space conditions, other utility service, or other structural support than those indicated on the drawings, the Contractor shall arrange for such changes with other affected Contractors and with the Architect. Required changes shall be noted on the submittal cover sheet. Should changes become necessary the Contractor shall make such changes at his expense.

1.7 SUBMITTALS

A. Furnish shop drawings on items as indicated in individual sections including switchgear, emergency generator system equipment, devices, fixtures, fire stopping, fire alarm equipment, and other miscellaneous equipment. Submit at least 6 copies for review which represents (2) copies for A/E, (1) copy for owner review, (2) copies for O&M manuals, (1) copies for other Prime Contractors plus (1) copy to be returned to contractor. The contractor acknowledges its responsibility to submit complete shop drawings and other required submittals. Incomplete submittals will be returned to the contractor unreviewed. No time extensions or cost increases will be allowed for delays caused by return of incomplete submittals. Shop drawings for equipment which are noted as being reviewed by Architect or his Engineer shall not supersede Contract Documents or relieve Contractor from responsibility for deviations from the Contract Documents.

B. Furnish 3 sets of standard operating instructions and complete repair parts lists for the

Owner for items of equipment and controls. Also include a summary of maintenance procedures required monthly, yearly, etc. for all equipment. Submit in binders to Engineer for approval.

1.8 HOUSEKEEPING

A. This Contractor shall periodically remove debris caused by his operations. On completion he shall remove all debris from his work and leave same neat and clean, ready for use by the Owner.

1.9 PROTECTION OF MATERIALS AND EQUIPMENT

A. Materials and equipment shall be protected at all times. This Contractor shall be responsible for all damage caused directly or indirectly by his workmen. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical injury. Protection of lighting equipment is especially important, do not install any lighting equipment while the possibility of soiling exists or if installation must be done to maintain schedule include protective covering for equipment. At the completion of all work, the equipment shall be thoroughly cleaned and delivered to the Owner in a condition satisfactory to the Engineer.

B. Equipment shall not be used during construction unless approved in writing by the Engineer. Equipment used during construction shall be returned to the original condition, which may include such items as replacing lamps, cleaning lenses, and replacing damaged devices.

1.10 PAINTING

A. All equipment shall have manufacturer's standard baked enamel finish and shall not be job painted "unless otherwise specified". Equipment in finished rooms shall have color selected by Engineer from manufacturer's standard colors. All required touch up painting of pre-finished surfaces by this Contractor.

1.11 ELECTRICAL IDENTIFICATION

A. Every piece of equipment, starters, disconnect, etc. shall be stenciled with identifying number and area or rooms served, neatly printed and applied on or near item as approved by Engineer. Motors and equipment nameplates and applicable UL labels shall be in place, free from dirt, grease or paint when Project is turned over to Owner. Also see section 26 05 00, Identification.

B. Junction boxes above the suspended ceiling, and six inches of the conduit entering the j-boxes shall be painted to identify these systems:

Fire Alarm	Red
Life Safety Power	Blue
Emergency Equipment	Green
Critical Branch Power	Yellow
Security	Orange

C. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 6 to 8 inches below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches, overall, use a single line marker. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:

1. Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend that indicates type of underground line.

1.12 INSTRUCTIONS

A. The Contractor shall review with the Owner's representative complete operating and maintenance procedures for equipment and systems installed under this contract. Provide 2 days of instructions during normal working hours when systems are fully operational and before final payment.

PART 2 - PRODUCTS

2.1 QUALITY REQUIREMENTS

A. Items indicated on the drawings and in the specifications are listed by manufacturer in order to describe minimum quality requirements.

B. Materials and equipment shall conform to requirements of Wisconsin Administrative Code.

C. All materials and equipment furnished shall be new and shall be the standard products of manufacturers regularly engaged in the production of Electrical and Fire Alarm materials and equipment.

+END SECTION 26 00 00

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including applicable provisions of Division 1 shall govern work under this section.

1.2 SUMMARY

A. This Section includes the following:

1. Raceways.
2. Building wire and connectors.
3. Supporting devices for electrical components.
4. Electrical identification.
5. Electricity-metering components.
6. Concrete equipment bases.
7. Cutting and patching for electrical construction.
8. Touchup painting.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For electricity-metering equipment.

B. Shop Drawings: Dimensioned plans and sections or elevation layouts of electricity-metering equipment.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70,NEC,IBC, State of Wisconsin,local codes and ordinances and any other codes or regulations that might apply to this project.

1.6 COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

C. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. EMT: ANSI C80.3, zinc-coated steel, with set-screw or compression fittings.

B. FMC: Zinc-coated steel.

C. IMC: ANSI C80.6, zinc-coated steel, with threaded fittings.

D. LFMC: Zinc-coated steel with sunlight-resistant and mineral-oil-resistant plastic jacket.

E. RNC: NEMA TC 2, Schedule 40 PVC, with NEMA TC3 fittings.

F. Raceway Fittings: Specifically designed for the raceway type with which used.

2.2 CONDUCTORS

A. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.

B. Conductors, Larger Than No. 10 AWG: Stranded copper.

C. Insulation: Thermoplastic, rated at 75 deg C minimum.

D. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

2.3 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- diameter slotted holes at a maximum of 2 inches o.c., in webs.

D. Slotted-Steel Channel Supports: Comply with Division 5 Section "Metal Fabrications" for slotted channel framing.

1. Channel Thickness: Selected to suit structural loading.
2. Fittings and Accessories: Products of the same manufacturer as channel supports.

E. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch-diameter holes at a maximum of 8 inches, in at least one surface.

1. Fittings and Accessories: Products of the same manufacturer as channels and angles.
2. Fittings and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

H. Expansion Anchors: Carbon-steel wedge or sleeve type.

I. Toggle Bolts: All-steel springhead type.

J. Powder-Driven Threaded Studs: Heat-treated steel.

2.4 ELECTRICAL IDENTIFICATION

A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Raceway and Cable Labels: Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway and cable size.

1. Type: Pretensioned, wraparound plastic sleeves. Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the item it identifies.
2. Type: Preprinted, flexible, self-adhesive, vinyl. Legend is overlaminated with a clear, weather- and chemical-resistant coating.
3. Color: Black letters on orange background.
4. Legend: Indicates voltage.

C. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick.

D. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:

1. Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend that indicates type of underground line.

E. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

F. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.

G. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch minimum thickness for signs up to 20 sq. in. and 1/8-inch minimum thickness for larger sizes. Engraved legend in black letters on white background. Special multiple service signs as required by N.E.C. Article 230.1(E) shall have minimum 1” engraved white letters on a red background.

H. Interior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.

I. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch, galvanized-steel backing, with colors, legend, and size appropriate to the application. 1/4-inch grommets in corners for mounting.

J. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.5 EQUIPMENT FOR UTILITY COMPANY'S ELECTRICITY METERING

A. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.

B. Meter Sockets: Comply with requirements of electrical power utility company.

2.6 CONCRETE BASES

A. Concrete Forms and Reinforcement Materials: As specified in Division 3 Section "Cast-in-Place Concrete."

B. Concrete: 3000-psi, 28-day compressive strength as specified in Division 3 Section "Cast-in-Place Concrete."

C. Provide concrete bases for utility transformers as directed by utility (MG&E).

2.7 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 RACEWAY APPLICATION

A. Use the following raceways for outdoor installations:

1. Exposed: IMC.
2. Concealed: IMC.
3. Underground, Single Run: RNC.
4. Underground, Grouped: RNC.
5. Connection to Vibrating Equipment: LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.

B. Use the following raceways for indoor installations:

1. Exposed: EMT.
2. Concealed: EMT.
3. Connection to Vibrating Equipment: FMC; except in wet or damp locations, use LFMC.
4. Damp or Wet Locations: IMC.
5. Boxes and Enclosures: NEMA 250, Type 1, unless otherwise indicated.

3.3 RACEWAY AND CABLE INSTALLATION

A. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.

B. Install raceways and cables at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.

C. Use temporary raceway caps to prevent foreign matter from entering.

D. Make conduit bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

E. Use raceway and cable fittings compatible with raceways and cables and suitable for use and location.

F. Install raceways embedded in slabs in middle third of slab thickness where practical, and leave at least 1-inch concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.

2. Space raceways laterally to prevent voids in concrete.
3. Install conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. Where conduit is at right angles to reinforcement, place conduit close to slab support.
4. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.
5. Make bends in exposed parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for exposed parallel raceways.

G. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.

H. Install telephone and signal system raceways, 2-inch trade size and smaller, in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements, in addition to requirements above.

I. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72-inch flexible conduit. Install LFMC in wet or damp locations. Install separate ground conductor across flexible connections.

J.Set floor boxes level and trim after installation to fit flush to finished floor surface.

3.4 WIRING METHODS FOR POWER, LIGHTING, AND CONTROL CIRCUITS

A. Feeders: Type THHN/THWN insulated conductors in raceway**.**

B. Underground Feeders and Branch Circuits: Type THWN or single-wire, Type UF insulated conductors in raceway.

C. Branch Circuits: Type THHN/THWN insulated conductors in raceway.

D. Branch Circuits: Type THW or THHN/THWN insulated conductors in raceway where exposed. **Metal-clad cable shall not be used on this project.**

E. Branch Circuits: Type THW or THHN/THWN insulated conductors in raceway where exposed. Armored or nonmetallic sheathed cable where permitted by authorities having jurisdiction and where concealed in ceilings and gypsum board partitions.

F. Remote-Control Signaling and Power-Limited Circuits: Type THHN/THWN insulated conductors in raceway for Classes 1, 2, and 3, unless otherwise indicated.

3.5 WIRING INSTALLATION

A. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

B. Install wiring at outlets with at least 12 inches of slack conductor at each outlet.

C. Connect outlet and component connections to wiring systems and to ground. Tighten electrical connectors and terminals, according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

D. Use compression type connectors for all stranded wire regardless of size.

3.6 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.7 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 1/4-inch-diameter or larger threaded steel hanger rods, unless otherwise indicated. Size as recommended by equipment manufacturer and approved by structural engineer.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
6. Steel: Welded threaded studs or spring-tension clamps on steel.
7. Field Welding: Comply with AWS D1.1.
8. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
9. Light Steel: Sheet-metal screws.
10. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.8 IDENTIFICATION MATERIALS AND DEVICES

A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.

C. Self-Adhesive Identification Products: Clean surfaces before applying.

D. Identify raceways and cables with color banding as follows:

1. Bands: Pretensioned, snap-around, colored plastic sleeves or colored adhesive marking tape. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
3. Colors: As follows:

    a. Fire Alarm System: Red.
    b. Telecommunication System: Green and Yellow.

E. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.

F. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 6 to 8 inches below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches, overall, use a single line marker.

G. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Black.
2. Phase B: Red.
3. Phase C: Blue.

H. Color-code 480/277-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Brown.
2. Phase B: Orange.
3. Phase C: Yellow.

I. Install warning, caution, and instruction signs where required to comply with 29 CFR, Chapter XVII, Part 1910.145, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

J. Install engraved-laminated emergency-operating signs with white letters on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, and other emergency operations.

K. Switchboard main and feeder breakers shall be identified with engraved plastic nameplates with white minimum 1/2” high lettering on a black background.
Include a permanent plaque at each service entrance equipment location warning that there are multiple services serving this facility. Lettering for this sign shall be a minimum of 1” high, white on a red background.

L. Panelboard directories shall be typed and shall indicate type of load and room numbers for location. Panelboard nameplates shall be on front of door for surface panels in unfinished areas and behind door on flush panels in finished areas.

3.9 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.10 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping."

3.11 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.12 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.13 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways.
2. Building wire and connectors.
3. Supporting devices for electrical components.
4. Electrical identification.

5. Electricity-metering components.
6. Concrete bases.
7. Cutting and patching for electrical construction.
8. Touchup painting.

3.14 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.15 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 26 05 00

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

B. Related Sections include the following:

1. Division 26 Section "Control-Voltage Electrical Cables" for transmission media used for control and signal circuits.
2. Division 27 Section “Communications Horizontal Cabling” for cabling used for voice and data circuits.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

C. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged byContractor.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

C. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CONDUCTORS AND CABLES

A. Manufacturers:

1. Alcan Aluminum Corporation; Alcan Cable Div.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

C. Conductor Material: Copper complying with NEMA WC 70; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger, except all circuits serving motors and equipment connections shall be stranded terminated using approved compression type connectors.

D. The use of aluminum conductors for panel feeders only might be considered based on possible cost savings and as approved by Owner. Aluminum conductors will not be considered for any other use. Base bid costs shall be based on the use of all copper conductors.

E. Conductor Insulation Types: Type THW,THHN-THWN, XHHW, complying with NEMA WC 70.

F. Multiconductor Cable: Armored cable, type AC. Type SO and Type USE with ground wire.

G.

2.3 CONNECTORS AND SPLICES

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. Gardner Bender.

3. Hubbell Power Systems, Inc.
4. Ideal Industries, Inc.
5. Ilsco; a branch of Bardes Corporation.
6. NSi Industries LLC.
7. O-Z/Gedney; a brand of the EGS Electrical Group.
8. 3M; Electrical Markets Division.
9. Tyco Electronics.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Insulation displacement and spring type connectors shall be limited to composite factory products (ex. light fixtures) where maximum current shall be 5 amps or less or where indicated on plans.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Type THHN-THWN, single conductors in raceway

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway

C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspaces: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, including in Crawlspaces: Type THHN-THWN, single conductors in raceway

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway

G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

H. Underground Feeders and Branch Circuits: Type UF multiconductor cable.

I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.

J. Fire Alarm Circuits: Type THHN-THWN, in raceway Power-limited, fire-protective**,** signaling circuit cable as recommended by equipment manufacturer and approved by code.

K. Class 1 Control Circuits: Type THHN-THWN, in raceway.

3.2 INSTALLATION

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables and raceways parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Common Work Results for Electrical."

F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."

G. Identify and color-code conductors and cables according to Division 26 Section Common Work Results for Electrical.

H. Derate conductors above roof per NEC Table 310.15(B)(2)(c).

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.4 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

B. Testing: Perform the following field quality-control testing:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

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SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Data: For the following:

1. Ground rods.
2. Connectors, fittings, etc.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

D. Field Test Reports: Submit written test reports to include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. Comply with UL 467.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grounding Conductors, Cables, Connectors, and Rods:

a. Apache Grounding/Erico Inc.
b. Boggs, Inc.
c. Chance/Hubbell.
d. Copperweld Corp.
e. Dossert Corp.
f. Erico Inc.; Electrical Products Group.
g. Framatome Connectors/Burndy Electrical.
h. Ideal Industries, Inc.
i. ILSCO.
j. Harger Lightning Protection Inc.
k. Heary Brothers Lightning Protection Co.
l. Raco, Inc.; Division of Hubbell.
m. Robbins Lightning Inc.
n. Superior Grounding Systems, Inc.
o. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

B. Material: copper-clad aluminum, and copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

E. Grounding Electrode Conductors: Stranded cable.

F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

G. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.

2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

H. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch (6.4 mm) in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

I. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

Ground rods: Copper clad. Size, ¾” diameter by 120”.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.

F. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and circuits.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.

D. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

E. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

F. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

H. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

I. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

J.Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

K. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6.4-by-50-by-300-mm) grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

L. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

3.3 INSTALLATION

A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A [and UL 486B].

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

n

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

    a. Equipment Rated 500 kVA and Less: 10 ohms.
    b. Equipment Rated 500 to 1000 kVA: 5 ohms.
    c. Equipment Rated More Than 1000 kVA: 3 ohms.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.6 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it

as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 32 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 26 05 26

SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
1. Division 7 Section "Through-Penetration Firestop Systems" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
2. Division 26 Section "Common Work Results for Electrical" for supports, anchors, and identification products.
3. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. RMC: Rigid metallic conduit.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible nonmetallic conduit.

H. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.

C. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Design Calculations: Calculate requirements for selecting seismic restraints.
2. Detail assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

D. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
6. LTV Steel Tubular Products Company.
7. Manhattan/CDT/Cole-Flex.
8. O-Z Gedney; Unit of General Signal.
9. Wheatland Tube Co.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

E. Plastic-Coated IMC and Fittings: NEMA RN 1.

F. EMT and Fittings: ANSI C80.3.

1. Fittings: Set-screw or compression type.
2. Fittings: All steel, set screw, water tight, concrete tight. Insulated throat connectors. No push-on or indenter types permitted. Conduit Bodies: All steel threaded conduit bodies (cast white metal type not permitted).

G. FMC: Zinc-coated steel

H. LFMC: Flexible steel conduit with PVC jacket.

I. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers:

1. American International.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.

4. Cantex Inc.
5. Certainteed Corp.; Pipe & Plastics Group.
6. Condux International.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; Division of Hubbell, Inc.
12. Spiralduct, Inc./AFC Cable Systems, Inc.
13. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

E. LFNC: UL 1660.

2.4 METAL WIREWAYS

A. Manufacturer:

1. Hoffman.
2. Square D.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA [1] [3R].

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Screw-cover typeor as indicated on drawings.

F. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS

A. Manufacturers:

1. Hoffman.
2. Lamson & Sessions; Carlon Electrical Products.

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and

fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

E. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

2.6 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating and field paint as directed by the Architect or Owner.

1. Manufacturers:

a. Airey-Thompson Sentinel Lighting; Wiremold Company (The).
b. Thomas & Betts Corporation.
c. Walker Systems, Inc.; Wiremold Company (The).
d. Wiremold Company (The); Electrical Sales Division.

B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.7 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company.
3. Erickson Electrical Equipment Co.
4. Hoffman.
5. Hubbell, Inc.; Killark Electric Manufacturing Co.
6. O-Z/Gedney; Unit of General Signal.
7. RACO; Division of Hubbell, Inc.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet-PLM Division.
10. Spring City Electrical Manufacturing Co.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
14. Strongwell Corp.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Floor Boxes: Cast metal, fully adjustable, rectangular.

F. Floor Boxes: Nonmetallic, nonadjustable, round.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

J.Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.8 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors:

1. Exposed: Rigid steel or IMC.
2. Concealed: Rigid steel or IMC.
3. Underground, Single Run: RNC.
4. Underground, Grouped: RNC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

6. Boxes and Enclosures: NEMA 250, Type 3R or 4.

B. Indoors:

1. Exposed: EMT
2. Concealed: EMT
3. Raceway in all animal holding areas to be RNC. If exposed to physical damage RMC.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations and for motors serving equipment that handles liquids of any type.
5. Damp or Wet Locations: Rigid steel conduit.
6. Boxes and Enclosures: NEMA 250, Type 1, except as follows:

a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel or nonmetallic.

C. Minimum Raceway Size: 3/4-inch trade size (DN 21).

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

3.2 INSTALLATION

A. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Support raceways as specified in Division 26 Section "Common Work Results for Electrical."

D. Install temporary closures to prevent foreign matter from entering raceways.

E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
2. Space raceways laterally to prevent voids in concrete.
3. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
4. Change from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above the floor.

I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.

1. Run parallel or banked raceways together on common supports.
2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

J.Join raceways with fittings designed and approved for that purpose and make joints tight.

1. Use insulating bushings to protect conductors.

K. Tighten set screws of threadless fittings with suitable tools.

L. Terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.

N. Telephone and Signal System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) d

with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

O. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces and between the interior and exterior of the building.
2. Where otherwise required by NFPA 70.

P. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

Q. Flexible Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

R. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

S. Set floor boxes level and flush with finished floor surface.

T. Set floor boxes level. Trim after installation to fit flush with finished floor surface.

U. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 26 05 33

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SECTION 260574 - OVERCURRENT PROTECTIVE DEVICE AND ARC-FLASH STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 SUBMITTALS

A. Submit the following submittals at the same time as the distribution equipment and protective devices submittals.

1. Submittals shall be in digital form.
2. Coordination-study input data including completed program input data sheets.
3. Arc-flash study input data, including completed computer program input data sheets.
4. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
5. The results of the arc flash study shall be reflected in the distribution equipment and system protective device submittals.
6. Overcurrent protective device coordination study report; signed, dated and sealed by a qualified registered professional engineer.
7. The results of the coordination study shall be reflected in the distribution equipment and system protective device submittals.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

B. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

C. Include from the Protective Device Coordination Study Report a one line diagram, protective device coordination study and time-current coordination curves.

1.6 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Arc-Flash Study Specialist and Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, available software developers offering software that may be used for the Work include, but are not limited to, the following]:

1. ESA Inc.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program shall be capable of plotting and diagramming time-current characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer generated, time-current coordination plots.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

1) Voltage.
2) Calculated symmetrical fault-current magnitude and angle.
3) Fault-point X/R ratio.
4) No AC Decrement (NACD) ratio.
5) Equivalent impedance.
6) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
7) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

F. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Working distance.
6. Incident energy.
7. Hazard risk category.
8. Recommendations for arc-flash energy reduction.

G. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. Calculated asymmetrical fault currents:

1) Based on fault-point X/R ratio.
2) Based on calculated symmetrical value multiplied by 1.6.
3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

F. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

a. Phase and Ground Relays:

1) Device tag.
2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:

1) Adjustable pickups and time delays (long time, short time, ground).
2) Adjustable time-current characteristic.
3) Adjustable instantaneous pickup.
4) Recommendations on improved trip systems, if applicable.

c. Fuses: Show current rating, voltage, and class.

G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

a. Power utility's overcurrent protective device.
b. Medium-voltage equipment overcurrent relays.
c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
f. Cables and conductors damage curves.
g. Ground-fault protective devices.
h. Motor-starting characteristics and motor damage points.
i. Generator short-circuit decrement curve and generator damage point.
j. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.
6. Provide adequate time margins between device characteristics such that selective operation is achieved.
7. Comments and recommendations for system improvements.

2.4 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on the device characteristics supplied by device manufacturer.

D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

E. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:

1. Electric utility's supply termination point.
2. Switchgear.
3. Low-voltage switchgear.
4. Motor-control centers.
5. Standby generators and automatic transfer switches.
6. Branch circuit panelboards.

3.3 PROTECTIVE DEVICE COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. The study shall be based on the device characteristics supplied by device manufacturer.

D. Begin analysis at the service and at the generator, extending down to the system overcurrent protective devices as follows:

1. All overcurrent protective devices in all branch circuit panelboards.

E. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

F. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

H. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.

I. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

J. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:

1. Electric utility's supply termination point.
2. Switchgear.
3. Unit substation primary and secondary terminals.
4. Low-voltage switchgear.
5. Motor-control centers.
6. Standby generators and automatic transfer switches.
7. Branch circuit panelboards.
8. <Insert significant locations in the system>.

K. 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 bars to withstand short-circuit stresses.

3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

3.4 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Use the short-circuit study output and the field-verified settings of the overcurrent devices.

C. Calculate maximum and minimum contributions of fault-current size.

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except 240-V ac and 208-V ac systems fed from transformers less than 125 kVA.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.5 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of Architect.

2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Gather and tabulate the following input data to support coordination study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
9. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
10. Motor horsepower and NEMA MG 1 code letter designation.
11. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.6 LABELING

A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:

1. Motor-control center.
2. Low-voltage switchboard.
3. Switchgear.
4. Control panel.

3.7 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.8 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 260574

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following lighting control devices:

1. Time switches.
2. Outdoor and indoor photoelectric switches.
3. Switch-box occupancy sensors.
4. Indoor occupancy sensors.
5. Indoor daylight sensors
6. Outdoor motion sensors.

B. Related Sections include the following:

1. Division 26 Section "Low Voltage Lighting Control" for low-voltage, manual and programmable lighting control systems.
2. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Lighting plan showing location, orientation, and coverage area of each sensor.
2. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.3 TIME SWITCHES

A. Manufacturers:
1. Intermatic, Inc.
2. Leviton Mfg. Company Inc.
3. Paragon Electric Co.
4. Square D.
5. TORK.
6. Watt Stopper (The).

B. Digital Time Switches: Electronic, solid-state programmable units with alphanumeric display complying with UL 917.

1. Contact Configuration: As indicated.
2. Contact Rating: **20-A ballast load, 120/240-V ac**
3. Programs: As indicated on drawings.
   a. For each channel, 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.

4. Circuitry: Allow connection of a photoelectric relay as substitute for on and off function of a program[on selected channels].
5. Astronomical Time: Allchannels.
6. Battery Backup: For schedules and time clock.

2.4 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers:

1. Area Lighting Research, Inc.
2. Fisher Pierce.
3. Grasslin Controls Corporation.
4. Intermatic, Inc.
5. Lithonia Lighting.
6. Novitas, Inc.
7. Paragon Electric Co.
8. Square D.
9. TORK.
10. Touchplate Technologies, Inc.
11. Watt Stopper (The).

B. Description: Solid state, with [SPST] [DPST] dry contacts rated for [1800-VA tungsten or 1000-VA inductive] <Insert value>, to operate connected relay, contactor coils, microprocessor input, and complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc (16 to 108 lx), with an adjustment for turn-on and turn-off levels within that range[**, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off**].
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor type, complying with IEEE C62.41 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.

C. Description: Solid state, with [SPST] [DPST] dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; and complying with UL 773.

1. Light-Level Monitoring Range: 1.5 to 10 fc (16 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
2. Time Delay: 15-second minimum, to prevent false operation.

3. Lightning Arrester: Air-gap type.
4. Mounting: Twist lock complying with IEEE C136.10, with base. Provide with stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.

2.5 INDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers:

1. Allen-Bradley/Rockwell Automation.
2. Area Lighting Research, Inc.
3. Cutler-Hammer; Eaton Corporation.
4. Fisher Pierce.
5. Grasslin Controls Corporation.
6. Intermatic, Inc.
7. Lithonia Lighting.
8. MicroLite Corporation.
9. Novitas, Inc.
10. Paragon Electric Co.
11. Square D.
12. TORK.
13. Touchplate Technologies, Inc.
14. Watt Stopper (The).

B. Ceiling-Mounting Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit mounted on luminaire, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
3. Light-Level Monitoring Range: [**10 to 200 fc (108 to 2150 lx)**] [**100 to 1000 fc (1080 to 10 800 lx)**], with an adjustment for turn-on and turn-off levels within that range.
4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
5. Indicator: Two LEDs to indicate the beginning of on and off cycles.

C. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded, plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit mounted on luminaire, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.

2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
3. Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lx), with an adjustment for turn-on and turn-off levels within that range.
4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
5. Indicator: Two LEDs to indicate the beginning of on and off cycles.

2.6 SWITCH-BOX OCCUPANCY SENSORS

A. Manufacturers:

1. Bryant Electric; a Hubbell Company.
2. Hubbell Lighting Inc.
3. Leviton Mfg. Company Inc.
4. Sensor Switch, Inc.
5. TORK.
6. Unenco Electronics; a Hubbell Company.
7. Watt Stopper (The).

B. Description: PIR type with integral power-switching contacts rated for 800 W at 120-V ac, suitable for incandescent light fixtures, flourescent light fixtures with magnetic or electronic ballasts, or 1/6-hp motors; and rated for 1000 W at 277-V ac, suitable for incandescent light fixtures, flourescent light fixtures with magnetic or electronic ballasts, or 1/3-hp motors, minimum.

1. Include ground wire.
2. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (215 to 2150 lx); keeps lighting off when selected lighting level is present.

2.7 INDOOR OCCUPANCY SENSORS

A. Manufacturers:

1. Hubbell Lighting Inc.
2. Leviton Mfg. Company Inc.
3. Sensor Switch, Inc.
4. TORK.
5. Unenco Electronics; a Hubbell Company.
6. Watt Stopper (The).

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted though a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (215 to 2150 lx); keeps lighting off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch (150-mm) minimum movement of any portion of a human body that presents a target of at least 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving at least 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.8 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying with Division 26 Low-Voltage Electrical Power Conductors and Cable."
B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. **18**AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cable."

C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. **14**AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cable."

D. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cable." Minimum conduit size shall be 1/2 inch (13 mm).

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "[Common Work Results for Electrical] [Identification for Electrical Systems]."

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify actuation of each sensor and adjust time delays.

B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION 26 09 23

SECTION 26 09 25-LOW VOLTAGE LIGHTING CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Applicable provisions of Division 1 shall apply to all work under this Section.

1.2 SUMMARY:

A. Power supplies, control equipment and enclosures and switches.

The low voltage lighting control system shall provide State of Wisconsin Energy Code mandated automatic lighting shut offs. The system shall control lighting zones as indicated on drawings. There will be low voltage switching for over-rides to the off hours lighting shutdown.

The low voltage switches shall have graphic representation of the controlled area. See switch "masking" requirements below. Provide a recessed box with hinged locking waterproof cover for each low voltage switch station indicated on drawing

In addition to the mandated controls, there will be some areas with Day lighting from sky lights where photocells will provide automatic daylight controls for part of lighting serving the space. These daylight sensing devices will be included in base bid and deleted as an alternate bid item. Refer to project bidding requirements.

The building lighting circuits shall be enabled during the owner specified occupied hours. At the end of occupied hours, circuits controlling fluorescent lighting shall provide a "blink" warning 5 minutes (adjustable from 5-15 minutes) before the automatic shut off.

Activation of the over-ride switch for a particular area within the warning period (or at any time during the unoccupied hours) will enable the selected areas lighting circuits to be enabled for an owner selected maximum time of 2 hours. Programmed sweeps, where the "first" over-ride is less than 2 hours are not acceptable.

During occupied hours, over-ride switches shall be able to be "masked" or inoperable.

The lighting control system shall provide switching for exterior fixtures and parking lot fixtures to meet applicable local ordinances and energy codes.

Lighting designated for emergency and night lighting shall be controlled with relays so that when building is being supplied from normal power from the utility fixtures shall be controlled from normal switching functions. If normal power to the building fails and power is provided from the emergency generator relays shall automatically turn all

emergency fixtures on regardless of the previous control mode. Include barriers in relay cabinets to separate emergency wiring from normal wiring. Fixtures designated as night lights shall be controlled separately and shall be capable of manual on-off control or programed control.

1.3 DEFINITIONS

A. ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS:

A. Submit product data under provisions of Division 1 and Division 26. Include compete installation diagrams and drawings that are specific for this project along with equipment shop drawings.

B. Submit samples of graphic representation of controlled area for over-ride switches

1.5 AS-BUILT DRAWINGS:

A. Submit as-built drawings under provisions of Division 1 and Division 26.

B. Accurately record location of switches, power supplies, and control enclosures. Include description of switching and circuiting arrangements.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Division 1 and Division 26.

B. Include replacement part numbers.

PART 2 PRODUCTS

2.1 COMPONENTS

A. The lighting control system design is based on equipment manufactured by LC&D – Acuity Brands. Equipment catalog numbers are indicated on drawings. Equivalent equipment from other manufacturers that meet or exceeds the performance and quality of the listed equipment will be considered for this project.

B. Power Supply: ANSI/NFPA 70; Class 2 energy limited. 120 or 277 volt to 24 volt transformer, rated 75 VA momentary, 40 VA continuous, with silicon rectifier rated 20 amperes intermittent, 7.5 amperes continuous, 30 VAC.

C. Low Voltage Relays: Heavy duty, two-coil momentary contact type remote control relays with contacts rated 20 amperes at 120 or 277 volts and with isolated and non-isolated pilot contacts where indicated. Include clamp type screw terminals for line voltage connections.

D. Switches: Momentary contact, decorator, digital type pushbutton type, of a color as selected by Architect. Switch shall have an integral LED pilot light to indicate status. Pushbuttons shall be engraved to identify zone served.

E. Key Switches: Match non-key switch.

F. All switching devices in areas where livestock is present shall be waterproof as required by NEC, Section 547.

G. Remote Control Interface: System shall be able to operate with remote input on an individual local switching basis.

H. Cabinets and Enclosures: Shop fabricated and wired in accordance with Division 26, "Raceways and Boxes for Electrical Systems". Include appropriate barrier strips for mounting relays and separating energy- limited wiring from line voltage wiring. Include knockouts for relay mounting. Include space for 25 percent minimum additional relays and one additional power supply in each cabinet and enclosure.

I. Include daylight sensing devices as indicated on drawings for control of lighting in interior day lighted areas and exterior mounted luminaires.

J. The entire system shall be capable of interface with building automation system.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field dimensions are as shown on Drawings.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts all conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Use 20 AWG copper conductor building wire in conduit for low voltage wiring.

C. Use remote control and signal cable suitable for purpose above accessible ceilings.

D. Install relays to be accessible. Allow space for adequate ventilation and circulation of air.

E. See drawings for information on wiring and cables.

F. Include the services of a factory trained technician to program system according to Owners operational schedule. Also include a follow up visit to the site 6 months after project completion to verify that system is operating according to Owners requirements and make any corrections / adjustments that may be required to accommodate Owners use of system.

3.3 DEMONSTRATION

A. Provide systems demonstration under the provisions of Division 26, “Electrical General Provisions”.

B. Demonstrate proper operation and explain required maintenance procedures of system to Owners designated representative.

END OF SECTION 26 09 25

SECTION 26 22 00 – LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.3 SUBMITTALS

A. Product Data Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Wiring and connection diagrams.

C. Source quality-control test reports.

D. Output Settings Reports: Record of tap adjustments specified in Part 3.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C 57.12.91.

C. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during

which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of wall-mounting and structure-hanging supports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton/Cutler-Hammer.
2. GE Electrical Distribution & Control.
3. Square D/Groupe Schneider NA.

2.2 MATERIALS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices, except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper or Aluminum.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.

D. Enclosure: Ventilated, dripproof, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Indoor Transformer Enclosure Finish: Comply with NEMA 250 for Indoor corrosion protection."

1. Finish Color: ANSI 49 gray

F. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

H. Wall Brackets: Manufacturer's standard brackets.

I. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

J. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 40dba
2. 30 to 50 kVA: 45dba
3. 51 to 150 kVA: 50dba
4. 151 to 300 kVA: 55dba
5. 301 to 500 kVA: 60dba
6. 501 to 750 kVA: 62dba
7. 751 to 1000 kVA: 64dba

2.4 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls and floors for suitable mounting conditions where transformers will be installed.

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

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Division 26 Section “Common Work Results For Electrical”.

B. Install floor-mounting transformers level on concrete bases. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.

1. Anchor transformers to concrete bases according to manufacturer's written instructions, and requirements in Division 26 “Common Work Results For Electrical”.
2. Maintain a minimum of 6” of clear space between rear of transformer cabinet and wall.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 26 22 00

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes service and distribution switchboards rated 600 V and less.

B. Related Sections include the following:

1. Division 26 Section "Fuses."

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. RFI: Radio-frequency interference.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

F. SPD: Surge protective device.

1.4 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, TVSS device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short-circuit current rating of switchboards and overcurrent protective devices.
d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.
e. Utility company's metering provisions with indication of approval by utility company.
f. UL listing for series rating of installed devices.
g. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Qualification Data: Submit data for testing agencies indicating that they comply with qualifications specified in "Quality Assurance" Article.

D. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Maintenance Data: For switchboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency that is a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA PB 2.

D. Comply with NFPA 70.

E. Product Selection for Restricted Space: Drawings indicate typical dimensions for switchboards, including clearances between switchboards, and adjacent surfaces and other equipment items. Verify layout with actual equipment submitted for this project and confirm that equipment will fit in allotted space. Verify that proposed switchboard layout with fit within indicated dimensions.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections of lengths that can be moved past obstructions in delivery path.

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250-W per section) to prevent condensation.

D. Handle switchboards according to NEMA PB 2.1.

1.7 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations: Rate equipment for continuous operation under the following, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2000 m).

C. Service Conditions: NEMA PB2, usual service conditions, as follows:

1. Altitude not exceeding 6600 feet (2000 m).
2. Ambient temperatures within limits specified.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

1.9 EXTRA MATERIALS

A. Spares: For the following:

1. Potential transformer fuses.
2. Control fuses.
3. Fuses for fused switches.

B. Spare Indicating Lights: Six of each type installed.

PART 2 - PRODUCT

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Corp/Cutler Hammer.
2. General Electric Co.
3. Square D Co.

2.2 MANUFACTURED UNITS

A. Front-Connected, Front-Accessible Switchboard: Panel-mounted main device, panel-mounted branches, and sections rear aligned.

B. Nominal System Voltage: 480Y/277 V

C. Main-Bus Continuous: See one line diagram on drawing for ratings.

2.3 FABRICATION AND FEATURES

A. Enclosure: Steel: NEMA 1

B. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

C. Barriers: Between adjacent switchboard sections.

D. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

E. Utility Metering Compartment: Fabricated compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.

F. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

G. Hinged Front Panels: Allow access to circuit-breaker, metering, accessory, and blank compartments.

H. Buses and Connections: Three phase, four wire, unless otherwise indicated. Include the following features:

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.

    a. If bus is aluminum, use copper or tin-plated aluminum for circuit-breaker line connections.
    b. If bus is copper, use copper for feeder circuit-breaker line connections.

2. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full ampere rating of circuit-breaker position.
3. Ground Bus: 1/4-by-2-inch minimum size, drawn-temper copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
4. Contact Surfaces of Buses: Silver plated.
5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
7. Neutral Buses: 100 percent of the ampacity of the phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus is braced.

I. Include ground fault interruption device(GFI) with all switchboard main breakers.

J. The surge protective device (SPD) shall be mounted as close to the main breaker device as possible. This can be intergral with switchboard or mounted on or near the switchboard cabinet.

K. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment. Include bussing that will permit the installation of a future feeder breaker switchboard section.

L. Bus-Bar Insulation: Factory-applied, flame-retardant, 105 deg C minimum tape wrapping of individual bus bars or flame-retardant, spray-applied insulation of same temperature rating.

2.4 SPD DEVICES

A. IEEE C62.41, integrally mounted, plug-in style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.

B. Minimum single-impulse current rating shall be as follows:

1. Line to Neutral: 100,000 A.
2. Line to Ground: 100,000 A.
3. Neutral to Ground: 50,000 A.

C. Protection modes shall be as follows:

1. Line to neutral.
2. Line to ground.
3. Neutral to ground.

D. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.

E. Category C combination wave clamping voltage shall not exceed 1000 V, line to neutral and line to ground on 277/480 V systems.

F. UL 1449 clamping levels shall not exceed 800 V, line to neutral and line to ground on 277/480 V systems.

G. Withstand Capabilities: 1000 Category C surges with less than 5 percent change in clamping voltage.

H. Accessories shall include the following:

1. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
2. Audible alarm activated on failure of any surge diversion module.
3. Six-digit transient-counter set to totalize transient surges that deviate from the sine-wave envelope by more than 125 V.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity 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 less than 250 A.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Unit Circuit Breakers: For breakers 250 amps and larger RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Compressionstyle, suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
5. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
6. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

2.6 CONTROL POWER

A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.2 EXAMINATION

A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.

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

3.3 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Support switchboards on concrete bases, 4-inch nominal thickness. Pad for switchboard may be constructed with a cable pit under switchboard to facilitate feeder installation as a contractors option.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section Common Work Results for Electrical. This includes the special warning plaques at each switchboard indicating that there are multiple electric services or distribution panels supplying power to this facility. See Section 26 05 00 for requirements for signs at switchboards.

B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.5 CONNECTIONS

A. Install equipment grounding connections for switchboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing: After installing switchboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switchboards checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.8 CLEANING

A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 24 13

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SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:

1. Lighting and appliance branch-circuit panelboards.
2. Distribution panelboards.

B. Related Sections include the following:

1. Division 26 Section "Fuses."

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. RFI: Radio-frequency interference.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

F. SPD: Surge Protecive Device..

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, SPD device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

    a. Enclosure types and details for types other than NEMA 250, Type 1.
    b. Bus configuration, current, and voltage ratings.
    c. Short-circuit current rating of panelboards and overcurrent protective devices.
    d. UL listing for series rating of installed devices.
    e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Qualification Data: Submit data for testing agencies indicating that they comply with qualifications specified in "Quality Assurance" Article.

D. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency that is a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.7 EXTRA MATERIALS

A. Keys: Six spares of each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

a. Eaton Corp/Cutler-Hammer.
b. General Electric Co.
c. Square D Co.

2.2 FABRICATION AND FEATURES

A. Enclosures: Flush- and surfacemounted cabinets. NEMA PB 1, Type 1, to meet environmental conditions at installed location.
1. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

C. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

F. Bus: Hard-drawn copper, 98 percent conductivity

G. Main and Neutral Lugs: Compression type suitable for use with conductor material.

H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

I. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

J. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

K. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.

L. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.Provide where indicated on drawings.

M. Split Bus: Vertical buses divided into individual vertical sections.

N. Gutter Barrier: Arrange to isolate individual panel sections.

O. Feed-through Lugs: Compression type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.

B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Front mounted with concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISTRIBUTION PANELBOARDS

A. Doors: Front mounted, Door in door construction with concealed hinges; secured with vault-type latch with tumbler lock; all keyed alike.

B. Main Overcurrent Protective Devices: Circuit breaker

C. Branch overcurrent protective devices shall be one of the following:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-oncircuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity 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 and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. GFCI Circuit Breakers: Single- and two-pole configurations with **5**-mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Compression style, suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Ground-Fault Protection: Integrally mountedrelay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at **75** percent of rated voltage.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mounting Heights: Top of trim 74 inches above finished floor, unless otherwise indicated.

C. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Circuit Directory: Create a typed directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

E. Install filler plates in unused spaces.

G. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch (27-GRC) empty conduits from each panelboard tub into accessible ceiling space or space designated to be ceiling space in the future or exposed space.

H. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Common Work Results for Electrical".

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.Install on door for surface mounted panels in unfinished areas and behind door on flush panels in finished areas.

3.3 ELEVATOR PANELS

A. Provide handle lock-off attachments for all breakers serving elevator loads.

3.4 CONNECTIONS

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Common Work Results for Electrical Systems."

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws or permanent adhesive..

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

C. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

D. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:

F. Measure as directed during period of normal system loading.

G. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.

H. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

I. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

J. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

K. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

L. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

M. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

B. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Single and duplex receptacles, ground-fault circuit interrupters, integral surge suppression units, and isolated-ground receptacles.
2. Single- and double-pole snap switches and dimmer switches.
3. Device wall plates.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. PVC: Polyvinyl chloride.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and cover plates through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

B. Colors and finishes of all wiring devices and cover plates shall be of a type and color as selected by the Architect on a room by room basis and as noted on equipment shop drawings .

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Wiring Devices:

a. Bryant Electric, Inc./Hubbell Subsidiary.
b. Eagle Electric Manufacturing Co., Inc.
c. Hubbell Incorporated; Wiring Device-Kellems.
d. Leviton Mfg. Company Inc.
e. Pass & Seymour/Legrand; Wiring Devices Div.

2. Multioutlet Assemblies:

a. Hubbell Incorporated; Wiring Device-Kellems.
b. Wiremold Company (The).

2.2 RECEPTACLES

A. Straight-Blade-Type Receptacles: Configuration 5-20R duplex receptacle. Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.

B. Straight-Blade and Locking Receptacles: HeavyDuty grade.

C. GFCI Receptacles: Straight blade,non-feed-through type, Heavy-Duty grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter.

D. Isolated-Ground Receptacles: Straight blade, Heavy-Duty grade, duplex receptacle, with equipment grounding contacts connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap.

2.3 CABLE REELS

A. Description: Industrial Duty as manufactured by Molex/Woodhead, #10513306G0L000 series, complete with 4 circuit (4 phase wires, 2 neutrals plus ground wire), 20 foot cord, #10 awg. Outlet shall consist of a two gang, back to back box arranged to accommodate 4-duplex ground receptacles each connected to a dedicated 120 volt, 20 amp circuit.Color of outlet boxes, receptacles, and cover plates shall be yellow to match cord reel.

B. See drawing for alternate # 8 custom outlet assembly (sheet E402) that will replace cord reels on a one to one basis.

2.4 SWITCHES

A. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.

B. Snap Switches: HeavyDuty grade, quiet type.

1. Lockable Switch: Snap switch with Arrow Hart Lockable Switch Guard #7949 or equal.

C. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.

1. Switch: 20 A, 120/277-V ac.
2. Receptacle: NEMA WD 6, Configuration 5-15R.

D. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.

1. Control: Continuously adjustable **slider**with single-pole or three-way switching to suit connections.
2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch (130-mm) wire connecting leads.

3. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

E. Timer Switches: Electronic, Single- Pole/3-Way, Adjustable, up to 24 Hour, 120-277V, LED display

1. Minimum Contact Ratings:
   a. Resistive: 20 Amp, 120-277 VAC, 1800 watts
   b. Tungsten: 15 Amp, 120 VAC
   c. Ballast: 16 Amp, 120-277 VAC
   d. Motor: 1 HP, 120 VAC
   e. DC Loads: 2 Amps – 12 VDC, 4 Amps – 28 VDC

2. Replaceable Lithium Battery to provide minimum 2- year life for memory of user selections. Low battery indicator on display.

3. Field selectable audible and/or visual signal.

4. Basis of design: Intermatic model EI1400 series

2.5 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic 0.035-inch- (1-mm-) thick or satin-finished stainless steel 0.04-inch- (1-mm-) thick.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
4. Material for Wet or damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

2.6 FINISHES

A. Color:
1. Wiring Devices and cover plates connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70.
2. Wiring Devices Connected to Emergency Power System: Red.
3. TVSS Devices: Blue.
4. Isolated-Ground Receptacles: Orange with orange triangle on face.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies level, plumb, and square with building lines.

B. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.

C. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.

D. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

E. Remove wall plates and protect devices and assemblies during painting. Reinstall after painting is complete.

F. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 TIMER SWITCH SETTINGS:

A. 15 Minute Timer: (Typical Shower Rooms, Heat Lamps)
1. Set Audible “Beep” warn
2. Set All for lock
3. Set for 15 minutes

B. 1 Hour Timer:
1. Set warn
   a. All for incandescent, LED and fluorescent
   b. Audible “Beep” for metal halide
2. Set All for lock
3. Set for 1 hour

C. 2 Hour Timer: (Lighting functions that must meet a code limit for 2 hour maximums)
1. Set warn
   a. All for incandescent, LED and fluorescent
   b. Audible “Beep” for metal halide
2. Set All for lock
3. Set for 2 hour

D. 12 Hour Timer: (Mechanical Spaces)
1. Set warn
   a. Visible “Flash” for incandescent, LED and fluorescent
   b. Audible “Beep” for metal halide
2. Set All for lock
3. Set for 12 hour

3.3 IDENTIFICATION

A. Comply with Division 26 Section Common Work Results for Electrical

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with [**black**] [**white**] [**red**]-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, controllers, and motor-control centers; and spare fuse cabinets.

1.3 SUBMITTALS

A. Product Data: Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.

B. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.
4. Fuse size for elevator feeders and elevator disconnect switches.

C. Ambient Temperature Adjustment Information. If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses adjusted.

1. For each adjusted fuse, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

D. Maintenance Data: For tripping devices to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Source Limitations: Provide fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA FU 1.

D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.

1. Fuses: Quantity equal to two of each fuse type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.; Bussmann Div.
2. General Electric Co.; Wiring Devices Div.
3. Gould Shawmut.
4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Motor Branch Circuits: Class RK1, time delay or Class RK5, time delay.

B. Other Branch Circuits: [Class RK1, time delay or Class RK5, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare fuse cabinet[**s**].

3.4 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 26 28 13

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SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes individually mounted enclosed switches and circuit breakers used for the following:

1. Emergency Service disconnecting means.
2. Feeder and branch-circuit protection.
3. Motor and equipment disconnecting means.

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices" for attachment plugs, receptacles, and toggle switches used for disconnecting means.
2. Division 26 Section "Switchboards" for individually enclosed, fusible switches used as feeder protection.
3. Division 26 Section "Fuses" for fusible devices.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. RMS: Root mean square.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switch and circuit breaker.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

    a. Enclosure types and details for types other than NEMA 250, Type 1.
    b. Current and voltage ratings.
    c. Short-circuit current rating.
    d. UL listing for series rating of installed devices.
    e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Manufacturer's field service report.

E. Maintenance Data: For enclosed switches and circuit breakers and for components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for components.
2. Manufacturer's written instructions for testing and adjusting switches and circuit breakers.
3. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA AB 1 and NEMA KS 1.

C. Comply with NFPA 70.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2000 m).

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

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. Spares: For the following:

a. Fuses for Fused Switches: Provide 3 of each type and size.

2. Spare Indicating Lights: Six of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Fusible Switches:

a. Eaton Corp/Cutler-Hammer .
b. General Electric Co.
c. Square D Co.

2. Molded-Case Circuit Breakers:

a. Eaton Corp.; Cutler-Hammer.
b. General Electric Co.

c. Square D Co.

3. Combination Circuit Breaker and Ground-Fault Trip:

a. Eaton Corp./Cutler-Hammer.
b. General Electric Co.
c. Square D Co.

2.2 ENCLOSED SWITCHES

A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.

B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle with two padlocks, and interlocked with cover in closed position.

2.3 ENCLOSED CIRCUIT BREAKERS

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity 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 and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Compressionstyle suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Ground-Fault Protection: Integrally mountedrelay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second] time delay.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.

2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2.5 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosures before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION

A. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "[Common Work Results for Electrical] [Electrical Identification for Electrical Systems]."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 CONNECTIONS

A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.

B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed switch, circuit breaker, component, and control circuit.
2. Test continuity of each line- and load-side circuit.

B. Testing Agency: Engage a qualified independent testing agency to perform specified testing.

C. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches and circuit breakers checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 28 16

SECTION 26 32 00 - PACKAGED GENERATOR ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged natural gas engine generator set rated at 45 KW/ 56.25 KVA, 480/277 volts, three phase, four wire. with the following features and accessories:

1. Battery charger.
2. Engine-generator set.
3. Muffler.
4. Exhaust piping .
5. Outdoor enclosure.
6. Remote annunciator.
7. Remote stop switch.
8. Starting batteies.
9. Load bank testing.
10. Load-bank remote-control panel.

B. Related Sections include the following:

1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

C. LP: Liquid petroleum.

1.4 SUBMITTALS

A. Product Data: Include the following:

1. Data on features, components, accessories ratings, and performance.
2. Thermal damage curve for generator.
3. Time-current characteristic curves for generator protective device.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Welding certificates.

D. Qualification Data: For Installer andmanufacturer.

E. Certified summary of prototype-unit test report.

F. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

G. Certified Summary of Performance Tests: Demonstrate compliance with specified requirement to meet performance criteria for sensitive loads.

H. Test Reports:

1. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
2. Report of sound generation.
3. Report of exhaust emissions showing compliance with applicable regulations.
4. Field quality-control test reports.

I. Certification of Torsional Vibration Compatibility: Comply with NFPA 110.

J. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures and Operation and Maintenance Data," include the following:

1. List of tools and replacement items recommended to be stored at the Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

K. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: A testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged generator sets and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

F. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX for welding exhaust system piping.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

H. Comply with NFPA 37 “Installation and Use of Stationary Combustion Engines and Gas Turbines”.

I. Comply with NFPA 70 “National Electrical Code”.

J. Comply with NFPA 110 “Emergency and Standby Power Systems” requirements for Level 1 emergency power supply system.

K. Engine Exhaust Emissions: Comply with applicable federal, state and local government requirements.

L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts and supplies as used in manufacture and installation of original equipment.

1.9 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. Fuses: One for every 10 of each type and rating, but not less than one of each.
2. Indicator Lamps: Two for every six of each type used, but not less than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Generac Power Systems, Inc.
2. Kohler Co; Generator Division.
3. Onan Corp./Cummins Power Generation; Industrial Business Group.

2.2 ENGINE-GENERATOR SET

A. Packaged engine-generator set shall be a coordinated assembly of compatible components.

B. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.

C. Output Connections: Three phase,four wire.

D. Safety Standard: Comply with ASME B15.1.

E. Nameplates: Each major system component shall be equipped with a nameplate to identify manufacturer's name and address, and model and serial number of component.

F. Fabricate engine-generator-set mounting frame and attachment of components to resist generator-set movement during a seismic event when generator-set mounting frame is anchored to building structure.

G. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components.

H. Vibration Isolation: Engine/Alternator shall have sping vibration isolation (pad style vibration isolation acceptable for generators 100 KW and less) between Engine/Alternator and Mounting Frame.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

2.3 GENERATOR-SET PERFORMANCE

A. Steady-State Voltage Operational Bandwidth: 4 percent of rated output voltage from no load to full load.

B. Steady-State Voltage Modulation Frequency: Less than 1 Hz.

C. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

D. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

E. 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.

F. Transient Frequency Performance: Less than 5 percent variation for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

G. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

H. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, the system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

I. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.4 GENERATOR-SET PERFORMANCE FOR SENSITIVE LOADS

A. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

1. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

B. Steady-State Voltage Operational Bandwidth: 2 percent of rated output voltage from no load to full load.

C. Steady-State Voltage Modulation Frequency: Less than 1 Hz.

D. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.

E. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.

F. 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.

G. Transient Frequency Performance: Less than 2-Hz variation for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.

H. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

I. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, the system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

J.Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

K. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.5 SERVICE CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 15 to plus 40 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 2000 feet.

2.6 ENGINE

A. Fuel: Natural gas with automatic LP-gas standby.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
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.

E. Engine Fuel System:

1. Dual Natural Gas with LP-Gas Backup (Vapor-Withdrawal) System:

a. Carburetor.
b. Secondary Gas Regulators: One for each fuel type.
c. Fuel-Shutoff Solenoid Valves: One for each fuel source.
d. Flexible Fuel Connectors: One for each fuel source.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Adjustable isochronous, with speed sensing.

2.7 ENGINE COOLING SYSTEM

A. Description: Closed loop, liquid cooled, with [radiator factory mounted on engine-generator-set mounting frame] [remote radiator] and integral engine-driven coolant pump.

B. Radiator: Rated for specified coolant.

C. D. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

D. 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.

E. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

F. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

1. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

2.8 FUEL SUPPLY SYSTEM

A. Comply with NFPA 30, NFPA 54 and NFPA 58.
B. Natural gas piping system from utility source independent from building system. Coordinate all requirements with Mechanical Contractor.

2.9 ENGINE EXHAUST SYSTEM

A. Muffler: Critical type, sized as recommended by engine manufacturer; sound level measured at a distance of 10 feet from exhaust discharge shall be 85 dBA or less.

B. Condensate Drain for Muffler: Schedule 40, black steel pipe connected to muffler drain outlet through a petcock.

C. Connection from Engine to Exhaust System: Flexible section of corrugated stainless-steel pipe.

D. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liner.

2.10 COMBUSTION-AIR INTAKE

A. Description: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

2.11 STARTING SYSTEM

A. Description: 24-V electric, with negative ground and including the following items:

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Environmental Conditions" Paragraph in "Service Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article. Include accessories required to support and fasten batteries in place.

7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A 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.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. 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.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.12 CONTROL AND MONITORING

A. Functional Description: 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 the generator set. When mode-selector switch is switched to the on position, the generator set starts. The off position of the same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.

B. Functional Description: Switching on-off switch on the generator control panel to the on position starts the generator set. The off position of the same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel.

E. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel features shall include the following:

1. Wall-Mounted Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
2. Switchboard Construction: Freestanding unit complying with Division 26 Section "Switchboards."
3. Switchgear Construction: Freestanding unit complying with Division 26 Section "Low Voltage Switchgear."
4. Current and Potential Transformers: Instrument accuracy class.

F. Indicating and protective devices and controls shall include those required by NFPA 110 for a Level 1 system, and the following:

G. Indicating and Protective Devices and Controls:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Start-stop switch.
11. Overspeed shutdown device.
12. Coolant high-temperature shutdown device.
13. Coolant low-level shutdown device.
14. Oil low-pressure shutdown device.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Generator overload.

H. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

I. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link

transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."

J. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

K. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.

1. Engine high-temperature shutdown.
2. Lube-oil low-pressure shutdown.
3. Overspeed shutdown.
4. Remote emergency-stop shutdown.
5. Engine high-temperature prealarm.
6. Lube-oil low-pressure prealarm.
7. Fuel tank, low-fuel level.
8. Low coolant level.
9. Overcrank shutdown.
10. Coolant low-temperature alarm.
11. Control switch not in auto position.
12. Battery-charger malfunction alarm.
13. Battery low-voltage alarm.

L. Remote Alarm Annunciator: Comply with NFPA 99. Labeled LED shall identify each alarm event. Common audible signal shall sound for alarm conditions. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

M. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation. Verify location in building with Owner.

2.13 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator rating.
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.

B. Generator Disconnect Switch: Molded-case type, 100 percent rated.

1. Rating: Matched to generator output rating.
2. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.

C. Ground-Fault Indication: Comply with NFPA 70, Article 700-7(d). Integrate ground-fault alarm indication with other generator-set alarm indications.

2.14 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1 and specified performance requirements.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Excitation shall use no slip or collector rings, or brushes, and shall be arranged to sustain generator output under short-circuit conditions as specified.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.15 LOAD BANK

A. Include a 4 hour load bank test after installation is 100% complete to verify that all equipment and installation is complete and correctly installed. Test at 25%, 50%, 75%

aned 100% of generator rating. Provide written documentation that testing was performed and that generator system and all its components are operating satisfactorly.

2.16 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Description: Prefabricated enclosure with the following features:

1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
2. Structural Design and Anchorage: Wind resistant up to 100 mph (160 km/h).
3. Space Heater: Thermostatically controlled and sized to prevent condensation.
4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
5. Hinged Doors: With padlocking provisions.
6. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
7. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
8. Muffler Location: External to enclosure.

C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

D. Interior Lights with Timer Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. 12-hour timer switch to prevent lights being accidently left on. Arrange for external electrical connection.

E. Convenience Outlets: Factory wired. Arrange for external electrical connection.

2.17 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard enamel over corrosion-resistant pretreatment and compatible standard primer.

2.18 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 Paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2.
2. Generator Tests: Comply with IEEE 115.
3. Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype shall have been factory tested to demonstrate compatibility and reliability.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Full load run.
2. Maximum power.
3. Voltage regulation.
4. Transient and steady-state governing.
5. Single-step load pickup.
6. Safety shutdown.
7. Observation of Factory Tests: Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

C. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.2 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with generator manufacturer and structural engineer.

B. Concrete base is specified in Division 26 Section "Common Work Results for Electrical," and concrete materials and installation requirements are specified in Division 3.

3.3 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generators level on concrete base.

1. Vibration Isolation: Mount packaged engine generators on restrained spring isolators. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration Isolation."

C. Vibration Isolation: Mount packaged engine generators on vibration isolation equipment base as specified in Division 23 Section "Vibration Isolation."

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Install exhaust-system piping. Extend to point of termination outside structure. Size piping according to manufacturer's written instructions.

1. Install condensate drain piping for engine exhaust system. Extend drain piping from low points of exhaust system and from muffler to condensate traps and to point of disposition.

F. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

G. Contractor shall provide all required fuel during testing.

3.4 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
2. Connect cooling-system water supply and drain piping to gas-engine heat exchangers. Install flexible connectors at connections to engine generator and remote radiator.
3. Connect fuel piping to engines with a gate valve and union.

a. Natural- and LP-gas piping, valves, and specialties for gas distribution outside the building are specified in Division 23 Section "Natural Gas Piping Systems."

4. Connect exhaust-system piping to engines.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Provide all control and interface wiring between the three automatic transfer switches and the generator on site so that the sensing of a power loss at any location will automatically start generator and supply standby power to the area with a power loss.

3.5 IDENTIFICATION

A. Identify system components according to Division 15 Section "Mechanical Identification" and Division 26 Section "Common Work Results for Elecrtrical."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect[, test, and adjust] field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.15.2.1 and 7.22.1 (except for vibration baseline test). Certify compliance with test parameters.
2. Perform tests recommended by manufacturer.
3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:

    a. Single-step full-load pickup test.

4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.

c. Verify acceptance of charge for each element of the battery after discharge.
d. Verify that measurements are within manufacturer's specifications.

5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
7. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
8. Exhaust Emissions Test: Comply with applicable government test criteria.
9. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
10. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
11. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

D. Coordinate tests with tests for transfer switches and run them concurrently.

E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of the National Institute for Standards and Technology, and adequate for making positive observation of test results. Make calibration records available for examination on request.

F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Remove and replace malfunctioning units and retest as specified above.

J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."

1. Coordinate this training with that for transfer switches.

END OF SECTION 26 32 00

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SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches. Three required, one at each service entrance. See one line diagram on drawings for sizes.
2. Remote annunciation system.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Wiring Diagrams: Single-line diagram. Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

C. Qualification Data: For manufacturer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "[Operation and Maintenance Data]," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: An agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches, nonautomatic transfer switches, remote annunciators, and remote annunciator and control panels through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70.

G. Comply with NFPA 99.

H. Comply with NFPA 110.

I. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Contactor Transfer Switches:
   a. Emerson; ASCO Power Technologies, LP.
   b. Generac Power Systems, Inc.
   c. GE Zenith Controls.

d. Kohler Co.; Generator Division.
e. Onan Corp./Cummins Power Generation; Industrial Business Group.
f. Russelectric, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels have communication capability matched with remote device.

D. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

G. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

H. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

I. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.

1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

K. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

L. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

G. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

H. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:

1. Fully automatic make-before-break operation.

2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

    a. Initiation occurs without active control of generator.
    b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

I. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

J. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

K. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

2.4 AUTOMATIC TRANSFER-SWITCH FEATURES

A. Undervoltage Sensing for Each Phase of Normal Source: Senses low phase-to-ground voltage on each phase. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

B. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

C. Voltage/Frequency Lockout Relay: Prevents premature transfer to generator. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

D. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

E. Test Switch: Simulates normal-source failure.

F. Switch-Position Pilot Lights: Indicate source to which load is connected.

G. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
2. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

H. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

I. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

J. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

K. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.

L. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

M. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

1. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
2. Push-button programming control with digital display of settings.
3. Integral battery operation of time switch when normal control power is not available.

2.5 BYPASS/ISOLATION SWITCHES

A. Comply with requirements for Level 1 equipment according to NFPA 110.

B. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

1. Means to lock the bypass/isolation switch in the position that isolates the transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.
2. Drawout Arrangement for Transfer Switch: Provides physical separation from live parts and accessibility for testing and maintenance operations.
3. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
4. Contact temperatures of bypass/isolation switches do not exceed those of automatic transfer-switch contacts when they are carrying rated load.
5. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.
6. Legend: Manufacturer's standard legend for control labels and instruction signs give detailed operating instructions.
7. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

C. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

2.6 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel annunciates conditions for indicated transfer switches. Locate where directed by Owner. Annunciation includes the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Switch position.
3. Switch in test mode.
4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.
2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.7 FINISHES

A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

2.8 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 APPLICATION

A. Four-Pole Switches: Where four-pole switches are indicated, install neutral switching.

3.2 INSTALLATION

A. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Floor-Mounted Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 2 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated. Cast anchor-bolt inserts into bases. Comply with Division 3 Section "Cast-in-Place Concrete."

C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

D. Identify components according to Division 26 Section "Common Work Results for Electrical.

3.3 WIRING TO REMOTE COMPONENTS

A. Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect**,** test, and adjust field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following field tests and inspections and prepare test reports:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.22.3. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.

g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.
b. Observe reaction of circuit-interrupting devices when simulated fault current is applied at sensors.

D. Coordinate tests with tests of generator and run them concurrently.

E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

F. Remove and replace malfunctioning units and retest as specified above.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Demonstration and Training."

1. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures with lamps and ballasts.
2. Lighting fixtures mounted on exterior building surfaces.
3. Emergency lighting units.
4. Exit signs.
5. Accessories, including fluorescent fixture dimmersand occupancy sensors

B. Related Sections include the following:

1. Division 26 Section "Low Voltage Lighting Control" for low-voltage, manual and programmable lighting control systems.
2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
3. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
4. Division 26 Section "Central Dimming Controls" for architectural dimming systems.

1.3 DEFINITIONS

A. BF: Ballast factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.

B. CRI: Color rendering index.

C. CU: Coefficient of utilization.

D. LER: Luminaire efficiency rating, which is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:

1. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.

E. RCR: Room cavity ratio.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of fixture, including dimensions and verification of indicated parameters.
2. Emergency lighting unit battery and charger.
3. Fluorescent and high-intensity-discharge ballasts.
4. Lamps.

B. Shop Drawings:

1. Show details of nonstandard or custom fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
2. Detail assemblies of equipment indicating dimensions, weights, components, and location and identification of each field connection for Central Inverter Systems. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.

C. Wiring Diagrams: Power, signal, and control wiring.

D. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which lighting-fixture suspension systems will be attached.
3. Other items in finished ceiling, including the following:

a. Air outlets and inlets.
b. Speakers.
c. Sprinklers.
d. Access panels.

4. Perimeter moldings.

E. Samples for Verification (if requested): For interior lighting fixtures designated for sample submission in the Interior Lighting Fixture Schedule.

1. Lamps: Specified units installed.
2. Ballast: 120-V models of specified ballast types.
3. Accessories: Cords and plugs.

F. Product Certificates: For each type of ballast for dimmer-controlled fixtures, signed by product manufacturer.

G. Source quality-control test reports.

H. Field quality-control test reports.

I. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Catalog data for each fixture. Include the diffuser, ballast, and lamps installed in that fixture.

J.Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicted, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

E. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

F. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Unit Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 7years from date of Substantial Completion. Full warranty shall apply for first three years, and prorated warranty for the remaining four years years from date of Substantial Completion. Full warranty shall apply for all five years.

B. Special Warranty for Fluorescent Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Fiveyears from date of Substantial Completion.
2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.

C. Manufacturer's Special Warranty for T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Two yearsfrom date of Substantial Completion.

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. Lamps: 10 for every 100of each type and rating installed. Furnish at least one of each type.
2. Battery and Charger Data: Onefor each emergency lighting unit.
3. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 FIXTURES AND COMPONENTS, GENERAL

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL **1598**. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL **1598**. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

H. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.125 inch minimum unless different thickness is scheduled.
b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

I. Electromagnetic-Interference Filters: A component of fixture assembly. Suppress conducted electromagnetic-interference as required by MIL-STD-461D. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.3 LIGHTING FIXTURES

A. Fixture .

1. Products:

a. See electrical drawings for product information.

2. Voltage: 277V ac.
3. Mounting: As indicated on drawing.Lamps: As indicated on drawing.
4. Ballast Types and Features: Electronic andDimming
5. Lens: As indicated elsewhere.
6. External Finish: Powder coated or as indicated.
7. Trim and Hardware: Spring-loaded door latches and as indicated.
8. Special Environmental Conditions: As required by area installed.
9. Minimum CU for typical RCR shall be as follows (typical cavity reflectances are ceiling = 80 percent, wall = 50 percent, and floor = 20 percent)
10. Provide fixtures as needed for mockups.

2.4 FLUORESCENT LAMP BALLASTS

A. Description: Include the following features, unless otherwise indicated:

1. Designed for type and quantity of lamps indicated at full light output except for emergency lamps powered by in-fixture battery-packs.
2. Externally fused with slow-blow type rated between 2.65 and 3.0 times the line current.

B. Electronic ballasts for linear lamps shall include the following features, unless otherwise indicated:

1. Comply with NEMA C82.11.
2. Ballast Type: Instant start, unless otherwise indicated.
3. Programmed Start: Ballasts with two-step lamp starting to extend life of frequently started lamps.
4. Sound Rating: A
5. Total harmonic distortion rating of less than 10 percent according to NEMA C82.11.
6. Transient Voltage Protection: IEEE 587, Category A.
7. Operating Frequency: 20 kHz or higher.
8. Lamp Current Crest Factor: Less than1.7
9. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.

C. Premium Electronic Ballasts (PEB) for linear lamps shall have the following features, unless otherwise indicated.

1. Comply with NEMA C82.1.
2. Ballast type: Instant start
3. Sound Rating: A
4. Total harmonic distortion shall not exceed 10 percent according to NEMA C82.11
5. Ballast factor (as indicated on plans):

    a. Low Ballast Factor (LBF) 0.75-0.78
    b. Normal Ballast Factor (NBF) 0.85-0.88
    c. High Ballast Factor (HBF) 1.15-1.20

6. Transient Voltage Protection: IEEE 587, Category A
7. Operating Frequency: 20 kHz or higher.
8. Lamp Current Crest Factor: Less than 1.7.
9. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.
10. Ballasts shall meet (Wisconsin) Focus on Energy guidelines (2007-2008) for commercial building rebates. http://www.focusonenergy.com
11. Manufacturers:

    a. Advance Transformer (Optanium)
    b. General Electric Lighting (Ultramax)
    c. Osram Sylvania (Quicktronic – High Efficiency)
    d. Or approved equal

D. Ballasts for compact lamps in recessed fixtures shall have the following features, unless otherwise indicated:

1. Type: Electronic.
2. Power Factor: 90 percent, minimum.
3. Flicker: Less than 5 percent.
4. Lamp Current Crest Factor: Less than 1.7.
5. Electronic Ballast Operating Frequency: 20 kHz or higher.
6. Lamp end-of-life detection and shutdown circuit.
7. Transient Protection: Comply with IEEE 587 for Category A1 locations.
8. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

E. Ballasts for compact lamps in nonrecessed fixtures shall include the following features, unless otherwise indicated:

1. Power Factor: 90 percent, minimum.
2. Ballast Coil Temperature: 65 deg C, maximum.
3. Transient Protection: Comply with IEEE 587 for Category A1 locations.
4. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

F. Ballasts for dimmer-controlled fixtures shall comply with general and fixture-related requirements above for electronic ballasts and the following features:

1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming system indicated.

G. Ballasts for Low-Temperature Environments:

1. Temperatures 0 deg F and Higher: Electronic or electromagnetic type rated for 0 deg F starting temperature.
2. Temperatures Minus 20 deg F and Higher: Electromagnetic type designed for use with high-output lamps.

H. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

2.5 EXIT SIGNS

A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum of rated lamp life.
2. Additional Lamps for DC Operation: Two minimum, bayonet-base type, for connection to external dc source.

C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

2.6 EMERGENCY LIGHTING UNITS

A. General: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.

3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Wire Guard: Where indicated, heavy-chrome-plated wire guard protects lamp heads or fixtures.
5. Integral Time-Delay Relay: Holds unit on for fixed interval when power is restored after an outage; time delay permits high-intensity-discharge lamps to restrike and develop adequate output.

2.7 FLUORESCENT LAMPS

A. Low-Mercury Lamps: Comply with Federal toxic characteristic leaching procedure test, and yield less than 0.2 mg of mercury per liter, when tested according to NEMA LL 1.

B. T8, medium bi-pin, low mercury, extended life lamps (**ELF**), rated 32 W maximum, CRI of 80 (minimum), color temperature of 3500K, minimum average rated life of 24,000 hrs based on 3-hrs per start, instant start. 3100 initial lumens (minimum). Lamps shall meet the Wisconsin Focus on Energy Rebate Program.

1. Manufacturers:

a. Philips (Alto Advantage)
b. General Electric Lighting (Ecolux Hi-Lumen Starcoat)
c. Osram Slyvania (Octron XPS)

C. Compact Fluorescent Lamps: CRI 80 (minimum), color temperature 3500, average rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated.

1. T4, Twin Tube: Rated 5 W, 250 initial lumens (minimum).
2. T4, Twin Tube: Rated 7 W, 400 initial lumens (minimum).
3. T4, Twin Tube: Rated 9 W, 600 initial lumens (minimum).
4. T4, Twin Tube: Rated 13 W, 825 initial lumens (minimum).
5. T4, Double-Twin Tube: Rated 13 W, 900 initial lumens (minimum).
6. T4, Double-Twin Tube: Rated 18 W, 1200 initial lumens (minimum).
7. T4, Double-Twin Tube: Rated 26 W, 1800 initial lumens (minimum).

2.8 FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Common work Results for Electrical" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gage.

E. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch-minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

H. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.9 FINISHES

A. Fixtures: Manufacturers' standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
2. Metallic Finish: Corrosion resistant.

2.10 LIGHTING CONTROL DEVICES

A. Dimming Ballast Controls: Sliding-handle type with on/off control; compatible with ballast and having light output and energy input over the full dimming range.

B. Light Level Sensor: Detect changes in ambient lighting level and provide dimming range of 20 to 100 percent in response to change.

1. Sensor Capacity: At least 40 electronic dimming ballasts.
2. Adjustable Ambient Detection Range: 10 to 100 fc (100 to 1000 lx) minimum .

C. Occupancy Sensors: Adjustable sensitivity and off delay time range of 5 to 15 minutes.

1. Device Color:

a. Wall Mounted: White.
b. Ceiling Mounted: White.

2. Occupancy detection indicator.
3. Ultrasonic Sensors: Crystal controlled with circuitry that causes no detection interference between adjacent sensors.
4. Infrared Sensors: With daylight filter and lens to afford coverage applicable to space to be controlled.
5. Combination Sensors: Ultrasonic and infrared sensors combined.

2.11 SOURCE QUALITY CONTROL

A. Provide services of a qualified, independent testing and inspecting agency to factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

B. Factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.

1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Fixture Support: As follows:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Continuous Rows: Suspend from cable.

D. Air-Handling Fixtures: Install with dampers closed and ready for adjustment.

E. Adjust aimable fixtures to provide required light intensities.

3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FORMS

A. Contractor shall provide documentation on lamps and ballast purchases and shall fill out the Wisconsin Focus on Energy Forms for Owner Rebates.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Verify normal operation of each fixture after installation.

C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

E. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.

END OF SECTION 26 51 00

SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior luminaires with lamps and ballasts, but not mounted on exterior surfaces of buildings.
2. Light poles, bases and foundations.
3. Luminaire-mounted photoelectric switches.

B. Related Sections include the following:

1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 SUBMITTALS

A. Product Data: For each luminaire, arranged in the order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of fixture, including dimensions and verification of indicated parameters.
2. Luminaire dimensions, effective projected area, details of attaching luminaires, accessories, and installation and construction details.
3. Luminaire materials.
4. Photoelectric relays.
5. Fluorescent and high-intensity-discharge ballasts.
6. Fluorescent and high-intensity-discharge lamps.
7. Electrical and energy-efficiency data for ballasts.
8. Pole dimensions, materials, wind loading capacity for luminaire(s) effective projected area, bolt hole pattern, inside pole dimension (for base conduits), ground lug location, access hole and cover.

B. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer.

C. Light Layout: [For fixture substitutions,] Provide a computer generated factory point to point foot-candle layout of the project for each area involved.

D. Wiring Diagrams: Power, signal, and control wiring.

E. Coordination Drawings: Mounting and connection details, drawn to scale, for exterior luminaries.

F. Source quality-control test reports.

G. Test Reports: Indicate measured illumination levels. Measurements shall be taken on a 10’ x 10’ grid. Use a measuring device approved by the engineer.

H. Operation and Maintenance Data: For luminaires to include in maintenance manuals.

I. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

C. Comply with IEEE C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate exterior luminaries, light poles and bases with mounting and wind load requirements.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace luminaires or components of luminaires and lamps that fail in materials or workmanship; corrode; or fade, stain, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.

a. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
b. Warranty Period for Color Retention Five years from date of Substantial Completion.

2. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.

1.7 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. Lamps: . Furnish at least one of each type.
2. Glass and Plastic Lenses, Covers, and Other Optical Parts: Furnish at least one of each type.
3. Ballasts: Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 LUMINAIRES, GENERAL

A. Complying with UL **1598** and listed for installation in wet locations.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

J. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

2.3 EXTERIOR LUMINAIRES

Provide as indicated on Fixture Schedule located on drawings.

2.4 FLUORESCENT LAMP BALLASTS

A. Ballasts shall be suitable for low-temperature environments.

1. Temperatures 0 Deg F and Higher: Electronic or electromagnetic type rated for 0 deg F starting temperature.
2. Temperatures Minus 20 Deg F and Higher: Electromagnetic type designed for use with high-output lamps.
3. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.

B. Ballasts for compact lamps shall be suitable for cold-weather starting and shall include the following:

1. Power Factor: 90 percent, minimum.
2. Ballast-Coil Temperature: 65 deg C, maximum.
3. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.

2.5 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS

A. General: Comply with NEMA C82.4 and UL 1029. Shall include the following features, unless otherwise indicated:

1. Type: Constant-wattage autotransformer or regulating high-power-factor type.

2. Reliable Minimum Starting Temperature: Minus 40 deg C for high pressure sodium, minus 30 deg C for Probe Start metal halide, and minus 30/40 deg C for Pulse Start metal halide (depending on lamp specifications) ballasts.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Open-circuit operation will not reduce average life.
5. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. Auxiliary, Instant-On, Quartz System: Automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when high-intensity-discharge lamp reaches approximately 60 percent light output.

C. High-Pressure-Sodium Ballasts: Solid-state igniter/starter with an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

1. Instant Restrike Device: Solid-state potted module, mounted inside high-pressure-sodium fixture and compatible with high-pressure-sodium lamps, ballasts, and sockets up to 150 W.

a. Restrike Range: 105- to 130-V ac.
b. Maximum Voltage: 250-V peak or 150-V ac RMS.

2. Single-Lamp Ballasts: Minimum starting temperature of minus 40 deg C.
3. Open-circuit operation will not reduce average life.

2.6 FLUORESCENT LAMPS

A. Compact Fluorescent Lamps: CRI 80 (minimum), color temperature 4000K, averaged rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated.

1. T4, Double-Twin Tube: Rated 18 W, 1200 initial lumens (minimum).
2. T4, Double-Twin Tube: Rated 26 W, 1800 initial lumens (minimum).

2.7 HIGH-INTENSITY-DISCHARGE LAMPS

A. Metal-Halide Lamps: ANSI C78.1372, coated, wattage and burning position as scheduled, CRI 65 (minimum), and color temperature 4000K.

2.8 LIGHT POLES

A. Material: Aluminum.
B. Finish:Annodized] finish.Color to be chosen by Architect.

C. Section Shape and Dimensions: See fixture schedule on drawings.

D. Height as indicated on the drawings or as scheduled].

E. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole.

F. Accessories:
Ground lug.
GFI Receptacle.

G. Loading Capacity Ratings:

Steady Wind:100 miles per hour ([160] kph), minimum.

2.9 LIGHT POLE FOUNDATION BASE

A. Construct from reinforced concrete in sizes as shown on drawings.

B. Provide 3/4" X 10'0" ground rods in the pole foundation so that the ground rod projects 3" up into center of pole base.

C. The exposed surface area of the foundation shall have the forms removed and the concrete rubbed out to a smooth finish.

2.10 LUMINAIRE FACTORY FINISHES

A. Field Painting Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping.

C. Factory-Painted Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Interior Surfaces: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected from manufacturer's standard catalog of colors.
b. Color: Match Architect's sample of [**manufacturer's standard**] [**custom**] color.
c. Color: As selected by Architect from manufacturer's full range.

D. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Color: As selected by Architect.

2.11 SOURCE QUALITY CONTROL

A. Factory test fixtures with ballasts and lamps; certify results for isofootcandle curves, zonal lumen, average and minimum ratios, and electrical and energy-efficiency data for ballasts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lamps in each fixture.

B. Luminaire Attachment: Fasten to indicated structural supports.

C. Adjust luminaires that require field adjustment or aiming.

D. Minimum underground conduit size is 1 inch.

E. Underground and exterior wire shall be type XHHW-2 or USE.

F. Project anchor bolts 2 inches (50 mm) minimum above base.

G. Install poles plumb. [Provide [shims] [double nuts] to adjust plumb. Grout around each base.]

H. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

I. Bond each luminaire, each metal accessory, the ground rod and the pole to the branch circuit equipment ground conductor with a separate ground wire sized per NEC or as shown on the drawings

3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Cleaning:

Clean electrical parts to remove conductive and deleterious materials.

Remove dirt and debris from enclosure.

Clean photometric control surfaces as recommended by manufacturer.

Clean finishes and touch up damage.

C. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

1. IESNA LM-5.
2. IESNA LM-50.
3. IESNA LM-52.
4. IESNA LM-64.
5. IESNA LM-72.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 56 00

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.3 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TGB: Telecommunications grounding busbar.

D. TMGB: Telecommunications main grounding busbar.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. Ground rods.
2. Ground and roof rings.
3. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Qualification Data: For installation supervisor, and field inspector.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

a. Result of the ground-resistance test, measured at the point of BCT connection.
b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI asa registered communications distribution designer to perform the on-site inspection.

PART 2 - <u>PRODUCTS</u>

2.1 SYSTEM COMPONENTS

A. Comply with J-STD-607-A.

2.2 CONDUCTORS

A. Comply with UL 486A-486B.

B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 8 AWG.

C. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

C. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

D. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

B. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying

with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inchesstainless-steel or copper-plated hardware for attachment to the rack.

2.5 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with J-STD-607-A.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.
4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

    a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 27 05 28 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.5 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

    a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

D. Excessive Ground Resistance: If resistance to ground at the BCT exceeds **5** ohms, notify Architect promptly and include recommendations to reduce ground resistance.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 00 00 00

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SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 05 33 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. General Requirements for Metal Conduits and Fittings:

1. Comply with all requirements listed in 26 05 33
2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with TIA-569-B.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. General Requirements for Nonmetallic Conduits and Fittings:

1. Comply with all requirements listed in 26 05 33
2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with TIA-569-B.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway, approved for general-use installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with all requirements listed in 26 05 33
2. Comply with TIA-569-B.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with TIA-569-B.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with openbottom unless otherwise indicated.

3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "COMMUNICATIONS."

2.6 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. See 26 05 33

B. Minimum Pathway Size for division 27 cables: 3/4-inch trade size. Minimum size for optical-fiber cables is 1 inch.

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of two 90-degree bends in any pathway run for division 27 cables. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

K. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

M. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

O. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

P. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lbtensile strength. Leave at least 12 inchesof slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

Q. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

R. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

S. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

T. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

U. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

V. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

W. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

X. Set metal floor boxes level and flush with finished floor surface.

Y. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 31 20 00 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

    a. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 05 28

SECTION 27 05 44 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.

B. Related Requirements:

1. Section 07 84 13 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

E. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide **1/4-inch** annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors **2 inches** above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using **steel** pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

END OF SECTION 27 05 44

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SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Grounding.

B. Related Requirements:

1. Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.
2. Section 27 05 36 "Cable Trays for Communications Systems" for cable trays and accessories.
3. Section 27 13 00 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
4. Section 27 15 00 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. LAN: Local area network.

C. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 06 10 00 "Rough Carpentry."

2.2 EQUIPMENT FRAMES

A. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

B. Floor-Mounted Racks: Modular-type, steel construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug and a power strip.
2. Baked-polyester powder coat finish.

C. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.3 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting. Six 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R receptacles.
3. LED indicator lights for power and protection status.
4. LED indicator lights for reverse polarity and open outlet ground.
5. Retain one of first two subparagraphs below.
6. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
7. Rocker-type on-off switch, illuminated when in on position.
8. Retain two subparagraphs below if power strips contain surge protection. In first subparagraph, retain 33 kA for high exposure and cost, 26 kA for medium exposure and cost, and 13 kA for low exposure and cost.
9. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
10. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.4 GROUNDING

A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with J-STD-607-A.

2.5 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.3 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 3 level of administration.

D. Labels shall be preprinted or computer-printed type.

END OF SECTION 27 11 00

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SECTION 27 13 00 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cable.
3. **50/125-**micrometer, optical fiber cabling.
4. Coaxial cable.
5. Cable connecting hardware, patch panels, and cross-connects.
6. Cabling identification products.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. For coaxial cable, include the following installation data for each type used:

   a. Nominal OD.
   b. Minimum bending radius.
   c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics including the following:

   a. Cross-connects.
   b. Patch panels.
   c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

   a. Vertical and horizontal offsets and transitions.
   b. Clearances for access above and to side of cable trays.
   c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
   d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

D. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Patch-Panel Units: Oneof each type.
2. Connecting Blocks: Oneof each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings=Cabling Administration Drawings, and field testing program development= by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of =Registered Technician=, who shall be present at all times when Work of this Section is performed at Project site.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-A.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

C. Conduit and Boxes: Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems

1. Outlet boxes shall be no smaller than 4 inches wide, 4 inches high, and 2-1/2 inches deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated,3/4 by 48 by 96 inches. Comply with requirements in Section 06 10 00 "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE

A. Description: 100-ohm, 25 -pair UTP, covered with agray thermoplastic jacket

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

    a. Communications, General Purpose: Type CM or CMG
    b. Communications, Plenum Rated: Type CMP complying with NFPA 262.
    c. Communications, Riser Rated: Type CMR complying with UL 1666.
    d. Communications, Limited Purpose: Type CMX Multipurpose: Type MP or MPG
    e. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
    f. Multipurpose, Riser Rated: Type MPR complying with UL 1666.

2.4 UTP CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

B. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

1. Number of Terminals per Field: One for each conductor in assigned cables.

C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated

D. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

E. Patch Cords: Factory-made, 4-pair cables in 36-**inch**lengths; terminated with 8-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

2.5 MULTIMODE OPTICAL FIBER CABLE

A. Description:

1. Multimode, 50/125-micrometer, 12-fiber, nonconductive, tight buffer, optical fiber cable.
2. Comply with ICEA S-83-596 for mechanical properties for indoor cable
3. Comply with ICEA S-87-640 for cable outside the building footprint.
4. Comply with TIA/EIA-568-B.3 for performance specifications.
5. Comply with TIA/EIA-492AAAA-B for detailed specifications.
6. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a. General Purpose, Nonconductive: Type OFN or OFNG .
    b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    c. Riser Rated, Nonconductive: Type OFNR complying with UL 1666.
    d. General Purpose, Conductive: Type OFC or OFCG.
    e. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
    f. Riser Rated, Conductive: Type OFCR, complying with UL 1666.

7. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
8. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

B. Jacket:

1. Jacket Color: Aqua for 50/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.6 SINGLEMODE OPTICAL FIBER CABLE

A. Description:

1. Singlemode, 9/125-micrometer, 12-fiber, nonconductive, tight buffer, optical fiber cable.
2. Comply with ICEA S-83-596 for mechanical properties for indoor cable

3. Comply with ICEA S-87-640 for cable outside the building footprint.
4. Comply with TIA/EIA-568-B.3 for performance specifications.
5. Comply with TIA/EIA-492CAAA for detailed specifications.
6. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a. General Purpose, Nonconductive: Type OFN or OFNG .
    b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    c. Riser Rated, Nonconductive: Type OFNR complying with UL 1666.
    d. General Purpose, Conductive: Type OFC or OFCG.
    e. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
    f. Riser Rated, Conductive: Type OFCR, complying with UL 1666.

7. Maximum Attenuation: **1.0** dB/km at 1310 nm; **1.0** dB/km at 1550 nm.

B. Jacket:

1. Jacket Color: Yellow for singlemode
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.7 OPTICAL FIBER CABLE HARDWARE

A. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

B. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

C. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB.
3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Unenclosed wiring methods may also be used where shown, on the drawings and details, routed in structural girts. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 27 11 00 "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

    a. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run in contact with pipes, ducts, or other potentially damaging items. Routing on top of structural girts is allowed where noted on plans and details.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

1. Administration Class: **3**
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 3 level of administration.

D. Comply with requirements in Section 27 15 00 "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables**,** terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engagea qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 27 13 00

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SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. Cable connecting hardware, patch panels, and cross-connects.
3. Telecommunications outlet/connectors.
4. Cabling system identification products.
5. Cable management system.

B. Related Requirements:

1. Section 27 13 00 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

H. RCDD: Registered Communications Distribution Designer.

I. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.
3. Device Plates: Five of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
2. Bridged taps and splices shall not be installed in the horizontal cabling.

B. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25or less.
2. Smoke-Developed Index: 50 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Grounding: Comply with J-STD-607-A.

2.3 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated 3/4 by 48 by 96 inches. Comply with requirements in Section 06 10 00 "Rough Carpentry" for plywood backing panels.

2.4 UTP CABLE

A. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, General Purpose: Type CM or CMG.
b. Communications, Plenum Rated: Type CMP complying with NFPA 262.
c. Communications, Riser Rated: Type CMR complying with UL 1666.
d. Communications, Limited Purpose: Type CMX.
e. Multipurpose: Type MP or MPG.
f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.5 UTP CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

B. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, or as noted on plans, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.

D. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

E. Patch Cords: Factory-made, four-pair cables in 36-inchlengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

2.6 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Workstation Outlets: Four port-connector assemblies mounted in Single faceplate. Provide number of jacks as shown on drawings and blanks in the remaining openings.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.7 GROUNDING

A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with J-STD-607-A.

2.8 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.

E. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

F. Cable will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements in Section 27 05 28 "Pathways for Communications Systems."
3. Comply with requirements in Section 27 05 36 "Cable Trays for Communications Systems."

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.

5. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and patch panels.
6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
11. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
12. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than **60 inches** apart.
3. Cable shall not be run in contact with pipes, ducts, or other potentially damaging items. Cables may be routed on structural girts as shown on plans and details.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

1. Administration Class: 3.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 3 level of administration.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

a. Test for each outlet. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.

6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

6. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 27 15 00

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SECTION 28 31 00 - FIRE DETECTION AND ALARM
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes fire alarm systems for the following:

1. New voice/alarm/detection system for new buildings

B. Related Sections include the following:

1. Division 8 Section "Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.

1.3 DEFINITIONS

A. AFF: Above Finished Floor.

B. FACP: Fire alarm control panel.

C. FAAP: Fire alarm annunciator panel

D. LED: Light-emitting diode.

E. NICET: National Institute for Certification in Engineering Technologies.

F. U.N.O.: Unless Noted Otherwise.

G. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Noncoded, addressable, voice system; multiplexed signal transmission dedicated to fire alarm service and interfaced with building public address system under non alarm conditions only. Fire alarm speakers only shall be capable of being used to supplement the

public address system speakers under non alarm conditions. Fire alarm system must take priority operation under alarm conditions.

B. This system shall be compatibile with other existing systems on site and shall be capable of being monitored by Dane County security personel.

1.5 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.

B. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Flame detectors.
4. Smoke detectors.
5. Verified automatic alarm operation of smoke detectors.
6. Automatic sprinkler system water flow.
7. Fire extinguishing system operation.
8. Fire standpipe system.

C. Fire alarm signal shall initiate the following actions:

1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciators.
3. De-energize electromagnetic door holders.
4. Transmit an alarm signal to the remote alarm receiving station.
5. Unlock electric door locks in designated egress paths.
6. Release fire and smoke doors held open by magnetic door holders.
7. Activate voice/alarm communication system.
8. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
9. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
10. Record events in the system memory.
11. Record events by the system printer.
12. Interface with elevator controls to perform emergency elevator operation functions.

D. Supervisory signal initiation shall be by one or more of the following devices or actions:

1. Operation of a fire-protection system valve tamper and flow switch.

E. System trouble signal initiation shall be by one or more of the following devices or actions:

1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.

2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at the FACP.
4. Ground or a single break in FACP internal circuits.
5. Abnormal ac voltage at the FACP.
6. A break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at the FACP or annunciator.
9. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

F. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators. Record the event on system printer.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Shop Drawings shall be prepared by persons with the following qualifications:

   a. Trained and certified by manufacturer in fire alarm system design.
   b. Fire alarm certified by NICET, minimum Level III.

2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
3. Device Address List: Coordinate with final system programming.
4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.
5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
6. Batteries: Size calculations.
7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
8. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
9. Voice/Alarm Signaling Service: Equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

10. Provide point-by-point calculations, overlaid on floorplans, for speech transmission index and sound pressure level of final audible notification appliance layout.
    a. See architectural plans and schedules for construction materials.
    b. Calculations points shall be shall be located on a 10’x10’ grid and measured at 5’0”AFF.
11. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. Qualification Data: For Installer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

F. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review. Include all submittal fees required by authorities having jurisdiction for review of fire alarm system documents required for submittal and approvals.

G. Documentation:

1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner[, Architect, and authorities having jurisdiction].
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner[, Architect, and authorities having jurisdiction]. Format of the written sequence of operation shall be the optional input/output matrix.

    a. Hard copies on paper to Owner**,** Architect, and authorities having jurisdiction
    b. Electronic media may be provided to Architect and authorities having jurisdiction.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Work of this Section be performed by a UL-listed company.

C. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level III.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 PROJECT CONDITIONS

1.9 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. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
3. Smoke, Fire, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
5. Keys and Tools: One extra set for access to locked and tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. FACP and Equipment:

a. Edwards Systems Technology Inc.
b. Faraday, LLC.
c. Federal Signal Corporation.
d. Gamewell Company (The).
e. Grinnell Fire Protection; a Tyco International Company.
f. NOTIFIER; a GE-Honeywell Company.
g. Siemens Building Technologies, Inc.; a Cerberus Division.
h. SimplexGrinnell LP; a Tyco International Company.

2. Wire and Cable:

a. Comtran Corporation.
b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
d. West Penn Wire/CDT; a division of Cable Design Technologies.

3. Audible and Visual Signals:

a. Amseco; a division of Kobishi America, Inc.
b. Commercial Products Group.
c. Gentex Corporation.
d. System Sensor; a GE-Honeywell Company.

2.2 FACP

A. General Description:

1. Modular, power-limited design with electronic modules, UL 864 listed.
2. Addressable initiation devices that communicate device identity and status.

a. Smoke sensors shall additionally communicate sensitivity settin and allow for adjustment of sensitivity at the FACP.
b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.
4. There are multiple FACP's on this project which shall all be connected together to perform as an intergrated system.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, three lines of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

1. Signaling Line Circuits: NFPA 72, Class A, Style 2, 5, 6 or 7 as required by code and as recommended by manufacturer.
2. Signaling Line Circuits: NFPA 72, Class B, Style 0.5, 1, 3, 3.5, 4, 4.5, as required by code and as recommended by manufacturer.

a. System Layout: Install no more than 50 addressable devices on each signaling line circuit.

3. Notification-Appliance Circuits: NFPA 72, Class A, Style Z.
4. Notification-Appliance Circuits: NFPA 72, Class B, Style W, X, Y as required.
5. Actuation of alarm notification appliances, emergency voice communications, annunciation, elevator recall,and actuation of suppression systems shall occur within 10 seconds after the activation of an initiating device.
6. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel FACP indication and system reset if the alarm is not verified.

E. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.

F. Elevator Controls: Heat detector operation shuts down elevator power by operating a shunt trip in a emergencypower module feeding the elevator. The shunt trip circuit (120V) shall be monitored by the fire alarm system. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shuts down elevators associated with the location without time delay.

1. A field-mounted relay actuated by the fire detector or the FACP closes the shunt trip circuit and operates building notification appliances and annunciator.

G. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

H. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.

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 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.

I. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

J. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and make a print-out of the final adjusted values on the system printer.

K. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a [digital alarm communicator transmitter and telephone lines] [radio alarm transmitter].

L. Voice/Alarm Signaling Service: A central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of the FACP.

1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones, or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall be UL 1711 listed.

    a. Allow the application of and evacuation signal to indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
    b. Programmable tone and message sequence selection.
    c. Standard digitally recorded messages for "Evacuation" and "All Clear."
    d. Generate tones to be sequenced with audio messages of the type recommended by NFPA 72 and that are compatible with tone patterns of the notification-appliance circuits of the FACP.

2. Notification-Appliance Circuits: NFPA 72, Class [A] [B].
3. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
4. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

M. Service Modem: Ports shall be RS-232 for system printer and for connection to a dial-in terminal unit.

1. The dial-in port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.

N. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble), and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including the same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

O. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, [supervisory signal] [supervisory and digital alarm communicator transmitter] [and] [digital alarm radio transmitter] shall be powered by the 24-V dc source.

1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."

P. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.

1. Batteries: Sealed lead calcium or Sealed, valve-regulated, recombinant lead acid.
2. Battery and Charger Capacity: Comply with NFPA 72.

Q. Surge Protection:

1. Install surge protection on normal ac power for the FACP and its accessories. Comply with Division 16 Section "Transient Voltage Suppression" for auxiliary panel suppressors.
2. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

R. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 MANUAL FIRE ALARM BOXES

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod pull-lever
2. type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
3. Station Reset: Key- or wrench-operated switch.
4. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
5. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm.
6. All devices located in animal confinement areas shall be waterproof as required by NEC, Article 547.

2.4 SYSTEM SMOKE DETECTORS

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Multipurpose type, containing the following:

    a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
    b. Piezoelectric sounder rated at 88 dBA at 10 feet according to UL 464.
    c. Heat sensor, combination rate-of-rise and fixed temperature.

4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

    a. Rate-of-rise temperature characteristic shall be selectable at the FACP for 15 or 20 deg per minute.
    b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACP to operate at 135 or 155 deg F.
    c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

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.

C. Remote Air-Sampling Detector System: Includes air-sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit.

1. UL 268 listed, operating at 24-V dc, nominal.
2. Pipe Network: Electrical metallic tubing connects control unit with designated sampling holes.
3. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of three preset values.
4. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05-inch wg at all sampling ports.
5. Control Unit: Single or multizone unit as indicated. Provides same system power supply, supervision, and alarm features as specified for the central FACP plus separate trouble indication for airflow and detector problems.
6. Signals to the Central FACP: Any type of local system trouble is reported to the central FACP as a composite "trouble" signal. Alarms on each system zone are individually reported to the central FACP as separately identified zones.

D. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:

    a. Sensor: LED or infrared light source with matching silicon-cell receiver.
    b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

2. UL 268A listed, operating at 24-V dc, nominal.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

    a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.

5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating [detector has operated] [and power-on] status.[Provide remote status and alarm indicator and test station where indicated.]

7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
8. Each sensor shall have multiple levels of detection sensitivity.
9. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
10. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.5 HEAT DETECTORS

A. General: UL 521 listed.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or rate-of-rise of temperature that exceeds 15 deg F per minute, unless otherwise indicated.

1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.

1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.6 NOTIFICATION APPLIANCES

A. Description: Equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.

B. Bells: Electric-vibrating, 24-V dc, under-dome type; with provision for housing the operating mechanism behind the bell. Bells shall produce a sound-pressure level of 94 dBA, measured 10 feet from the bell. 10-inch size, unless otherwise indicated. Bells are weatherproof where indicated.

C. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.

D. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.

E. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn.

F. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output: Candela as indicated on drawings.
2. Strobe Leads: Factory connected to screw terminals.
3. Strobes shall be synchronized.

G. Voice/Tone Speakers:

1. UL 1480 listed.
2. High-Range Units: Rated 2 to 15 W.
3. Low-Range Units: Rated 1 to 2 W.
4. Mounting: Flush, semirecessed, or surface mounted; bidirectional as indicated.
5. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.
6. To be connected to building paging system under non alarm conditions.

2.7 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
3. Rating: 24-V ac or dc.
4. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

2.8 REMOTE ANNUNCIATOR

A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush where mounted in finished areas, surface mount in unfinished areas cabinet, NEMA 250, Class 1.

B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.9 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall to a shunt trip power module for power shutdown. A relay shall also be included to dicconnect the Public Address System audio connection in the event of a fire alarm condition.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Listed and labeled according to UL 632.

B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, 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 2 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. Verify type of remote monitoring connection equipment to suit the existing on site security monitoring system.

C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

D. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.11 SYSTEM PRINTER

A. Listed and labeled as an integral part of the fire alarm system.

2.12 GUARDS FOR PHYSICAL PROTECTION

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of the device.
2. Finish: Paint of color to match the protected device.

2.13 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.
3. Multiconductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Smoke or Heat Detector Spacing:

1. Smooth ceiling spacing shall not exceed 30 feet or the rating of the detector.
2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

B. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.

C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct. Verify exact location with HVAC contractor.

D. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

E. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

F. Wall Mounted Audible/Visual and Visual Only Alarm-Notification Devices: Install such that the entire lens is not less than 80” AFF or not greater than 96” AFF. Devices shall all be mounted at the same elevation throughout project, U.N.O. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

G. Ceiling Mounted Audible/Visual and Visual Only Alarm-Notification Devices. Install such that the entire lens is not greater than 30’ AFF. Provide pendant mounting if required to drop lens down to less than 30’AFF

H. Voice Evacuation Intelligibility: The Audible/Visual layout shown on the drawings is for reference and coordination. showing acceptable locations for devices. While less devices may be utilized in the final design (provided all code and AHJ requirements are met), prior approval shall be obtained from Engineer/Architect prior to adding devices to new locations or locating device in locations not shown on the plans.

The Contractor shall perform calculations to determine speaker tap and location requirements to meet NFPA 72 requirements and Annex recommendations for Sound Pressure Level (SPL) and Speech Transmission Index (STI). STI shall be calculated at 5’ AFF and shall have an average of 0.50 STI with no more than 10% of the floorplan having point reading of less than 0.45 STI,

I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

J. FACP: Surface mount with tops of cabinets not more than 72 inches above the finished floor.

K. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

L. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100-mph wind load with a 1.3 gust factor without damage.

M. All devices, equipment etc.located in areas that will house any animals shall be

3.2 WIRING INSTALLATION

A. Install wiring according to the following:

1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes for Electrical Systems."

1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour fire-rated fire alarm cables, NFPA 70 Types MI and CI, is not permitted.

3. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by 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.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. 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.

G. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Common Work Results for Electrical."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.

2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.

   a. Include the existing system in tests and inspections.

3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
4. Testing: Follow procedure and record results complying with requirements in NFPA 72.

   a. Detectors that are outside their marked sensitivity range shall be replaced.
5. Test voice fire alarm system speech transmission index (STI) and sound pressure level (SPL) using an STI test signal and associated measurement device.

6. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.

C. Semiannual Test and Inspection: Six months after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

D. Annual Test and Inspection: One year after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 28 31 00

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 02 56 39 “Temporary Tree & Plan Protection” for preserving existing vegetation.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and abandoning site utilities in place.
7. Temporary erosion and sedimentation control measures.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion and sedimentation control and plant protection measures are in place.

D. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.

2. Parking vehicles or equipment.

3. Foot traffic.

4. Erection of sheds or structures.

5. Impoundment of water.

6. Excavation or other digging unless otherwise indicated.

7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

E. Do not direct vehicle or equipment exhaust towards protection zones.

F. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

G. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Flag each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

2. Water shutoff shall be coordinated with Owner and Madison Water Utility.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Architect's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

D. Remove manhole casting and manhole to 6-inches below finish grade. Plug inverts and backfill manholes with granular material and compact.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.

2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.

3. Use only hand methods for grubbing within protection zones.

4. Chip removed tree branches and dispose of off-site.

5. Remove vegetation shall be hauled off site and will not be buried on site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Do not stockpile topsoil within protection zones.

2. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.

2. Paint cut ends of steel reinforcement in concrete to remain with two coats of anti-rust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END SECTION 31 10 00

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SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for walks, pavements, turf, and plants.

2. Excavating and backfilling for buildings and structures.

3. Subbase course and base course for asphalt paving.

4. Excavating and backfilling trenches for utilities and pits for buried utility structures.

5. Aggregate surfacing

B. Related Sections:

1. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

2. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.

3. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.3 REFERENCES

A. Where reference is made to the “Standard Specifications”, it shall be construed to mean the pertinent section of the Wisconsin Department of Transportation (WDOT) 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 Exploration Proposed Barns and maintenance Building Alliant Energy Center Grounds, Madison, Wisconsin” dated April 15, 2013.

C. ASTM D1557-78 - Test Methods for Moisture-Density relation of Soil and Soil-Aggregate Mixtures Using 10-lb. (4.54-kg) Rammer and 18-in. (457 mm) Drop

1.4 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Excavation: Removal of material encountered above 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 Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

G. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.5 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, he shall notify the Owner's Project Representative for clarification.

1.6 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.7 PROJECT CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

B. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Section 311000 "Site Clearing," are in place.

C. Do not commence earth moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: All materials shall 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.

B. Borrow Soil: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

C. Sub-base Material: Provide materials meeting the requirements of the Geotechnical Report and WDOT, Sections 301, 305 and 306.

D. Base Course: Provide materials meeting the requirements of the Geotechnical Report and WDOT, Sections 301, 305 and 306.

E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Breaker Run: Provide materials meeting the requirements of the Geotechnical Report and WDOT, Section 311.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Sand: ASTM C 33; fine aggregate.

I. Clay: As specified on the plan.

J. Free Draining Material: Under concrete floor slabs, provide washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448, coarse aggregate grading size 57; with 100 percent passing a 1-1/2 inch sieve and not more than 5 percent passing a No. 8 sieve.

2.2 Aggregate Surfacing

A. Match existing aggregate surfacing in plaza area.

B. Aggregate Stabilizer

1. Non-toxic, organic binder that is colorless and odorless that is designed to bind 3/8" or ¼" minus aggregate.

2.3 GEOTEXTILES

A. Paving Geotextile: Per Geotechnical Report

2.4 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

D. Prepare the subgrade in accordance with the Geotechnical Report and necessary for undercut.

3.2 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. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

C. All dewatering outfalls shall be directed through an appropriately sized settling tank and/or sediment bag.

3.3 EXCAVATION, GENERAL

A. Excavations shall be in conformance with the requirements of the Geotechnical Report.

B. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

2. Contractor shall haul away all unsuitable materials and excess soil to the contractor’s pre-arranged dump site. Contractor is responsible for all fees and permits associated with the selected dump site.

3. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.

b. 12 inches outside of concrete forms at footings.

c. 6 inches outside of minimum required dimensions of concrete cast against grade.

d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.

e. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.4 EXCAVATION FOR STRUCTURES

A. Excavations shall be in conformance with the requirements of the Geotechnical Report.

B. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

C. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavations shall be in conformance with the requirements of the Geotechnical Report.

B. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Tolerance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect 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 recommendations.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

A. Proof-roll shall be completed in accordance with Geotechnical recommendations.

B. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.

2. Testing and inspecting underground utilities.

3. Removing concrete formwork.

4. Removing trash and debris.

5. Removing temporary shoring and bracing, and sheeting.

C. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill voids with satisfactory soil while removing shoring and bracing.

D. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

E. Place and compact final backfill of satisfactory soil to final subgrade elevation.

F. Install detectable warning tape directly above utilities, 18 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.

2. Under walks and pavements, use satisfactory soil material.

3. Under steps and ramps, use engineered fill.

4. Under building slabs, use engineered fill.

5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil 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 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.

2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.

3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.

4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free of 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 Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.

2. Walks: Plus or minus 1 inch.

3. Pavements: Plus or minus 1/2 inch.

3.16 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. EQUIPMENT

1. Meet requirements of WDOT, Section 301.3.1.

B. SPREADING AND SHAPING

1. Meet requirements of WDOT, Section 305.3.4.

C. COMPACTION

1. Meet requirements of WDOT, Section 305.3.2.2, except as modified below.

2. Provide minimum compaction of 95 percent of maximum dry density in accordance with ASTM D1557.

D. TOLERANCES

1. Smoothness: Maximum variation of 3/8 inch when measured with a 10-foot straight edge.

2. Compacted thickness: within 1/4 inch.

3.17 AGGREGATE SURFACING

A. Blending

1. Blend 12 to 16-lbs of aggregate stabilizer per 1-ton of aggregate surfacing. Verify with manufacturer for exact blend.

2. The stabilizer shall be thoroughly and uniformly mixed throughout aggregate. Bucket blending is not acceptable. Blending with a rake and or shovel is not acceptable. Blend material dry as water will make the material hard.

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B. Placement

1. After pre-blending, place the aggregate on prepared sub-grade. Level to desired grade and cross section.

C. Watering

1. Water heavily for full-depth moisture penetration of the aggregate surfacing profile. Follow manufacturer's recommendations to achieve saturation of

aggregate profile. During water application randomly test for depth using a probing device, which reaches full depth.

D. Compaction

1. Upon thorough moisture penetration, compact aggregate screenings to 85% relative. Does not use a vibratory plate compactor or vibration function on roller as vibration separates large aggregate particles. Do not begin compaction for 6 hours after placement and up to 48 hours.

2. If surface aggregate dries significantly quicker than subsurface material, lightly mist surface before compaction.

3.18 FIELD QUALITY CONTROL

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

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.

2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.

3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.19 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish 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 Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END SECTION 31 20 00

SECTION 31 36 00 – GABION - GALVANIZED

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This work shall consist of furnishing, assembling, and filling woven wire mesh gabions with rock as specified in the contract to the dimensions, lines and grades shown on the plans, or as determined by the engineer. These specifications are in accordance with ASTM A975.

B. Related Sections:

1. Section 33 14 00 "Storm Utility Drainage Piping".

PART 2 - PRODUCTS

2.1 WOVEN WIRE MESH

A. Wire (Zinc Coated): All tests on the wire must be performed prior to manufacturing the mesh.

1. Tensile strength: both the wire used for the manufacture of gabions and the lacing wire, shall have a maximum tensile strength of 75,000 psi (515 MPa), in accordance with ASTM A641/A641M.
2. Elongation: the test must be carried out on a sample at least 12 in. (30 cm) long. Elongation shall not be less than 12%, in accordance with ASTM A370.
3. Zinc coating: minimum quantities of zinc according to ASTM A641/A641M, Class III soft temper coating.
4. Adhesion of zinc coating: the adhesion of the zinc coating to the wire shall be such that, when the wire is wrapped six turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers, in accordance with ASTM A641/A641M.

B. Galvanized (zinc coated) woven wire mesh gabions (8 x 10 mesh type):

1. Wire mesh: Diameter - 0.120 in. (3.05 mm)
2. Selvedge wire: Diameter - 0.153 in. (3.90 mm)
3. Mesh opening: Nominal Dimension D = 3.25 in. (83 mm), as per Fig.1

Fig. 1

Mesh Type	Nominal Dimension D
8 x 10	3.25 in. (83 mm)

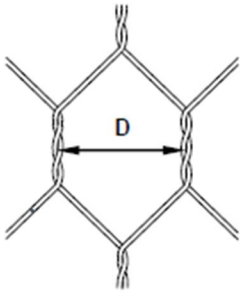
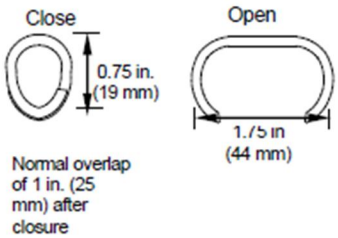


Fig. 2



C. Galvanized (zinc coated) lacing wire and internal stiffeners:

1. Lacing wire: Diameter - 0.087 in. (2.20 mm)
2. Cross tie/stiffener wire: Diameter - 0.087 in. (2.20 mm)
3. Preformed Stiffener: Diameter – 0.153 in. (3.9 mm) internal.

D. Steel Mesh Properties

1. Mesh Tensile Strength shall have a minimum strength of 3500 lb/ft (51.1 kN/m) when tested in accordance with ASTM A975 section 13.1.1
2. Punch Test Resistance shall have a minimum resistance of 6000 lb (26.7 kN) when tested in accordance with ASTM A975 section 13.1.4
3. Connection to selvedges shall have a minimum resistance of 1400 lb/ft (20.4 kN/m) when tested in accordance with ASTM A975.

E. Overlapping Fasteners: Overlapping fasteners may be used in lieu of, or to complement, lacing wire for basket assembly and installation.

1. High tensile fasteners shall have a nominal spacing of 4 in. (100 mm) not to exceed 6 in (150 mm) for all assembly and installation. This is based on a 1,400 lb/ft (20.4 kN/m) pull apart resistance for galvanized mesh with this spacing (ASTM A975 section 13.1.2).
2. Fasteners used for assembly and installation of the units on the field shall be tested for compliance with the ASTM A975 section 13.1.2.2 Pull-Apart Resistance. Producer or supplier of the wire mesh shall provide certification no later than 15 days prior of starting construction.
3. When tested in accordance with section 13.1.2.1, the average maximum resistance of the fasteners from the field shall not be lower than 90% of the resistance provided in the certification.
4. Galvanized Fasteners: Diameter = 0.120 in. (3.05 mm), according to ASTM A313/A313M, Type 302, Class I.
5. Tensile strength: 230,000 to 273,000 psi (1586-1882 MPa) in accordance with ASTM A764(2001).
6. Proper installation of rings: A properly formed overlapping fastener shall have a nominal overlap of one (1) in. after closure (Fig. 2). Fencing fixed in position and meeting the following requirements. Previously used materials may be used when approved by Architect.

2.2 TOLERANCES

A. Wire: Zinc coating, in accordance with ASTM A641/A641M, Class III soft temper coating.

B. Gabion sizes: ± 5 % on the length, width, and height.

C. Mesh opening: Tolerances on the hexagonal, double twisted wire mesh opening shall not exceed ± 10% on the nominal dimension D values (see Fig.1):

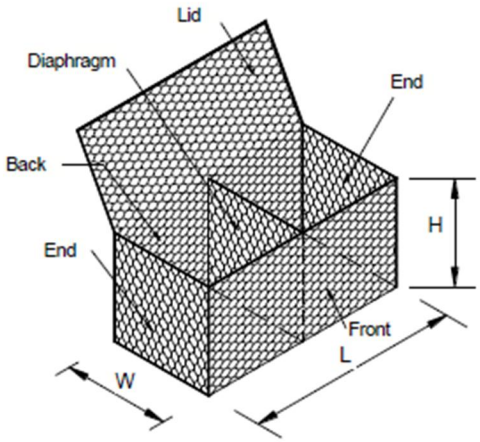
2.3 STANDARD UNIT SIZE

Table of sizes for gabions			
L=Length ft (m)	W=Width ft (m)	H=Height ft (m)	# of cells
6 (1.8)	**3 (0.9)**	**3 (0.9)**	**2**
9 (2.7)	3 (0.9)	3 (0.9)	3
12 (3.6)	3 (0.9)	3 (0.9)	4
6 (1.8)	3 (0.9)	1.5 (0.45)	2
9 (2.7)	3 (0.9)	1.5 (0.45)	3
12 (3.6)	3 (0.9)	1.5 (0.45)	4
6 (1.8)	3 (0.9)	1 (0.3)	2
9 (2.7)	3 (0.9)	1 (0.3)	3
12 (3.6)	3 (0.9)	1 (0.3)	4
4.5 (1.4)	3 (0.9)	3 (0.9)	1

All sizes and dimensions are nominal. Tolerances of ± 5% of the width, and length height, of the gabions shall be permitted.

2.4 FABRICATION

A. Gabions shall be manufactured and shipped with all components mechanically connected at the production facility. The front, base, back and lid of the gabions shall be woven into a single unit. The ends and diaphragm(s) shall be factory connected to the base. All perimeter edges of the mesh forming the basket and top, or lid, shall be selvedged with wire having a larger diameter.



B. The gabion is divided into cells by means of diaphragms positioned at approximately 3 ft (1 m) centers. The diaphragms shall be secured in position to the base so that no additional lacing is necessary at the jobsite.

2.5 ROCK

A. The rock for gabions shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure. Gabion rocks shall range between 4 in. and 8 in. The range in sizes may allow for a variation of 5% oversize and/or 5% undersize rock, provided it is not placed on the gabion exposed surface. The size shall be such that a minimum of two layers of rock must be achieved when filling the gabions.

PART 3 - EXECUTION

3.1 ASSEMBLY

A. Gabions are supplied folded flat and packed in bundles. The units are assembled individually by erecting the sides, ends, and diaphragms, ensuring that all panels are in the correct position, and the tops of all sides are aligned. The four corners shall be connected first, followed by the internal diaphragms to the outside walls. All connections should use lacing wire or fasteners as previously described Section 2.1.C and Section 2.1.E.

B. The procedure for using lacing wire consists of cutting a sufficient length of wire, and first looping and/or twisting to secure the lacing wire to the wire mesh. Proceed to lace with alternating double and single loops through every mesh opening approximately every 6 in. (150 mm) pulling each loop tight and finally securing the end of the lacing wire to the wire mesh by looping and/or twisting.

C. The use of fasteners shall be in accordance with the manufacturer's recommendations as specified in Section 2.1.E.

3.2 INSTALLATION

A. After assembly, the gabion baskets are carried to their final position and are securely joined together along the vertical and top edges of their contact surfaces using the same connecting procedure(s) described in Section 3.1.

B. Whenever a structure requires more than one layer, the upper empty baskets shall also be connected to the top of the lower layer along the front and back edges of the contact surface using the same connecting procedure(s) described in Section 3.1.

3.3 FILLING

A. Baskets shall be filled with rock as specified in Section 2.5. During the filling operation some manual stone placement is required to minimize voids.

B. Slightly overfill the baskets by 1 to 2 in. (25 to 50 mm) to allow for settlement of the rock. The exposed faces of vertical structures may be carefully hand placed to give a neat, flat, and compact appearance.

C. The cells shall be filled in stages so that local deformation may be avoided. That is, at no time shall any cell be filled to a depth exceeding 1-foot (0.30 m) higher than the adjoining cell.

D. Behind gabion walls, compact the backfill material simultaneously to the same level as the filled gabions

3.4 INTERNAL CONNECTING WIRES

A. Mac Tie preformed stiffeners or lacing wire shall be used as internal connecting wires when a structure requires more than one layer of gabions to be stacked on top of each other.

B. Internal Connecting Wires with lacing wire shall connect the exposed face of a cell to the opposite side of the cell.

C. Internal Connecting Performed stiffeners shall connect the exposed face of a cell to the adjacent side of the cell.

D. Preformed stiffeners are installed at 45° to the face/side of the unit, extending an equal distance along each side being braced (approximately 1 ft).

1. An exposed face is any side of a gabion cell that will be exposed or unsupported after the structure is completed.

E. 3 FEET HIGH GABIONS

1. 3 feet high gabions shall be filled in three layers, 1 foot at a time.
2. Connecting wires/bracings shall be installed after the placement of each layer, that is, at 1 foot high and 2 feet high.

F. 1.5 FEET HIGH GABIONS

1. 1.5 feet high gabions do not require connecting wires/bracings unless the baskets are used to build vertical structures.
2. Units shall be filled in two layers, 9 in. at a time.
3. Connecting wires shall be installed after the placement of the first layer, which is at 9 in. high.

3.5 LID CLOSING

A. Once the gabion baskets are completely full, the lids are pulled tight until the lid meets the perimeter edges of the basket.

B. The lid must then be tightly laced and/or fastened along all edges, ends and tops of diaphragm(s) in the same manner as described in Section 3.1.

3.6 MESH CUTTING AND FOLDING

A. Where shown on the drawings or otherwise directed by the engineer, the basket mesh shall be cut, folded and fastened together to suit existing site conditions.

B. The mesh must be cleanly cut and surplus mesh either folded back or overlapped so that it can be securely fastened together with lacing wire or fasteners in the manner described in Section 3.1.

C. Any reshaped gabions shall be assembled, installed, filled and closed as specified in the previous sections.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off Owner's property.

END SECTION 31 36 00

SECTION 32 12 16 – ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Hot-mix asphalt patching.
2. Hot-mix asphalt paving.
3. Hot-mix asphalt paving overlay.
4. Asphalt surface treatments.
5. Pavement-marking paint.
6. Wheel Stops

B. Related Requirements:

1. Section 31 10 00 "Site Clearing" for demolition and removal of existing asphalt pavement.
1. Section 31 20 00 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.

1.3 STANDARD SPECIFICATIONS

A. Where reference is made to the “Standard Specifications”, it shall be construed to mean the pertinent section of the Wisconsin Department of Transportation (WDOT) 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 Exploration Proposed Barns and maintenance Building Alliant Energy Center Grounds, Madison, Wisconsin” dated April 15, 2013.

1.4 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

B. Material Certificates: For each paving material, from manufacturer.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of WisDOT for asphalt paving work.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

1.7 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.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F.

2. Tack Coat: Minimum surface temperature of 60 deg F.

3. Slurry Coat: Comply with weather limitations in ASTM D 3910.

4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.

5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40°F for oil-based materials 55°F for water-based materials, and not exceeding 95°.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and methods for on-site pavement shall conform to recommendations in the Geotechnical Report.

B. All materials and methods for on-site pavement shall conform to WDOT Standard Specifications. Where conflicts between this specification and the WDOT Standard Specifications exist, requirements of the WDOT shall govern.

2.2 ASPHALT MATERIALS

A. Provide asphaltic pavement per WDOT Standard Specifications Section 460.2 and 460.3 and the Pavement Design section of the Geotechnical Report

B. Mixture Type:

1. Type 1 Asphalt: E-0.3, Section 460, Table 460-2 of the WDOT Standard Specifications.

2. Type 2 Asphalt: E-1, Section 460, Table 460-2 of the WDOT Standard Specifications.

C. Bituminous material: Per WDOT Standard Specifications, of suitable grade and consistency for application.

D. Tack Coat: Per WDOT Standard Specifications.

E. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Paving Geotextile: Per Geotechnical Report

B. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.

1. Color: White.

C. WHEEL STOPS

1. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.

2. Dowels: Galvanized steel, 3/4 inch in diameter, 10-inch minimum length.

D. Temporary Mulch or Sand Surface:

If asphalt paving cannot be completed by April 9, 2014, an alternative surface acceptable to County must be in place on all proposed asphalt pavement areas from April 9, 2014 to April 14, 2014. Acceptable surfaces include a 6" depth of bark/wood chip mulch or 4" depth of sand. The bark/wood chips must meet the requirements of the material that Dane County currently obtains from the City of Madison.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding per Geotechnical Report

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of 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: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply 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. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.3 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.

2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.4 SURFACE PREPARATION

A. General:

1. Sawcut existing asphalt edges to provide a clean joint to match into with the new asphalt.

2. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

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.

C. Temporary Mulch and Sand:

All traces of the alternative surfacing must be removed by whatever means necessary prior to the placement of the base course and asphalt pavement. Prior to the placement of the asphalt pavement base course the removal of the temporary surface must be approved by the County and Engineer before paving can commence.

3.5 PAVING GEOTEXTILE INSTALLATION

A. Apply tack coat uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd.

B. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.

1. Protect paving geotextile from traffic and other damage and place hot-mix asphalt paving overlay the same day.

3.6 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in 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 base course in number of lifts and thicknesses indicated.

2. Spread mix at a minimum temperature of 250 deg 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 infill 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. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.

2. Complete a section of asphalt base 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.

3.7 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.

3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

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 percent of specified course density.

3.8 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 with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg 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 percent of reference laboratory density according to AASHTO T 245, but not less than 94 percent or greater than 100 percent.

2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

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. 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.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.9 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.

2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement 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. Base Course: 1/4 inch.

2. Surface Course: 1/8 inch.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.

B. Allow paving to age for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 WHEEL STOPS

A. Securely attach wheel stops to paving with not less than two galvanized-steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.12 FIELD QUALITY CONTROL

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

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549

E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.13 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 milled materials to accumulate on-site.

END SECTION 32 12 16

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SECTION 32 13 13 – CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Vehicular Pavement.
2. Walks.
3. Exposed Aggregate Walks
4. Curb and Gutters.
5. Concrete Flume.
6. Concrete Pads
7. Concrete Pavement Under Pavilion Canopy
8. Building Stoops

1.3 STANDARD SPECIFICATIONS

A. Where reference is made to the "Standard Specifications", it shall be construed to mean the pertinent section of the Wisconsin Department of Transportation (WDOT) 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 Exploration Proposed Barns and maintenance Building Alliant Energy Center Grounds, Madison, Wisconsin" dated April 15, 2013.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Action Submittals:

1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.

2. Admixtures.

3. Curing compounds.

4. Applied finish materials.

5. Bonding agent or epoxy adhesive.

6. Joint fillers.

1.6 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment. Manufacturer to design concrete mixes.

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

C. Concrete Testing Service: Owner to engage a qualified testing agency to perform material evaluation tests.

D. ACI Publications: Comply with ACI 301 unless otherwise indicated.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.

A. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.

B. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.3 CONCRETE MATERIALS

A. Concrete shall conform to WDOT Section 501and as indicated within the Geotechnical Report

B. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, gray portland cement Type II.

a. Fly Ash: ASTM C 618, Class C or Class F.

b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

C. Normal-Weight Aggregates: ASTM C 33, Class 4M, uniformly graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Water: Potable and complying with ASTM C 94/C 94M.

E. Air-Entraining Admixture: ASTM C 260.

F. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

2. Retarding Admixture: ASTM C 494/C 494M, Type B.

3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

2.4 FIBER REINFORCEMENT

A. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.

2.5 CURING MATERIALS

A. Liquid membrane-forming compound conforming to requirements of WDOT 415.3.16.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

2.6 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4500 psi.

2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.

3. Slump Limit: 3 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding per Geotechnical Report.

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

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

3.5 PLACING AND FINISHING

A. PortIand Cement Concrete Pavement Type-2: See DOT Section 501.

B. Concrete Pavement Type-2: See DOT Section 602.

3.6 SPECIAL FINISHES

A. Exposed-Aggregate Finish:

1. Finish to match exposed aggregate concrete at 640 West Wilson, Madison, WI.

2. Proceed as soon as the surface grout can be removed by simultaneous brushing and flushing with water without overexposing or dislodging the aggregate.

3. Avoid traffic on the concrete during this operation.

4. High pressure water may be used if desired finish is more easily achieved without harm to the concrete.

5. Use same method of exposure, either with or without retarder, throughout the job.

3.7 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 30 feet unless otherwise indicated.

2. Extend joint fillers full width and depth of joint.

3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.

4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 3/8-inch radius. Repeat grooving of contraction joints after applying surface finishes.

a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes.

3.8 FIELD QUALITY CONTROL

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

B. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no

compressive-strength test value falls below specified compressive strength by more than 500 psi.

C. Test results shall be reported in writing to Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

E. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

F. Concrete paving will be considered defective if it does not pass tests and inspections.

G. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

H. Prepare test and inspection reports.

3.9 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END SECTION 32 13 13

SECTION 32 92 00 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Sodding.
3. Turf renovation.

B. Related Sections:

1. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.

1.3 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

1.5

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

B. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

C. Qualification Data: For qualified landscape Installer.

D. Product Certificates: For fertilizers, from manufacturer.

E. Material Test Reports: For imported or manufactured topsoil.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.

1. Experience: Five years' experience in turf installation.

2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

3. Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of

sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.

2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.

3. Report suitability of tested soil for turf growth.

    a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

    b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

1.8 PROJECT CONDITIONS

A. Work Notification: Notify Engineer at least 10 working days prior to start of seeding operations. Work may be performed during the months of April, May, August and September, unless otherwise approved by the Architect. Do not sow seed when weather conditions are unfavorable, such as during drought or high winds.

B. Protect existing facilities from damage caused by seeding operations.

C. Perform seeding work after planting, irrigation, and other work affecting ground surface has been completed.

D. Restrict traffic form lawn areas until grass is established. Erect signs and barriers as required.

E. Provide hose and lawn watering equipment as required.

1.9 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turf: 60 days from date of Substantial Completion.

a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

2. Sodded Turf: 30 days from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: State-certified seed of grass species as follows:

1. Full Sun and Partial Sun: Proportioned by weight as follows:

a. 50 percent Kentucky bluegrass (4 varieties).

b. 25 percent creeping red fescue (1 variety).

c. 25% Turf-type perennial ryegrass (1 elite variety).

2. Part to Full Shade: Proportioned by weight as follows:

a. 30 percent Creeping red fescue (1)

b. 25 percent Chewing fescue (1 elite variety)

c. 20 percent Hard fescue (1 elite variety)

d. 15 percent Intermediate ryegrass (1 elite variety)

e. 10 percent Kentucky bluegrass (1variety)

2.2 TURFGRASS SOD

A. Turfgrass Sod: Complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Full Sun and Partial Sun: Proportioned by weight as follows:

a. 50 percent Kentucky bluegrass (4 varieties).

b. 25 percent creeping red fescue (1 variety).

c. 25% Turf-type perennial ryegrass (1 elite variety).

2. Part to Full Shade: Proportioned by weight as follows:

a. 30 percent Creeping red fescue (1)

b. 25 percent Chewing fescue (1 elite variety)

c. 20 percent Hard fescue (1 elite variety)

d. 15 percent Intermediate ryegrass (1 elite variety)

e. 10 percent Kentucky bluegrass (1variety)

2.3 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

2. Provide lime in form of ground dolomitic limestone.

B. Aluminum Sulfate: Commercial grade, unadulterated.

C. Perlite: Horticultural perlite, soil amendment grade.

D. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

E. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

2.4 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.

2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.

C. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.5 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.6 PLANTING SOILS

A. Planting Soil: Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land bogs or marshes.

1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous

materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2. Mix imported topsoil or manufactured topsoil with the following soil amendments and fertilizers as required per soil report.

2.7 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

D. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.8 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.9 STRAW MULCH

A. Clean, weed-free mulch of sedge marsh hay (not from reed canary grass) straw well-seasoned before baling.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.

2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply fertilizer directly to subgrade before loosening.

2. Thoroughly blend planting soil off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.

a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.

3. Spread planting soil to a depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.

b. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.

2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.

a. Apply fertilizer directly to surface soil before loosening.

3. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, trash, and other extraneous matter.

4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 SEEDING

A. Sow seed during the months of April, May, August and September, unless otherwise approved by the Engineer. Do not sow seed when weather conditions are unfavorable, such as during drought or high winds.

B. Perform drill seeding using approved equipment such as cultipacker seeders and grass seed drills.

C. Drill the seed uniformly to an average depth of 1/2 inch and at a rate of 4 pounds per 1,000 square feet. All areas shall be seeded in at least two directions. Turfgrass seeds shall not be covered by more than 1/4 inch of soil. The seeding device shall lightly roll the seed bed to provide good moisture contact between the seed and soil.

D. Water thoroughly and immediately with a fine mist until soil is soaked to a depth of 3 inches. Maintain soil in a moist condition until seeds have sprouted and reached a height of 1 inch. Water thereafter at least once every 14 days unless natural rainfall has provided equivalent watering.

E. Spread mulch evenly at the rate of 1 1/2 tons per acre. Place all mulch on given areas within 8 hours after seeding. A mechanical blower may be used to apply mulch material, provided the machine has been specifically designed and approved for this purpose. Anchor the mulch by either using a light serrated disc or a spray tackifier. If a spraying tackifier is used, it may be applied either simultaneously or in a separate application. Take precautionary measures to prevent tackifier materials from marking or defacing structures, pavements, utilities or plantings.

3.5 HYDROSEEDING

A. Apply seed and fertilizer by spraying them on the previously prepared seed bed in the form of an aqueous mixture, and by using the methods and equipment specified. The rate of seed application shall be 4 pounds per 1,000 square. Apply the seed, fertilizer and water mixture at a rate not less than 1,000 gallons per acre.

B. Water used shall be obtained from fresh water sources, and shall be free from injurious chemicals and other toxic substances at all times. Identify to the Engineer all sources of water at least two weeks prior to use. The Engineer, at this direction, may take samples of the water at the source or from the tank at any time and have a laboratory test the samples for chemical and saline content. Use no water from a source which is disapproved by the Engineer following such tests.

C. Mixtures shall be constantly agitated from the time they are combined until they are finally applied to the seed bed. Once combined, mixtures shall be used within 8 hours; portions not used within 8 hours shall be wasted and disposed of at locations acceptable to the Engineer.

D. Direct application nozzle sufficiently upward so that the mixture falls to the ground in a uniform shower. Never direct spray toward the ground in a manner that produces erosion or runoff.

E. Apply uniformly and at the prescribed rate, avoiding misses and overlapped areas, gauging quantities of mixture to measured application areas. Checks on the rate and uniformity of application may be made by observing the degree of wetting, or by distributing test sheets and observing the quantity of material deposited thereon.

F. The spray method shall not be used during periods of high winds.

G. Seed and commercial fertilizer applied by the spray method need not be raked into the soil.

H. Mulch all seeded areas at the following rates and stabilize with tackifier at rate recommended by the manufacturer.

1. Straw at 2 tons per acre.

2. Wood cellulose at 1,500 pounds per acre.

3.6 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.

2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.7 TURF RENOVATION

A. Renovate existing turf damaged by Contractor's operations, such as storage of materials

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.

2. Install new planting soil as required.

B. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

C. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

D. Mow, dethatch, core aerate, and rake existing turf.

E. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

H. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

I. Apply seed and protect with straw mulch or sod as required for new turf.

J. Water newly planted areas and keep moist until new turf is established.

3.8 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.

2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow to a height of 2-1/2 to 3-1/2 inches.

D. Turf Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.9 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.10 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after grass establishment period.

END SECTION 32 92 00

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SECTION 33 10 00 - WATER UTILITIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Work shall include the furnishing of all material and installation and testing of water mains complete with valves, hydrants, fittings, connections, house services and other specials, of the type and size indicated on the plans and as specified herein.

1.2 STANDARD SPECIFICATIONS

A. All construction of water mains and services laterals shall conform to the requirements and conditions of the City of Madison Standard Specifications for Public Works Construction, Part VII – Water Mains and Service Laterals except the method of measurement and basis of payment shall not apply.

1.3 SHOP DRAWINGS

A. Before starting fabrication of pipe, fittings and valves, the Contractor shall submit to the Engineer shop drawings showing piping, and descriptive lists of all pipe, fittings, hangers, supports and appurtenances.

B. Where special fittings are required, they shall be shown in large detail with all necessary dimensions.

C. The Owner reserves the right to refuse to make partial payments until satisfactory shop drawings and descriptive lists of pipe, fittings and valves have been submitted.

D. Each section of pipe shall bear the manufacturer's serial number and shall be certified by the manufacturer to meet standard specifications. Each section of pipe shall be visually inspected in the field for manufacturer's certification.

1.4 DELIVERY, STORAGE, AND HANDLING

A. All pipe, valves hydrants, and fittings delivered to the job shall be accompanied by certification papers showing that it has been tested in accordance with the applicable specifications for this project.

B. All pipe and fittings will be inspected by the Contractor upon delivery to the job site. No cracked, broken, or damaged pipe will be allowed in this work.

C. Each piece of ductile iron pipe and each fitting shall have its weight and class designation conspicuously painted or cast on it. All other pipe materials shall have the class designation painted thereon. Where required, other designation marks shall be

painted on the pipe or fittings to indicate correct location in the pipeline in conformity to a detailed layout plan.

1.5 PROJECT CONDITIONS

A. The Contractor shall verify existing utility locations. All utility information is based on record drawings, field location of surface features, and survey data when available.

B. Utilities must be located (location and depth) prior to ordering water structures.

C. Dewatering shall be provided as required and routed through an appropriately sized settling tank and/or sediment bag.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall be new and free of defects.

2.2 MATERIALS

A. Per Article 702 of the City of Madison Standard Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Per Article 703 of the City of Madison Standard Specifications.

3.2 DISINFECTION

A. Per Article 703.10 of the City of Madison Standard Specifications.

3.3 TESTING

A. Per Article 701.4 and 703.14 of the City of Madison Standard Specifications.

3.4 FINAL INSPECTION

B. Per Article 703.16 of the City of Madison Standard Specifications.

END SECTION 33 11 00

SECTION 33 14 00 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. References:

1. Applicable provisions of Division 1 shall govern all work under this section.
2. Where these specifications do not cover portions of the work to be undertaken, the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition, shall govern the work.

B. 31 20 00 - Earth Moving

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure transition couplings.
3. Precast Concrete Box
4. Manholes.
5. Catch basins.
6. Stormwater inlets.
7. Pipe outlets.

1.3 DEFINITIONS

A. HDPE: High Density Polyethylene.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Precast Concrete Box: Include plans, elevations, sections, details, frames, and covers.
2. Manholes: Include plans, elevations, sections, details, frames, and covers.
3. Storm Water Inlets. Include plans, elevations, sections, details, frames, covers, and grates.
4. Remaining paragraphs are defined in Division 01 Section "Submittal Procedures" as "Informational Submittals."

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Field quality-control reports.

E. Record Drawings: Maintain record drawings that show the actual locations, sizes and types of utilities and other features encountered. Note any modifications to proposed sewer system size, location or elevation. Record any other deviations from the drawings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic drains, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

D. Be responsible for the safe storage and handling of all materials utilized in the work. Store all materials in areas designated by the Construction Representative in cooperation with the Owner.

E. Handle storm water inlets according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days (2) in advance of proposed interruption of service.

1. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 Unless otherwise specified, the contractor shall refer to the City of Madison Specifications for products and materials

2.2 HDPE PIPE AND FITTINGS

A. Corrugated High Density Polyethylene (HDPE) Piping:

1. Pipe for storm water shall conform to ASTM F2306 and AASHTO M294, or the latest revisions thereof, and shall be Type S.

2. All HDPE pipe joints shall consist of integral bell and spigot with rubber gasket that meets specification requirements of ASTM F477. Bell shall span over three (3) spigot corrugations.

3. All joints shall be soil tight, per ASTM F2306 and AASHTO M294.

2.3 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.

1. Bell-and-spigot ends and gasketed joints with ASTM C 443, rubber gaskets

2. Class III, Wall B.

3. Class IV, Wall B.

4. Class V, Wall B.

2.4 PRECAST CONCRETE BOX

A. Precast Reinforced-Concrete Box Culvert: ASTM C 1577.

B. Joints: Rubber gasket joints for concrete box complying with ASTM c 1677.

2.5 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Concrete Pipes: ASTM C 443, rubber.

2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

2.6 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478 precast, reinforced concrete, of depth indicated, with provision for sealant joints.

2. Diameter: 48 inches minimum unless otherwise indicated.

3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.

4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.

5. Riser Sections: 4-inch minimum thickness and lengths to provide depth indicated.

6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.

7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.

9. Steps: Per City of Madison Standard Specifications

10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Designed Precast Concrete Manholes:
1. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
3. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
4. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
5. Steps: Per City of Madison Standard Specifications.
6. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
7. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope.

C. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover per to City of Madison

2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.7 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.

2. Fine Aggregate: ASTM C 33, sand.

3. Coarse Aggregate: ASTM C 33, crushed gravel.

4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.

2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

a. Invert Slope: 1 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

b. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.

2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.8 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.

3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.

4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.

5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.

8. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Designed Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.

1. Joint Sealants: ASTM C 990, bitumen or butyl rubber.

2. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

3. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.

4. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum unless otherwise indicated.

2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.7 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening.

B. Gutter Inlets: Made with horizontal gutter opening. Include heavy-duty frames and grates.

C. Combination Inlets: Made with vertical curb and horizontal gutter openings. Include heavy-duty frames and grates.

D. Frames and Grates: Heavy duty.

2.9 PIPE OUTLETS

A. Apron End Walls:

1. Apron End Walls are to be provided as shown on the drawings including where all storm sewers outfall into ditches, swales or other bodies of water and on both ends of culvert pipes.

2. Unless otherwise indicated, apron end walls shall be constructed of the same material, same sidewall thickness and to the same design standards as the pipe to which it is being connected. Apron end walls shall be the same diameter as the pipe to which it is being connected.

3. Apron end walls for pipe greater than 18" in diameter shall be restrained using a minimum of two pipe ties per section. Pipe ties shall also be used to restrain the first two pipes located immediately upstream of the apron end wall. Pipe ties shall be constructed using galvanized ¾" diameter steel rod and hardware, or other approved materials. Pipe ties shall be bolted through the sidewall of the pipe.

4. Apron end walls for pipe greater than 18" in diameter shall be provide with pipe gates. Pipe gates shall be constructed of 1" diameter standard steel pipe members with welded connections and spaced no greater than 12" O.C.E.W. Pipe gate shall be attached to end wall at a minimum of 4 locations using 4"x4"x3/16" thick steel angles and 3/8" galvanized machine bolts. Pipe gates shall be provided with a galvanized finish, unless noted.

5. At each area where the outfalls are located, Class III Type A Turf Reinforcement Mat with riprap shall be installed so that it is incorporated into the Apron End Wall to prevent undermining of the End Wall.

B. LOCATOR TAPE

1. Detectable metallic locator tape, specifically manufactured for marking utilities.

2. Tape shall be a minimum of 6" wide and shall be marked "STORM".

3. Install per City of Madison Specifications

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes or inlets for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Dewatering shall be provided as required.

F. Install gravity-flow, non-pressure drainage piping according to the following:

1. Install all pipes in accordance with ASTM specifications which pertain to the specified type of pipe material and the installation situation.

2. Do not use any pipe or fittings cracked in cutting or handling or otherwise not free from defects.

3. Clean all pipe of any dirt and/or debris both inside and out prior to placing in the trench.

4. Make joints in accordance with manufacturer's directions with due care to avoid damaging pipe and/or disturbing previously laid pipe.

5. Cut pipe only according to manufacturer's directions.

6. Lay all sewer pipes to horizontal alignment and grade shown on the plans with bell ends up hill. Establish and maintain horizontal alignment using total station, transit or theodolite. Use pipe laser or level to establish and maintain grade of

pipe. Discrepancies from the required horizontal alignment or grade at any location shall not be greater than 0.10’ or 0.05’, respectively.

7. Do not exceed specified trench widths.

G. APRON END WALL INSTALLATION

1. Limit the excavation for apron end walls so as to provide only the necessary amount of space to sufficiently prepare the subgrade, set the end wall and lay pipe. Provide a minimum of 1’ of clearance between structure and trench wall for adequate backfilling and compaction.

2. Where excavation occurs below the bottom elevation of the apron end wall bottom, bring the excavation to the required elevation by the use of compacted crushed stone bedding. A minimum of 8 inches of compacted Crushed Stone Bedding shall be placed below the bottom of the apron end wall.

3. Set apron end wall in accordance with elevation and location as indicated on the plans. Install base plumb and level. Provide joint restraint between the apron end wall and the first two pipes located immediately upstream of the apron end wall.

4. At each area where the outfalls are located, Class III Type A Turf Reinforcement Mat shall be installed so that it is incorporated into the Apron End Wall to prevent undermining of the End Wall.

3.3 PRECAST CONCRETE BOX INSTALLATION

A. General: Install precast concrete box complete with appurtenances and accessories needed to complete work.

B. Install precast concrete box with gaskets according to ASTM C 1677.

C. Where specific concrete box construction is not indicated, follow precast concrete box manufacturer's written instructions.

3.4 MANHOLE INSTALLATION

D. General: Install manholes, complete with appurtenances and accessories indicated, according to City of Madison Specifications.

E. Install precast concrete manhole sections with sealants according to ASTM C 891.

F. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

G. Set tops of frames and covers according to City of Madison Specifications.

3.5 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.6 STORMWATER INLET[AND OUTLET] INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

D. Construct energy dissipaters at outlets, as indicated.

3.7 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.8 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Where indicated on the plans, existing sewer to be left in place shall be abandoned in accordance with Section 3.2.24 of the Standard Specifications for Sewer & Water Construction in Wisconsin, current edition. Sewer shall not be abandoned until existing services have been reconnected to the replacement sewer. Abandoning sewers is considered incidental to the construction.

B. Backfill to grade according to Division 31 Section "Earth Moving."

3.9 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over all piping and over edges of underground structures. Install directly over and within 18 inches vertical of each item to be marked.

3.10 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.

2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.

b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.

c. Damage: Crushed, broken, cracked, or otherwise damaged piping.

d. Infiltration: Water leakage into piping.

e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.

4. Re-inspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to City of Madison requirements.

3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.

4. Submit separate report for each test.

5. Gravity-Flow Storm Drainage Piping: Test according to City of Madison requirements,

3.11 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END SECTION 33 41 00

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SECTION 33 30 00 - SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Work shall include the furnishing of all material and installation and testing of sanitary sewerage utilities of the type and size indicated on the plans and as specified herein.

1.2 STANDARD SPECIFICATIONS

A. All construction of water mains and services laterals shall conform to the requirements and conditions of the City of Madison Standard Specifications for Public Works Construction, Part V – Sewers and Sewer Structures except the method of measurement and basis of payment shall not beapplicable.

1.3 SHOP DRAWINGS

A. Before starting fabrication of pipe, fittings and valves, the Contractor shall submit to the Engineer shop drawings showing piping, and descriptive lists of all pipe, fittings, hangers, supports and appurtenances.

B. Where special fittings are required, they shall be shown in large detail with all necessary dimensions.

C. The Owner reserves the right to refuse to make partial payments until satisfactory shop drawings and descriptive lists of pipe, fittings and valves have been submitted.

D. Each section of pipe shall bear the manufacturer's serial number and shall be certified by the manufacturer to meet standard specifications. Each section of pipe shall be visually inspected in the field for manufacturer's certification.

1.4 DELIVERY, STORAGE, AND HANDLING

A. All pipe, valves, and fittings delivered to the job shall be accompanied by certification papers showing that it has been tested in accordance with the applicable specifications for this project.

B. All pipe and fittings will be inspected by the Contractor upon delivery to the job site. No cracked, broken, or damaged pipe will be allowed in this work.

C. Each piece of ductile iron pipe and each fitting shall have its weight and class designation conspicuously painted or cast on it. All other pipe materials shall have the class designation painted thereon. Where required, other designation marks shall be painted on the pipe or fittings to indicate correct location in the pipeline in conformity to a detailed layout plan.

1.5 PROJECT CONDITIONS

A. The Contractor shall verify existing utility locations. All utility information is based on record drawings, field location of surface features, and survey data when available.

B. Utilities must be located (location and depth) prior to ordering structures.

C. Dewatering shall be provided as required and routed through an appropriately sized settling tank and/or sediment bag.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall be new and free of defects.

2.2 MATERIALS

A. Per Article 503 and 507 of the City of Madison Standard Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Per Article 503 and 507 of the City of Madison Standard Specifications.

3.2 TESTING

A. Per Article 501.3 of the City of Madison Standard Specifications.

3.3 FINAL INSPECTION

B. Per Article 703.16 of the City of Madison Standard Specifications.

END SECTION 33 11 00

SECTION 41 22 13 -CRANES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Applicable provisions of Division 1 shall govern work under this Section.

1.2 DESCRIPTION OF WORK:

A. This section includes the following:

1. Jib Crane
2. Trolley
3. Hoist
4. Related accessories

B. Related sections:

1. Cast-In-Place Concrete for crane base is specified in Division 3.
2. Electrical connections are specified in Division 26.

1.3 QUALITY ASSURANCE:

A. Furnish Jib crane, trolley and hoist as a complete unit provided by one dealer-installer, including hardware, accessories, mounting and installation components.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's product data and installation instructions for each type of equipment, including.

B. Shop Drawings: Submit shop drawings for fabrication and erection of crane. Include plans, elevations and large scale detail. Show anchorages and accessory items. Provide location template drawings for items supported or anchored to permanent construction.

C. Maintenance Data: Submit manufacturer's maintenance and service data, including address and telephone number of nearest authorized service representative.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Subject to compliance with requirements set forth in this section, provide products from one of the following:

1. Handling Systems International, LaGrange , IL
2. Architect pre-approved equal by other manufacturers.

2.2 JIB CRANES:

A. 360 Degree Jib Cranes: Basis of specification manufacturer and model:

1. Manufacturer: Handling Systems International, LaGrange , IL
2. Model: 351-1000-16-11 HD
3. Capacity: 1,000 pounds.
4. Span: 16 feet.
5. Clearance under beam: 11 feet.
6. Finish: Yellow enamel paint.
7. Provide signage indicating capacity in accordance with all regulations.

B. Trolley: Provide manufacturer's standard trolley designed specifically for use with provided jib crane beam.

1. Provide trolley with rated capacity which is compatible with jibcrane.
2. Provide safety features complying with all saftey agencies having jurisdiction.

C. Electric Chain Hoist having the following characteristics:

1. Capacity: Match capacity to rating of jib crane.
2. Provide Class B insulated motor, 30 minute rated.
3. Provide 2-button pushbutton station and cord swag.
4. Meet NEMA 3R & 12 for control enclosure.
5. Voltage: 230 VAC, 3 phase, 60 cycle.

D. Accessories, Provide:

1. Anchor bolts and nuts
2. Tagline
3. Templates
4. Stops
5. Collector ring assemblies where required
6. All hardware and other accessories to result in a complete operational system.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of jib crane equipment.

B. Examine roughing-in for electrical systems for equipment to verify actual locations of connections before installation.

C. Proceed with installation of equipment only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Coordinate installation of equipment indicated to be attached to or recessed into concrete or masonry, and furnish anchoring devices with templates, diagrams, and instructions for their installation.

3.3 INSTALLATION. GENERAL

A. General: Comply with manufacturer's detailed written instructions for installing equipment.

B. Install equipment, motor, control stations and wiring, safety devices, and accessories as required for a complete installation.

C. Electrical Connections: Rough-in electrical connections according to requirements in Division 26.

3.5 JIB CRANE:

A. Attach crane securely to surface of concrete base per manufacturer's shop drawings.

3.6 ADJUSTING

A. Adjust equipment for safe, efficient operation.

3.7 CLEANING AND PROTECTING

A. Restore marred, abraded surfaces to their original condition.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure equipment is without damage or deterioration at the time of Substantial Completion.

END SECTION 41 22 13

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