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SECTION 23 05 00
HVAC GENERAL PROVISIONS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. HVAC work includes:

1. Furnish all labor and materials necessary for the complete installation of heating, ventilating and air conditioning system as shown on the drawings and/or specified herein.
2. Drawings: Refer to H-Series drawings for graphic representations, schedules and notations showing HVAC work.
3. Specifications: Applicable portions of Division 1 govern all work under this Section. Refer to Division 23 Sections for primary technical specifications of HVAC work, as listed below:

23 05 00	HVAC General Provisions
23 06 00	Pipe and Pipe Fittings
23 06 30	Piping Specialties
23 09 10	Supports and Anchors
23 25 00	Mechanical Insulation
23 63 00	Air Purification Treatment
23 66 00	Air-Cooled Condensing Units
23 95 00	Control Sequence
23 95 10	DDC Point List
4. HVAC demolition and remodeling.
5. Equipment structural supports, prime painted.
6. Motors for all HVAC equipment.
7. Secure and pay all fee
8. Cutting and patching existing conditions for HVAC equipment by the HVAC Contractor.
9. HVAC Contractor submit and shall pay all City of Madison HVAC permits.

1.2 RELATED DOCUMENTS

A. Coordination of Work:

1. General: Contract Documents are diagrammatic in showing certain physical relationships which must be established within HVAC work, and in its interface with other work including electrical work, and that such establishment is the exclusive responsibility of the Contractor.
2. Arrange HVAC work in neat, well organized manner with piping and similar services running parallel with primary lines of building construction, and with minimum of 7 foot overhead clearance where possible.
3. Give right-of-way to piping which must slope for drainage.
4. Advise other trades of openings required in their work for subsequent move-in of large units of HVAC work.
5. Install all sensor wells, dampers and valves provided by the Temperature Control Contractor.

1.3 SHOP DRAWINGS AND SAMPLES

- A. The Contractor shall submit to the Engineer for approval, shop drawings, giving details, dimensions, capacities, accessories, wiring diagrams, etc., of all materials as indicated in respective specification sections.

- 1 B. All shop drawings shall include proper identification of equipment by name and/or number, as
 2 indicated in the specification and/or shown on the plans.
 3
 4 C. Shop drawings shall be submitted for approval as soon as practicably possible after award of contract.
 5 Shop drawings must be approved before installation of materials and equipment. Drawings shall be
 6 submitted in accordance with the requirements outlined in Division 1 of the Specifications.
 7
 8 D. The examination and approval of shop drawings shall not relieve the Contractor from any obligation
 9 to perform the work strictly in accordance with the Contract Drawings and Specifications. The
 10 responsibility for errors in shop drawings shall remain with the Contractor.
 11
 12 E. Electronic shop drawing submittals require file labeling to match specification section contained and
 13 all equipment identified properly compatible with construction documents. All shop drawings
 14 improperly labeled and identified will be returned for corrections.
 15

16 **1.4 QUALITY ASSURANCE**
 17

- 18 A. Qualifications of Installers: For the actual fabrication, installation and testing of work under this
 19 Section, use only thoroughly trained and experienced workmen completely familiar with the items
 20 required and the manufacturer's current recommended methods of installation.
 21
 22 B. In acceptance or rejection of installed work, the Architect will make no allowance for lack of skill on
 23 the part of the workmen.
 24
 25 C. Reference Standards: Specifically, for HVAC work in addition to standards specified in individual
 26 work section, the following standards are imposed, as applicable to work in each instance:
 27

28	AABC	Associated Air Balance Council
29	ADC	Air Diffusion Council
30	AGA	American Gas Association
31	AMCA	Air Movement and Control Association
32	ANSI	American National Standard Institute
33	ARI	Air Conditioning and Refrigeration Institute
34	ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
35	ASME	American Society of Mechanical Engineers
36	ASTM	American Society of Testing and Materials
37	AWS	American Welding Society
38	IEEE	Institute of Electrical and Electronics Engineers
39	MICA	Midwest Insulation Contractors Association
40	MSS	Manufacturer's Standardization Society
41	NBS	National Bureau of Standards
42	NEBB	National Environmental Balancing Bureau
43	NEC	National Electrical Code
44	NEMA	National Electric Manufacturer's Association
45	NFPA	National Fire Protection Association
46	SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
47	UMC	Uniform Mechanical Code
48	UL	Underwriter's Laboratories
49		All federal, state, local codes, ordinances and utility regulations.

- 50
 51 D. Environmental design conditions for all occupied areas are as follows:
 52

	<u>Winter</u>	<u>Summer</u>
54 Inside:	70 degrees F	74 deg. F 50% RH
55 Outside:	-15 degrees F	91 deg. dbF/75 deg. wbF

- 1 E. Approval of Materials: Refer to General Conditions, Supplementary General Conditions and other
2 requirements of Division 1 for approval of materials and requirements of substituted equipment.
3

4 **1.5 JOB CONDITIONS**

- 5
6 A. Building Access: Arrange for the necessary openings in the building to allow for admittance of all
7 HVAC equipment.
8

- 9 B. Temporary Services: No service shall be interrupted or changed without the prior approval of the
10 Owner. Refer to Division 1 requirements.
11

- 12 C. Compatibility: Provide products which are compatible with other products of HVAC work, and with
13 other work requiring interface with HVAC work. Provide products with proper or correct power
14 characteristics, fuel-burning characteristics and similar adaptation for Project. Coordinate selections
15 from among options for compatibility of products. Design and layout is based on equipment
16 scheduled on drawings or in specifications.
17

- 18 1. Contractor shall coordinate installation of equipment supplied by other approved equal
19 manufacturers and shall make necessary field modifications to allow for installation of this
20 equipment at no additional expense to the Owner.
21

- 22 D. Record Drawings: Refer to Division 1 requirements.
23

24 **1.6 REMODELING REQUIREMENTS**

- 25
26 A. Prebid Survey: HVAC Contractor shall survey the job site before submitting his bid to determine the
27 extent of areas requiring demolition, relocating and remodeling. The extent of equipment and
28 materials to be removed. Routings for existing and new piping services and systems. Examine
29 accessibility, material storage and working space available.
30

- 31 B. Maintenance of Service: The building will be continuously occupied during the construction period
32 except as noted. Special efforts shall be made to avoid interference with building functions. Consult
33 with the Owner prior to performing work in public areas of building or to turn off services, so that
34 Owner can advise as to most suitable time for the necessary interruptions. All such work and
35 interruptions to services shall be performed at times, which are approved by the Owner.
36

- 37 C. Demolition: Carefully examine the present building site, together with all of the drawings and
38 specifications. Within areas involving remodeling, each Contractor shall be responsible for removal
39 of, relocation of, or revisions to existing equipment, wiring, piping, fixtures and all other existing
40 facilities under appropriate headings of his work, which is necessary to accomplish the final
41 arrangement indicated on the Architect's plans. To assist the Contractor in meeting the above
42 requirement, the drawings note certain of these items, but the absence of such notes shall not limit the
43 responsibility of each Contractor to perform all work as described in this paragraph.
44

- 45 D. Disposition of Demolition Materials and Equipment: Materials demolished or removed shall become
46 the property of the Contractor and shall be removed from the site, except items, which are to be
47 reused or are specifically noted as remaining the property of the Owner.
48

- 49 1. HVAC Contractor shall retain the services of a certified refrigerant recovery technician for
50 all R-22 refrigerant evacuation and recovery.
51

- 52 E. Cutting or Patching Existing Facility:
53

- 54 1. HVAC Contractor will be required to do all remodeling, cutting and/or construction removal
55 and all patching or construction replacement as required for his work except for specific
56 cutting and patching described in the documents as being performed by a specific Contractor.

2. HVAC Contractor shall not endanger any work by any demolition, cutting, digging or otherwise. Any cost caused by defective or ill-timed work shall be borne by the contractor responsible.
3. HVAC Contractor requiring cutting and patching shall hire men skilled in such cutting and patching to do the work.
4. All new work in existing areas shall match existing work in material, quality, texture, finish and color unless specifically noted or scheduled otherwise.

1.7 DEMOLITION

- A. The Contractor is responsible for removal and relocation of all existing HVAC equipment and related items affected by the remodeling area.
- B. To assist the Contractor in meeting the above design intent, the drawings note certain of these items, but the absence of such notes shall not limit responsibility of the Contractor to perform all demolition work as required to accomplish new design plan.
- C. Contractor shall coordinate his remodeling efforts with the building functions and avoid interference wherever possible. All such interruptions of existing services shall be performed at times which are approved by the Postmaster.
- D. Interruption of domestic water service during the course of demolition and new work shall be minimized. Interruptions of domestic water service shall be coordinated and approved by the Postmaster, prior to disconnecting or turning off.
- E. All existing demolished or removed equipment shall be removed from site and disposed of properly at the cost of the Contractor.

PART 2 - PRODUCTS

2.1 ELECTRICAL PROVISIONS OF HVAC WORK

- A. General: The electrical provisions of HVAC work, where indicated to be furnished integrally with HVAC equipment, can be summarized, but not by way of limitation, to include the following: 1) Motors, 2) Motor starters, 3) Control switch, pilot lights, interlocks, and similar devices, and 4) Drip pans to protect electrical work.
 1. Temperature Control Contractor (T.C.C.) shall furnish and install control wiring as part of the Temperature Control Contractor work.
 2. Power wiring, connections to equipment, motor control wiring and related work by Electrical Contractor.
 3. Motor starters, disconnects, relays, pushbuttons, pilot lights and related motor control items not furnished integrally with HVAC equipment shall be furnished by Electrical Contractor.
 4. Provide equipment list, locations and wiring diagrams to Electrical Contractor for all HVAC equipment requiring electrical connections.
- B. Wiring Connections:
 1. Motors: Wired connections in flexible conduit, except where plug-in electrical cords are indicated and permitted by governing regulations.
 2. General Wiring: Comply with applicable provisions of Electrical Division 16 sections of specifications.

2.2 FLOOR, WALL, ROOF AND CEILING OPENINGS

- 1 A. Provide sleeves for pipes and ducts passing through masonry, concrete or other similar construction.
- 2 Openings for pipes shall be 1" larger in diameter than pipe passing through, including insulation,
- 3 where indicated. Openings for ductwork shall be 1/2" larger on all sides than size of duct passing
- 4 through, including duct insulation, where indicated. Coordinate additional space requirements for fire
- 5 or smoke damper installation.
- 6
- 7 1. Pipe sleeves: Standard weight steel pipe.
- 8 2. Duct sleeves: 24 gauge galvanized sheet metal, unless noted otherwise.
- 9
- 10 B. Grout openings between sleeves and concrete or masonry walls and floors with sand-cement mortar
- 11 consisting of one part portland cement and three parts sand, by volume. Add sufficient water to make
- 12 a stiff placeable mortar.
- 13
- 14 C. Close joints between sleeves and non-masonry walls and floors with suitable caulking applied over
- 15 polyethylene foam backer, compatible with caulking used.
- 16
- 17 D. Pack annular space between sleeves and insulation pipe or ducts with glass fiber blanket insulation
- 18 and seal with Urethane caulking compound.
- 19
- 20 E. Where penetrations occur through fire rated walls or floors, fill annular space with fire-resistive
- 21 materials in compliance with a UL approved fire rated assembly. Seal annular space through fire
- 22 rated walls or floors with a UL listed fire resistant sealant and materials in conjunction with the fire
- 23 rated assembly.
- 24

25 **2.3 CUTTING AND PATCHING**

- 26
- 27 A. General: Perform all cutting and patching required for complete installation of HVAC systems,
- 28 unless specifically noted otherwise. Provide all materials required for patching unless otherwise
- 29 noted. All cutting and patching necessary of structural members to install any HVAC work shall not
- 30 be done without permission, and then only carefully done under the direction of the Architect.
- 31
- 32 B. All new work cut or damaged shall be patched and restored to its original condition.
- 33

34 **2.4 EQUIPMENT ACCESS**

- 35
- 36 A. General: All valves, volume dampers, equipment and accessories shall be installed to permit access
- 37 to equipment for maintenance, servicing or repairs. Any relocation of piping ductwork, equipment or
- 38 accessories required to provide maintenance access shall be accomplished by the HVAC Contractor at
- 39 no additional cost to the Owner.
- 40
- 41 B. Provide access doors where equipment is located in chases or generally inaccessible. Access doors
- 42 used in fire-rated construction must have UL label. Minimum access panel size 12" x 12" or of
- 43 sufficient size to allow total access for maintenance. Coordinate location with General Contractor.
- 44
- 45 C. Access panels shall be furnished and installed by the HVAC Contractor in plaster walls, ceilings and
- 46 related inaccessible surfaces.
- 47
- 48 D. Access Doors: Milcor or approved equal, steel frames and door, prime coated, except stainless steel
- 49 in areas subject to excessive moistures, such as toilet rooms.
- 50

51 **2.5 EQUIPMENT SUPPORTS**

- 52
- 53 A. General: Provide all supporting steel and related materials not indicated on structural drawings as
- 54 required for the installation of equipment and materials, including angles, channels, beams and
- 55 hangers.
- 56

57 **2.6 EQUIPMENT GUARDS**

- 1
2 A. General: Provide equipment guards over belt-driven assemblies, pump shafts, exposed fans and
3 elsewhere, as indicated in this specification or required by code.
4

5 **2.7 CONCRETE FOR HVAC WORK**
6

- 7 A. General: All concrete work necessary for HVAC equipment by the HVAC Contractor.
8
9 B. General Standards: Except as otherwise indicated, comply with applicable provisions of Division 3
10 for concrete work.
11
12 C. Concrete Equipment Pads: For each piece of HVAC equipment as indicated on the drawings, arrange
13 to install a 4" concrete housekeeping pad a minimum of 2 inches wider than full size of the respective
14 equipment's base. Equipment pads are required for the following equipment.
15
16 1. Air-cooled Condensing Units.
17

18 **2.8 PAINTING HVAC WORK**
19

- 20 A. General: All painting of mechanical equipment will be done by the HVAC Contractor unless
21 equipment is hereinafter specified to be furnished with factory applied finish coats. Coordinate the
22 exterior finish painting and color of exterior HVAC equipment with the General Contractor.
23
24 1. Exposed ductwork in finished areas outside mechanical rooms shall be cleaned for accepting
25 a paint finish or have factory-applied paint grip finish.
26 2. Exposed ductwork scheduled for a paint finish shall be shop painted from a finish color
27 selected by the Owner.
28
29 B. Prime paint all field fabricated metal work under HVAC work, comply with applicable provisions of
30 Division 9.
31

32 **2.9 HVAC SYSTEM IDENTIFICATION**
33

- 34 A. General: Provide adequate marking of HVAC system and control equipment to allow identification
35 and coordination of maintenance activities and maintenance manuals. Tag and label HVAC
36 equipment located in exposed or in accessible areas to conform to ANSI A13.1-1981. After painting
37 and/or covering is complete, identify all equipment, piping and ductwork by its abbreviated generic
38 name as shown/scheduled/specified.
39
40 B. Equipment: Identify all major HVAC equipment with plastic-laminate signs or 2" minimum high
41 painted stencils and contrasting background. Provide text of sufficient clarity and lettering to convey
42 adequate information at each location and mount permanently. Identify control equipment by 1-1/2"
43 x 4" plastic nameplates with 1/2" high lettering.
44
45 C. Piping and Ductwork: Identify piping and ductwork once every 30 feet at each branch, at termination
46 of lines, and near valve or equipment connections. Place flow directional arrows at each pipe or duct
47 identification. Provide 2" minimum high letters on wrap-around siphonage, adhesive-backed or paint
48 stenciled.
49
50 1. Within boiler room provide piping identification every 10 feet and at each branch and
51 termination.
52
53 D. Valves: Identify all valves with 1-1/2" minimum polished brass stamp-engraved or plastic laminate
54 tags. Prefix or color-code tags for each generic piping service. Prepare and submit valve tag
55 schedule, listing location, service and tag description, incorporate in Instruction Manual. Mount
56 valve tag schedule behind glass in mechanical room at location determined by Owner.
57

- 1 E. Operational Tags: Where needed for proper or adequate information on operation and maintenance
2 of HVAC systems, provide tags of plasticized or laminated card stock, typewritten to convey the
3 message.
4

5
6 **PART 3 - EXECUTION**
7

8 **3.1 HVAC WORK CLOSEOUT**
9

- 10 A. Lubrication: Upon completion of the work and before turning over to the Owner clean and lubricate
11 all bearings except sealed and permanently lubricated bearings. Use only lubricant recommended by
12 the
13 manufacturer.
14
15 B. Contractor is responsible for maintaining lubrication of all mechanical equipment under his contract
16 until work is accepted by the Owner.
17
18 C. Cleaning: After installation has been completed, Contractor shall clean all systems. All piping and
19 ductwork shall be cleaned both internally and externally to remove all dirt, plaster dust or other
20 foreign materials. All temporary throwaway or replaceable media air filters used during the
21 construction period shall be replaced by new filters or new filter media after construction has been
22 completed and before the building is turned over to the Owner. Check all strainers for clean screens.
23
24 D. All dirt, plaster dust and other foreign matter shall be blown and/or vacuum cleaned from coils,
25 terminal devices, diffusers, registers and grilles. Equipment shall be thoroughly cleaned of all stains,
26 paint spots, dirt and dust.
27
28 E. House Cleaning and Cleanup: Periodically as work progresses and/or as directed by the Architect,
29 the Contractor shall remove waste materials from the building and leave his area of work broom
30 clean. Upon completion of work, remove all tools, scaffolding, broken and waste materials, etc.,
31 from the site.
32

33 **3.2 INSTRUCTION AND MAINTENANCE MANUALS**
34

- 35 A. Instruction Manuals: Upon completion of work, but before final acceptance of the system, furnish to
36 the Engineer for approval, three (3) instruction and maintenance manuals in loose leaf binders. One
37 approved copy shall be returned for use during instructional period. Manual shall have an index of
38 contents and tab for each piece of equipment or system, as well as the following:
39
40 1. Manufacturer's O&M instructions, parts list and data sheets.
41 2. Copies of all shop drawings.
42 3. Wiring diagrams.
43 4. Start-up and shutdown procedures.
44 5. Composite electrical diagrams, and flow diagrams.
45 6. Test records.
46
47 C. Equipment Parts Lists: Include a complete list of all equipment furnished for project, with a
48 tabulation of descriptive data of all the equipment replacement parts proposed for each type of
49 equipment or system. Properly identify each part of part number and manufacturer.
50
51 D. Instruct Owner's maintenance personnel in the operation and maintenance of all equipment, including
52 composite operating cycle of all equipment. Include not less than 8 hours of instruction, using the
53 O&M manuals during this instruction. Demonstrate startup and shutdown procedures for all
54 equipment.
55

- 1 E. Service Organizations: At time of substantial completion, Contractor shall provide Owner with
2 listing of qualified service organizations, including addresses and telephone numbers for each piece
3 of major equipment.
4

5 **3.3 RECORD DRAWINGS**
6

- 7 A. Refer to Division 1 for further requirements.
8
9 B. Maintain a record set of as-built drawings for all HVAC work performed. As-built drawings shall be
10 continuously updated as the project progresses and be available for periodic inspection by the A/E.
11

12 **3.4 GUARANTEE PERIOD**
13

- 14 A. Guarantee all equipment, materials, and workmanship to be free from defects for one year after
15 acceptance by the Owner. Repair, replace or alter systems found defective at no extra cost to the
16 Owner.
17
18 B. At the time of substantial completion, turn over the prime responsibility for operation of HVAC
19 equipment and systems to the Owner's operating personnel. During guarantee period, provide one
20 operating engineer, familiar with the work, to consult with and continue training Owner's personnel
21 on an as-need basis.
22

23 **END OF SECTION**
24

**SECTION 23 06 00
PIPE AND PIPE FITTINGS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of pipe and pipe fitting work is indicated on drawings and by the requirements of this section.
- B. Types of pipe and pipe fittings required for this project include the following:
 - 1. Refrigerant piping.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Specified Elsewhere:
 - 1. 23 05 00 HVAC General Provisions
 - 2. 23 06 30 Piping Specialties
 - 3. 23 09 10 Supports and Anchors

1.3 QUALITY ASSURANCE

- A. Employ piping materials meeting the latest revision of ASTM specifications as listed in this specification.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Where possible, store pipe and tube inside and protected from weather. When necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping.
- B. Prevent dirt and construction debris from accumulating inside the pipe and pipe fittings, cap open ends whenever possible. Store plastic pipe out of direct exposure to sunlight and support to prevent sagging and bending.

1.5 SUBMITTALS

- A. Submit schedule of pipe and pipe fittings showing manufacturer and catalog number.
- B. Submittal may be in the form of a typewritten list, with proper references, indicating service and pipe or pipe fitting specifications.

PART 2 - PRODUCTS

2.1 REFRIGERATION PIPING

- A. ASTM B88 seamless, Type L, ACR hard temper copper tube with flare-type fittings or wrought copper ANSI/ASTM B32 grade 96TS silver-lead solder-joint fittings. Frost proof flare nuts on suction piping.

1. Refrigerant grade tubing; cleaned, dehydrated and capped.
2. Soft temper ACR copper tube line sets may be used on units less than 5 tons.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Set pipe on end and hammer sides to remove foreign materials before erection. Ream ends of all piping to remove burrs.

3.2 ERECTION

- A. Install all piping parallel to building walls and ceilings and at such heights not to obstruct any portion of window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings or other architectural details before installing piping.
- B. Provide anchors, expansion joints, swing joints and expansion loops so that piping may expand and contract without damage to itself, equipment or building.
- C. Install all valves, control valves and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

3.3 INSTALLATION OF PIPE

- A. Run pipe lines straight and true, parallel to building lines with minimum use of offsets and couplings.
- B. Provide only such offsets as may be required to provide necessary head room or clearance and to provide necessary flexibility in pipe lines.

C. Changes:

1. Changes in direction of pipe lines made only with fittings or pipe bends.
2. Changes in size shall be made only with fittings.
3. Do not use miter fittings, face of flush bushings or street elbows.
4. All fittings of long radius type, unless otherwise indicated.

D. Use full and double lengths wherever possible:

1. Cut pipe to exact measurement and install without springing or forcing except in case of expansion loops where cold springing is indicated.
2. Take particular care to avoid creating, even temporarily, undue loads, forces, or strains on valves, equipment or building elements either piping connections or piping supports.

- E. Install piping to allow for expansion and contraction without stressing pipe or equipment connected.

- F. Provide clearance for installation of insulation and for access to valves, air vents, drains, and unions.

G. Sizing:

1. Unless otherwise indicated, install all supply piping, including shut-off valves and strainers, to coils, pumps, and other equipment at line size with reduction in size being made only at inlet to control valve or pump.
2. Install supply piping from outlet of control valve at full size connection in equipment served.
3. Install outlet piping including dirt pockets or mud legs from equipment full size of connection in equipment served.
4. Install piping, check valves, strainers, and shut-off valves in these equipment outlet or return lines beyond dirt pockets size of tapping in trap or if no trap, size of equipment connection.

3.4 COPPER PIPE JOINTS

- A. Remove all slivers and burrs remaining from the tube cut by reaming and filing both pipe surfaces. Clean fitting and tube with emery or sand cloth. Remove residue from the cleaning operation, apply flux and assemble joint. Use solder or brazing to secure joint as specified for the specific piping service.

3.5 PIPE SYSTEM LEAK TESTS

- A. Conduct pressure test with test medium of air or water unless specifically indicated. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.
- B. No systems to be insulated until it has been successfully tested. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Minimum test time shall be as scheduled below plus such additional time as may be necessary to conduct the examination for leakage.
- C. For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges. Measure and record test pressure at the high point in the system.
- D. For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking. Perform the leak tests as follows:

System	Test Pressure	Medium	Duration
Refrigerant Piping	200 PSIG	Air	8 hours

END OF SECTION

**SECTION 23 06 30
PIPING SPECIALTIES**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Refrigeration Specialties.

1.2 RELATED DOCUMENTS

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

B. Specified Elsewhere:

1. 23 06 00 Pipe and Pipe Fittings

1.3 QUALITY ASSURANCE

A. Standards:

1. American National Standards Institute, ANSI: B31.1: Power Piping.
2. ANSI/ASHRAE 15, "Safety Code for Mechanical Refrigeration".

1.4 SUBMITTALS

- A. Submit shop drawings for all items including all data concerning dimensions, capacities, materials of construction, ratings, ranges, pressure drop and appropriate identification.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Construct devices for the highest pressures and temperatures existing in the respective systems in accordance with ANSI specifications.

2.2 REFRIGERATION SPECIALTIES

- A. Refrigerant Strainer: Brass shell and end connections, brazed joints, Monel screen, 100 mesh, UL listed, 350 psig working pressure.
- B. Moisture-Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections, UL listed 299 degrees F temperature rating, 500 psig work pressure.
- C. Refrigerant Filter-Driers: 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 psig working pressure.
- D. Expansion Valves:
1. Angle type or straight through design suitable for the 250 degree F temperature, 500 psig working pressure.

- 1 2. Brass body, internal or external equalizer, and adjustable superheat setting, complete with
- 2 capillary tube and remote sensing bulb.
- 3 3. Size expansion valves to avoid of being undersized at full load and excessively oversized at
- 4 partial load. Select valves for maximum load at design operating pressure and minimum 43
- 5 degrees F superheat.
- 6 4. Provide electronic controlled expansion valves where scheduled and recommended by the
- 7 equipment manufacturer for the application.
- 8
- 9

10 **PART 3 - EXECUTION**

11

12 **3.1 REFRIGERATION SPECIALTIES**

- 13
- 14 A. Refrigerant Strainers: Install in refrigerant lines as indicated, and in accessible location for servicing.
- 15
- 16 B. Moisture-Liquid Indicators: Install as indicated on refrigerant liquid lines, and in accessible
- 17 locations.
- 18
- 19 C. Refrigerant Filter-Dryers: Install in refrigerant lines as indicated, in accessible locations for service.
- 20 Install with bypass assembly to permit isolation for servicing.
- 21
- 22 D. Expansion Valves: Locate expansion valve sensing bulb immediately after evaporator outlet mounted
- 23 on the suction line properly insulated.
- 24
- 25 E. Install the expansion valve, indicator, solenoid valve and filter-drier as close to the evaporator as
- 26 possible.
- 27
- 28

29

END OF SECTION

**SECTION 23 09 10
SUPPORTS AND ANCHORS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Pipe hangers and supports for mechanical system piping.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of Division 1 govern work under this section.
- B. Specified Elsewhere:
- | | | |
|----|----------|-----------------------|
| 1. | 23 06 30 | Piping Specialties |
| 2. | 23 25 00 | Mechanical Insulation |

1.3 QUALITY ASSURANCE

A. Standards:

- | | | |
|----|--------------------|--------------|
| 1. | <u>ANSI B31.1:</u> | Power Piping |
| 2. | MSS SP58 & SP69 | |

1.4 SUBMITTALS

A. Submit shop drawings for the following:

1. Schedule of all manufactured hanger and support devices, indicating type of device for each pipe size range and type of service, including shielding devices as specified.

1.5 MANUFACTURERS

- A. Grinnell, Fee and Mason, Michigan Hanger, B-Line or Elcen, or approved equal.
- B. Grinnell figures listed as reference only.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 and SP-69 unless otherwise specified.
- B. Design supports of strength and rigidity to suit loading, service, and in manner, which will not unduly stress the building construction. Where support is from concrete construction, take care not to weaken concrete or penetrate waterproofing. Fasten supports and hangers to building steel framing whenever practical. Do not use perforated iron, chain or wire as hangers.
- C. Where piping can be conveniently grouped to allow the use of trapeze type supports, the supporting steel shall be by means of standard structural shapes or continuous insert channels. Where continuous

1 insert channels are used, pipe-supporting devices made specifically for use with the channels may be
2 substituted for the specified supporting devices provided that similar types are used and all data is
3 submitted for approval.

4 5 **2.2 EQUIPMENT SUPPORTS**

- 6
7 A. Provide all supporting steel, not indicated on the structural drawings, that is required for the
8 installation of mechanical equipment and materials, including angles, channels, beams, etc. to
9 suspend or floor support tanks and equipment.
10
11 B. Refer to HVAC Drawing details for further requirements.
12

13 **2.3 PIPE HANGERS AND SUPPORTS**

- 14
15 A. Manufacturers: Grinnell, Fee and Mason, Michigan Hanger, B-Line or Elcen similar to the Grinnell
16 figures listed.
17
18 B. Pipe Hangers Application:
19
20 1. 2" and smaller: Adjustable, swivel split ring type Grinnell Fig. 104 or lightweight,
21 adjustable clevis type Grinnell Fig. 65.
22 2. 2-1/2" and larger: Adjustable clevis type Grinnell Fig 260.
23
24 C. Hangers for copper pipe without insulation shall be either copper plated or PVC coated.
25

26 **2.4 INSULATION PROTECTION SHIELDS**

- 27
28 A. Application: Insulation protection shields are required on the following piping systems:
29
30 1. Cold piping (under 60 deg. F): All sizes.
31 2. Hot piping (over 120 deg. F): 2-1/2" and larger piping.
32
33 B. Insulation Protection Shields: Grinnell Fig. 167, Fee & Mason or Elcen or other approved product,
34 constructed of galvanized carbon steel. Select shield to accommodate outer diameter of insulation.
35 Shield lengths and gauge shall be as follows:
36

<u>Pipe Size</u>	<u>Length</u>	<u>Gauge</u>
1/2" thru 2-1/2"	12"	18
3" thru 6"	18"	16
8" thru 12"	24"	14

41 42 **2.5 HANGER SUPPORT INSULATION**

- 43
44 A. Application: Piping 2-1/2" diameter and larger in conjunction with insulation protection shields to
45 resist compression of insulation system.
46
47 B. Hanger insulation system shall cover bottom half of pipe at the same thickness as pipe insulation
48 system.
49

50 **2.6 PIPE HANGER RODS**

- 51
52 A. Support rods shall conform to the latest MSS standards except as modified herein.
53
54 B. Size rods for individual hangers and trapeze support as indicated in the following schedule:

<u>Pipe size</u>	<u>Maximum Rod Diameter</u>	<u>Load (lbs.)</u>
Up to 2"	3/8"	610

- C. Furnish rods complete with adjusting and lock nuts.
- D. In piping 4 inches and larger, each valve shall be supported.

2.7 HANGERS AND SUPPORT SPACING

- A. Space pipe hangers and supports in accordance with the following schedule, with exceptions as indicated herein:

<u>Pipe size</u>	<u>Steel</u>	<u>Copper</u>
Up thru 1-1/4"	8'-0"	6'-0"
1-1/2" and 2"	10'-0"	8'-0"
2-1/2" and 3"	12'-0"	10'-0"
4" and 5"	14'-0"	10'-0"
6" to 12"	14'-0"	10'-0"

- B. Place hangers to meet the requirements of the piping section of this specification, with regard to pitch for drainage and venting, and clearance between services.
- C. Place hangers within one foot of each elbow and at each valve and strainer for piping 4" and above.

2.8 BEAM CLAMPS

- A. Grinnell Fig. 87 Series beam clamps with retaining clip for hanger rods to 5/8". Maximum load 440 lbs.
- B. Grinnell Fig. 228 beam clamps with links for hanger rods 3/4" and above.

2.9 RISER CLAMPS

- A. Grinnell Fig. 261 for steel pipe, CT-121 for copper tubing.

2.10 CONCRETE INSERTS

- A. Grinnell Fig. 285, 281 or 282, poured concrete ceiling insert, suitable for rod diameter and weight supported.
- B. Inserts drilled and placed after concrete pour shall have steel shell with expander plug, not depending on soft lead for holding power.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install supports to provide for free expansion of the pipe. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.
- B. Coordinate hanger and support installation to properly group piping of all trades.

- 1
- 2 **3.2 INSULATION PROTECTION SHIELDS**
- 3
- 4 A. Install insulation protection shields at support points for insulated piping as scheduled herein.
- 5
- 6 B. Spacing shall be 10'-0" maximum based on insulation with a compressive strength of 15 psi. For
- 7 insulation with compressive strengths greater than 15 psi, span may be increased proportionally up to
- 8 a maximum allowable as listed under hanger and support spacing in this section.
- 9
- 10 **END OF SECTION**

SECTION 23 25 00
MECHANICAL INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of mechanical insulation required by this section is indicated on drawings, and by requirements of this section.
- B. Work shall include all labor, equipment, accessories, materials and services required to furnish and install all insulation, fittings and finishes for piping, ducts and related mechanical equipment in the Heating, Ventilating and Air Conditioning Systems.
- C. The following types of insulation are specified in this section:
 - 1. Pipe insulation.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Specified Elsewhere:
 - 1. 23 06 00 Pipe and Pipe Fittings
 - 2. 23 09 10 Support and Anchors

1.3 QUALITY ASSURANCE

- A. Acceptable Manufacturers:
 - 1. Owens-Corning
 - 2. Schuller
 - 3. Certainteed
- B. All insulating products delivered to the construction site shall be labeled with the manufacturer's name and description of materials.
- C. All insulation installation methods shall be performed in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions, except as modified in this section of specifications.

1.4 SUBMITTALS

- A. Submit shop drawings for insulation systems, including a schedule for all insulating materials, including adhesives, fastening methods, fitting materials, installed thickness and intended use of each material.
- B. Submittal shall include catalog sheets indicating density, thermal characteristics, jacket, and installation instructions.

PART 2 - PRODUCTS

1
2 **2.1 MATERIALS**

3
4 A. All products including vapor barriers and adhesives shall conform to NFPA Section 90A. All
5 products except pipe insulation shall possess a flame spread rating of not over 25, without evidence of
6 continued progressive combustion, and a smoke developed rating no higher than 50.
7

8 **2.2 PIPING INSULATION SCHEDULE**

9
10 A. Insulation Thickness Pipe Size Schedule:

Type of System	Fluid Temp. Range Deg F	*Run-outs Up to 2"	1" and Less	1-1/4" -2"	2-1/2" -4"	5&6 inch	8"& Up
----------------	-------------------------	--------------------	-------------	------------	------------	----------	--------

11
12
13
14
15
16
17 Cooling Systems:

Refrigerant Suction	40-55	0.5	0.75	1.0	1.0	1.0	1.0
---------------------	-------	-----	------	-----	-----	-----	-----

18
19
20 *Runouts are extensions to individual terminal units not exceeding 12 ft. in
21 length.
22

23 B. Insulation thickness shown in schedule are based on products having a maximum "k" factor of 0.26 at
24 a mean temperature of 75 degrees F. These thicknesses can be reduced for products having
25 significantly lower "k" values and shall be increased for products having higher "k" values in order to
26 produce equivalent or greater thermal resistance. ("R" value of products equals the thickness of the
27 insulation divided by the "k" factor.)
28

29 C. Insulation Application Schedule:

Type of System	Fluid Temp. Range (deg. F)	Type of Insulation
Refrigerant Suction	40-55	Elastomeric

30
31
32
33
34
35
36
37 **2.3 PIPE INSULATION**

38
39 A. Flexible elastomeric thermal insulation with a "k" factor of 0.26 at 75 degrees F mean density of 5.0
40 lbs./cu. ft. and a maximum water vapor transmission of 0.17 per inch. Seal joints with manufacturers
41 standard sealant. (Armaflex AP-Flame Spread 25, smoke development 50 per ASTM E 84-75, -40
42 degrees to 220 degrees F usage).
43

44 1. Provide Aluminum or UV-resistant PVC jacket for all exposed exterior piping insulation.
45
46

47 **PART 3 - EXECUTION**

48
49 **3.1 GENERAL INSTALLATION**

50
51 A. Application of insulation materials to piping, equipment, tanks and ductwork shall be done in
52 accordance with manufacturer's written recommendations. Where thickness of insulation is not
53 specified, use applicable thickness recommended by manufacturer and required by applicable codes.
54

- 1 B. All insulation shall be continuous through wall and ceiling openings and sleeves. All covered pipe
2 and ductwork is to be located a sufficient distance from walls, other pipe, ductwork and other
3 obstacles to permit the application of the full thickness of insulation specified. (If necessary, extra
4 fittings and pipe are to be used.).
5

6 **3.2 PIPING INSTALLATION**

7

- 8 A. All pipe installation shall be installed with joints butted firmly together. All valves and fittings shall
9 be insulated with mitered sections of insulation equal in density and thickness to the adjoining
10 insulation by one of the following methods:
11

- 12 1. Premolded PVC fittings installed in accordance with the manufacturer's instructions.
- 13 2. Jackets on pipe insulation laps are to be vapor sealed using self-sealing lap, lap-seal tape gun
14 or adhesive such as Armstrong 520. All insulation ends are to be tapered and sealed
15 regardless of service.
16

- 17 B. Provide removable insulation sections to permit easy access where inspection, service and/or repairs
18 are required.
19

- 20 1. Insulation for valves, unions (cold only), strainers, flexible connections and expansion joints
21 shall be removable for inspection and repair.
22

- 23 C. On all cold piping insulated with vapor barrier covering, use protection shield to over bottom one-half
24 of insulated pipe. Provide half-round, 12" long, hanger block at the bottom half of the pipe in place
25 of the fiberglass pipe insulation. The hanger blocks shall be molded cork or calcium silicate pipe
26 insulation of the same thickness as the adjoining fiberglass pipe insulation. The vapor barrier jacket
27 shall be continuous through the hanger location.
28

- 29 1. Provide removable elastomeric insulation wraps over cold piping unions.
30

- 31 D. Vapor barrier jackets shall be applied with a continuous, unbroken vapor seal. Pipe hangers on cold
32 lines (dual temperature piping) are to be sized large enough to be installed over the outer surface of
33 the insulation.
34

- 35
36 F. Refrigerant line insulation shall be at room temperatures when insulation is applied.
37

- 38 G. Omit insulation for the following:
39

- 40 1. Discharges piping from safety and relief valves to outlets.
- 41 2. Piping unions on hot only (HWS&R) systems.
- 42 3. Provide removable insulation jackets over unions and valves for hot/chilled water systems.
- 43 4. Hot water piping inside convactor, wall fin radiation and cabinet heater enclosures.
44

- 45 H. Seal all exposed end sections of pipe covering with a coat of vapor barrier mastic. Childers CP-30 or
46 equal.
47

- 48 I. No covering shall be applied until after piping is cleaned and tested, inspected and approved.
49

50 **3.3 PROTECTION AND REPLACEMENT**

51

- 52 A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor
53 barrier damage and moisture saturated units.
54

1 B. Protection: Insulation installer shall advise Contractor of required protection for insulation work
2 during remainder of construction; period, to avoid damage and deterioration.
3
4
5

END OF SECTION

SECTION 23 63 00
AIR PURIFICATION TREATMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This section includes requirements for water treatment related to the following:
1. Air Purification Treatment System
- B. Specification of an item in this section shall not relieve the HVAC Contractor from providing all items, materials, operations, methods, labor, equipment and incidentals necessary for a complete and functional system.
- C. All services will be performed by a qualified technician for the air purification treatment manufacturer.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Specified Elsewhere:
1. 23 06 00 Pipe and Pipe Fittings

1.3 REFERENCED CODES & STANDARDS

- A. The following codes and standards are referenced through out. The edition to be used is that currently enforced by the authority having jurisdiction (AHJ) or in absence of such direction that referenced by the current enforceable IBC code or as indicated by the contract documents, except where specifically referenced by this section of the specifications.
1. ASHRAE Standards 62 & 52
 2. National Electric Code NFPA 70
 3. UL 867-2007 including ozone chamber test required as of December 21, 2007
 4. UL 2998 Environment – No Ozone Certification
 5. The cold plasma equipment and power supply shall be UL listed.
 6. ASHRAE 62 now requires all electronic air cleaners to be UL 2998 certified as an ozone free device. Products without UL 2998 shall not be acceptable.

1.4 QUALITY AND ASSURANCE

- A. Basis of design is Global Plasma Solutions.
1. All other manufacturers requesting prior approval must submit product drawings, specifications and test results specified in section 2.2 at least two weeks prior to bid date.
- B. The Air Purification System shall be a product of an established manufacturer within the USA. Direct Current (DC) Ion modules manufactured outside the USA and assembled in the USA on mounting plates or formed channels shall not be acceptable.

- 1 C. A qualified representative from the manufacturer shall be available to inspect the installation
2 of the air purification system to ensure installation in accordance with manufacturer's
3 recommendation.
4
- 5 D. The Air Purification Technology shall have been tested by UL to prove conformance to UL
6 867-2007 including the ozone chamber testing and peak ozone test for electronic devices.
7 Manufacturers that achieved UL 867 prior to December 21, 2007 and have not been tested in
8 accordance with the newest UL 867 standard with the ozone amendment shall not be
9 acceptable.
10
- 11 1. All manufacturers requesting prior approval shall submit their independent UL 867
12 test data with ozone results to the engineer for preliminary review and during the
13 submittal process.
 - 14 2. All manufacturers shall submit a copy with their quotation. Contractors shall not
15 accept any proposal without the proper ozone testing documentation.
 - 16 3. The maximum allowable ozone concentration per the UL 2998 chamber test shall be
17 5 PPB.
 - 18 4. Manufacturers with ozone output exceeding these ozone values shall not be
19 acceptable.
 - 20 5. All manufacturers shall have their product tested to UL 2998 Environmental Standard
21 for confirmation of no ozone with certificate available. The final report shall indicate
22 the ozone levels and high voltage output the device's electrode(s) were operating
23 during the test. Reports that do not include high voltage output during the UL 2998
24 testing shall not be acceptable.
25

26 **1.5 SUBMITTALS**

- 27
- 28 A. Product Data: Submit manufacturer's technical product data for ion generators including:
29
- 30 1. Schedule of plasma generators indicating unit designation, number of each type
31 required for each unit/application.
 - 32 2. Data sheet for each type of plasma generator, and accessory furnished; indicating
33 construction, sizes, and mounting details.
 - 34 3. Performance data for each type of plasma device furnished.
 - 35 4. Product drawings detailing all physical, electrical and control requirements.
 - 36 5. Copy of UL 867 independent ozone test.
 - 37 6. Copy of UL 2998 conformance certificate.
 - 38 7. Statement on the manufacturer's letterhead stating that the technology contains no
39 titanium dioxide (TiO₂).
40

- 41 B. Operating & Maintenance Data: Submit O&M data and recommended spare parts lists.
42

43 **1.6 SUPERVISION AND INSPECTION**

- 44
- 45 A. Air purification treatment manufacturer or his qualified representative to provide supervision
46 and final inspection upon completion of installation and adjustment, shall submit report in
47 writing, certifying the correctness of the installation in compliance with the specifications and
48 proper operation.
49

50 **1.7 WARRANTY**

- 51
- 52 A. Equipment shall be warranted by the manufacturer against defects in material and
53 workmanship for a period of eighteen months after shipment or twelve months from owner

1 acceptance, whichever occurs first. Labor to replace equipment under warranty shall be
2 provided by the owner or installing contractor.
3
4

5 **PART 2 - PRODUCTS**

7 **2.1 AIR PURIFICATION TREATMENT**

8
9 **A. GENERAL:** The air purification system(s) shall be of the size, type, arrangement and
10 capacity indicate and required by the unit furnished and shall be of the manufacturer
11 specified.
12

- 13 1. Basis of Design: Global Plasma Solutions
- 14 2. Ionization bars manufactured using DC output ionization modules shall not be
15 permitted due to corrosion, ion short-circuiting, and intermittent coil coverage and
16 shock hazard.
- 17 3. Ionization bars manufactured using ion modules not having epoxy coating all circuit
18 boards and internal components shall not be acceptable.
19

20 **B. BI-POLAR IONIZATION DESIGN & PERFORMANCE CRITERIA:** Each piece of
21 air handling equipment, so designated on the plans, details, equipment schedules and/or
22 specifications shall contain a Plasma Generator with Bi-polar Ionization output as described
23 here within.
24

- 25 1. The Bi-polar Ionization system shall be capable of:
 - 26 a. Effectively killing microorganisms downstream of the bi-polar ionization
27 equipment (mold, bacteria, virus, etc.).
 - 28 b. Controlling gas phase contaminants generated from human occupants,
29 building structure, furnishings and outside air contaminants.
 - 30 c. Capable of reducing static space charges.
 - 31 d. Effectively reducing space particle counts.
 - 32 e. When mounted to the air entering side of a cooling coil, keep the cooling coil
33 free from pathogen and mold growth.
- 34 2. All manufacturers shall provide documentation by an independent NELEC accredited
35 laboratory that proves the product has minimum kill rates for the following pathogens
36 given the allotted time and in a space condition:
 - 37 a. MRSA - >96% in 30 minutes or less
 - 38 b. E.coli - > 99% in 15 minutes or less
 - 39 c. TB - > 69% in 60 minutes or less
 - 40 d. C. diff - >86% in 30 minutes or less
 - 41 e. Noro Virus -> 93.5% in 30 minutes or less
 - 42 f. Legionella -> 99.7% in 30 minutes or less
- 43 3. Manufacturers not providing the equivalent space kill rates shall not be acceptable.
44 All manufactures requesting prior approval shall provide to the engineer independent
45 test data from a NELAP accredited independent lab confirming kill rates and time
46 meeting the minimum requirements stated in section 2.2 B, points 6A, 6B and 6C.
47 Products tested only on Petri dishes to prove kill rates shall not be acceptable.
48 Products being sold under different trade names than those tested shall not be
49 acceptable.
- 50 4. Capable of modular field assembly in six inch (150mm) sections.
- 51 5. The bi-polar ionization system shall operate in a manner such that equal amounts of
52 positive and negative ions are produced. Uni-polar ion devices shall not be
53 acceptable. Ionizers with positive and negative output (DC type) shall not be

- 1 acceptable. All ionizers provided shall be AC type ionizers with one electrode
- 2 pulsing between positive and negative.
- 3 6. Velocity Profile: The air purification device shall not have maximum velocity
- 4 profile.
- 5 7. Humidity: Plasma Generators shall not require preheat protection when the relative
- 6 humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%,
- 7 condensing, shall not cause damage, deterioration or dangerous conditions within the
- 8 air purification system. Air purification system shall be capable of wash down duty.
- 9

10 **C. EQUIPMENT REQUIREMENTS: Electrode Specifications (Bi-polar Ionization):**

- 11
- 12 1. Each alternating current (AC) Ionization Bar with Bi-polar Ionization output
- 13 shall include a minimum of eighteen carbon fiber cluster ion needles per foot of coil
- 14 face width shall be provided.
- 15 2. The entire cooling coil width shall have equal distribution of ionization across the
- 16 face.
- 17 3. Systems without ion needles at least 0.50" (12.5mm) apart shall not be acceptable.
- 18 4. The plasma electrode shall require no more than 1.0" (25mm) in the direction of
- 19 airflow for mounting.
- 20 5. All hardware required for mounting shall be provided by the air purification
- 21 manufacturer except self-tapping screws for the power supply.
- 22 6. Bi-polar ionization tubes manufactured of glass and steel mesh shall not be
- 23 acceptable due to replacement requirements, maintenance, and performance output
- 24 reduction over time, ozone production and corrosion.
- 25 7. Electrodes shall be provided in 6.0" (150mm) increments, epoxy filled for an IP55
- 26 rating and utilizing brass connection hardware that is recessed into the connection
- 27 joint once fully engaged and assembled.
- 28 8. Electrodes shall be energized when the main unit disconnect is turned on.
- 29 9. The ionization output shall be a minimum of 60 million ions/cc per inch of cooling
- 30 coil width as measured 1 inch from the cold plasma needles.
- 31 10. Ionization bars shall be provided with magnet mounting kits to prevent penetration
- 32 into cooling coils.
- 33 11. Ionization bars shall be constructed of UL 94VO and UL746C composite material.
- 34 If the ionization bars are mounted immediately downstream from a humidifier,
- 35 protective rain covers shall be provided over the ionization bars by the installing
- 36 contractor. The design of the cover shall be confirmed with the ionization
- 37 manufacturer prior to installation.
- 38

39 **D. AIR HANDLER MOUNTED UNITS:** Where so indicated on the plans and/or schedules

40 Plasma Generator(s) shall be supplied and installed.

- 41
- 42 1. The mechanical contractor shall mount the Plasma Generator and wire it to the
- 43 remote mount power supply using the cables provided by the air purification
- 44 manufacturer.
- 45 2. A 24VAC, 115VAC or 208-230VAC circuit shall be provided to the plasma
- 46 generator power supply panel.
- 47 3. No more than 15 watts shall be required per power supply. Each power supply shall
- 48 be capable of powering up to 6 ionization bars or a total of 50 linear feet of bar(s).
- 49 4. Each plasma generator shall be designed with fiberglass housing, liquid tight flexible
- 50 conduit and a high voltage quick connector.
- 51 5. Where the ionization bars are mounted downstream of steam humidifiers, the air
- 52 handler manufacturer shall provide an angled hat section that will cover the
- 53 ionization bars and deflect any direct condensation towards the floor and off the bars.
- 54

- 1 **E. PLASMA REQUIREMENTS:** Plasma Generators with Bi-polar ionization output shall
2 be capable of controlling gas phase contaminants and shall be provided for all equipment
3 listed above.
4
- 5 1. The Bi-polar ionization system shall consist of Bi-Polar Plasma Generator and power
6 supply.
 - 7 2. The Bi-polar system shall be installed where indicated on the plans or specified to be
8 installed.
 - 9 3. The device shall be capable of being powered by 24VAC, 115VAC or 208-230VAC
10 without the use of an external transformer.
 - 11 4. Ionization systems requiring isolation transformers shall not be acceptable.
 - 12 5. Ionization Output: The ionization output shall be controlled such that an equal
13 number of positive and negative ions are produced (AC Ionizers only are acceptable).
14 Imbalanced levels shall not be acceptable.
 - 15 6. Ionization output from each bar shall be a minimum of 120 million ions/cc per inch
16 of bar when tested at 1" from the ionization bar. Bars with needles spaced further
17 apart than 0.5" shall not be acceptable.
 - 18 7. Each plasma electrode shall be made from an all fiberglass composite, UL 94V0 and
19 UL 746C rated material for prevention of corrosion and electrical insulation.
 - 20 8. Ozone Generation: The operation of the electrodes or Bi-polar ionization units shall
21 conform to UL 2998 as tested by UL proving no ozone output.
22
- 23 **F. ELECTRICAL REQUIREMENTS:** Wiring, conduit and junction boxes shall be installed
24 within housing plenums in accordance with NEC NFPA 70. Plasma Generator shall accept
25 an electrical service of 24VAC, 115 VAC or 208-230VAC, 1 phase, 50/60 Hz.
26
- 27 **G. CONTROL REQUIREMENTS:** All Plasma Generators shall have internal short circuit
28 protection, overload protection, and automatic fault reset. Systems requiring fuses shall not
29 be acceptable.
30
- 31 1. The Plasma Generator power supply shall have internal circuitry to sense the
32 ionization output and provide dry contact alarm status to the BMS as well as a local
33 "Plasma On" indication light.
 - 34 2. If scheduled, the ionization system shall be provided with a stand-alone, independent
35 ion sensor designed for duct mounting to the ionization bar to monitor the ion output
36 and report to the BAS system that the ion device is working properly.
 - 37 3. Ion systems provided without an independent ion sensor, shall not be permitted.
 - 38 4. The control voltage to power the ion sensor shall be 24VAC to 260VAC and draw no
39 more than 150mA of current.
 - 40 5. The sensor shall provide at minimum, dry contact status to the BAS and optionally a
41 BacNet or Lonworks interface as specified on the control drawings. If scheduled,
42 manufacturers not providing a stand-alone ion sensor shall not be acceptable.
 - 43 6. The installing contractor shall mount and wire the Plasma device within the air
44 handling unit specified or as shown on the plans.
 - 45 7. The contractor shall follow all manufacturer IOM instructions during installation.
 - 46 8. An optional fiberglass NEMA 4X panel with Plasma On/Off Indicator Light
47 (interfaced with stand-alone ionization detector), Ionization Output On/Off Indicator
48 Light and an On/Off Illuminated Switch shall be provided to house the power supply,
49 if noted on the schedule.
50
51

52 **PART 3 - EXECUTION**

53 **3.1 GENERAL**

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26

- A. The Contractor shall be responsible for maintaining all air systems until the owner accepts the building (Owner Acceptance).

3.2 ASSEMBLY & ERECTION: PLASMA GENERATOR

- A. All equipment shall be assembled and installed in a workman like manner to the satisfaction of the owner, architect, and engineer.
- B. Any material damaged by handling, water or moisture shall be replaced, by the mechanical contractor, at no cost to the owner.
- C. All equipment shall be protected from dust and damage on a daily basis throughout construction.

3.3 TESTING

- A. Provide the manufacturers recommended electrical tests.

3.4 COMMISSIONING & TRAINING

- A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

END OF SECTION

SECTION 23 66 00
AIR-COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Pad-mounted condensing units.
- B. Refrigerant piping and controls.
- C. Refrigerant charge.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Specified Elsewhere:
 - 1. 23 05 00 HVAC General Provisions
 - 2. 23 06 00 Pipe and Pipe Fittings
 - 3. 23 06 30 Piping Specialties

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Air Conditioning and Refrigeration Institute, ARI:
 - a. ARI 210: Unitary Air Conditioning Equipment.
 - b. ARI 270: Sound Rating.
 - 2. Underwriter's Laboratories, UL: Conform to requirements of UL.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit with shop drawings, schematic layouts showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system.
 - 2. Submit complete pipe sizing data and piping schematic for refrigerant piping with valves and refrigerant specialties indicated.
 - 3. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Air Cooled Condensing Units:

- 1. AAON

2.2 TYPE AND PERFORMANCE

1 A. Self-contained, packaged, factory-assembled and prewired units suitable for outdoor use
2 consisting of cabinet, compressors, condensing coils and fans, integral sub-cooling coil,
3 controls, liquid receiver, wind deflector, and screens.
4

- 5 1. Refrigerants: R-410A as scheduled.
6 2. Two circuits, where scheduled.
7

8 B. Minimum Operating Condition EER: As scheduled minimum.
9

10 C. Electrical Service: 208 volt, 3-phase, 60 Hertz.
11

12 **2.3 MATERIALS**

13
14 A. Use corrosion-resistant materials for parts in contact with refrigerant.
15

16 B. Timer circuits to prevent rapid loading and unloading of compressor.
17

18 **2.4 CABINET**

19
20 A. Galvanized steel (14 gauge) with anti-corrosion, baked enamel finish, and removable access
21 doors or panels with quick fasteners.
22

23 1. 2500 hrs salt spray tested exterior paint finish.
24

25 B. PVC coated steel wire condenser coil guard.
26

27 **2.5 COMPRESSORS**

28
29 A. Hermetically sealed, 1750 or 3500 RPM, resiliently mounted compressor with positive
30 lubrication, crankcase heater, motor overload protection, service valves, and filter-drier.
31

- 32 1. Modular scroll compressors.
33 2. Digital modulating capacity scroll compressors, where scheduled.
34

35 B. Extended compressor warranty: 5 years.
36

37 **2.6 CONDENSER**

38
39 A. Coil: Seamless copper tubing with aluminum fins.
40

41 B. Fans: Vertical discharge, direct-drive axial fans, resiliently mounted with guard and motor.
42

43 C. Motors: Permanently lubricated ball bearing motors with built-in current and overload
44 protection.
45

46 **2.8 CONTROLS**

47
48 A. High and low pressure cut-outs for compressor, oil pressure control, anti-cycle timer 5 min.
49 (adj.) and reset relay.
50

51 B. Accessory Controls: As scheduled on Drawings.
52

- 53 1. One circuit: digital scroll compressor with modulating capacity(0-5 VDC control
54 signal).

- 1 2. Low-ambient(35 deg F) modulating condenser fan speed(ECM motor) controlled by
2 refrigerant condensing pressure.
- 3 3. Anti-corrosion paint finish.
- 4
- 5 C. Unit Controls:
- 6
- 7 1. 115 volt 1-phase fusing and control power transformer.
- 8 2. Magnetic contactors for compressor and condenser.
- 9 3. High/low pressure cutouts.
- 10 4. Reset relay.
- 11 5. Anti-recycle compressor timer.
- 12 6. Terminal strip for Temperature Control Contractor interface and control of cooling
13 enable/disable and steps or modulation.
- 14
- 15

16 **PART 3 - EXECUTION**

17

18 **3.1 INSTALLATION**

19

- 20 A. Complete structural, mechanical, and electrical connections in accordance with
21 manufacturer's installation instructions.
- 22
- 23 B. Furnish charge of refrigerant and oil.
- 24

25 **3.2 FIELD QUALITY CONTROL**

26

- 27 A. Start-up: Supply initial charge of refrigerant and oil for each refrigeration system.
- 28
- 29 B. Testing:
- 30
- 31 1. Charge system with refrigerant and test entire system for leaks after completion of
32 installation.
- 33 2. Repair leaks, put system into operation, and test equipment performance.
- 34 3. Shut-down system if initial start-up and testing takes place in winter and machines
35 are to remain inoperative.
- 36 4. Repeat start-up and testing operation at beginning of first cooling season.
- 37
- 38 C. Manufacturer's Start-up Test Report and Acceptance:
- 39
- 40 1. Submit start-up test report and acceptance letter from Manufacturer's representative
41 indicating the air-cooled condensers are properly installed and piped for refrigerant
42 flow.
- 43 2. Test report shall indicate operating pressures and temperatures for the suction and
44 liquid lines under normal cooling operation.
- 45
- 46

47 **END OF SECTION**

48

**SECTION 23 76 30
AIR HANDLING UNIT COILS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This section includes material specifications and installation requirements for air handling unit coils mounted in the units and other accessories normally furnished by the equipment supplier.
- B. Types of air handling units coils specified in this Section.
 - 1. Refrigerant Coils.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Specified Elsewhere:
 - 1. 23 06 30 Piping Specialties
 - 2. 23 63 00 Air Purification Treatment

1.3 SUBMITTALS

- A. Submittals are required for all material in this section.
- B. Submittals shall include all data concerning dimensions, performance capacities, materials of construction, weights.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

- A. Furnish units DX coils as shown on the plans and/or as scheduled. All materials shall meet requirements of NFPA 90A.
- B. Coils shall have the configuration as indicated on the plans and/or as scheduled.

2.2 REFRIGERANT COILS

- A. Construct coils of 1/2" or 5/8" O.D. min. copper tubes with aluminum fins suitable for working pressures to 200 PSIG.
 - 1. Provide distributor quantities as scheduled for multiple DX stages.
- B. Coil fins shall be the continuous or plate fin type. Maximum fin spacing 12 fins per inch.
- C. Construct coil headers with copper tubes expanded into the headers, copper pipe with brazed tube connections, or of heavy seamless copper with all tubes brazed to the header.

1 D. Casing shall have galvanized steel end supports and top and bottom channels of rigid construction
2 with allowance for expansion and contraction of the finned tube section.
3
4

5 **PART 3 - EXECUTION**
6

7 **3.1 COILS IN GENERAL**
8

9 A. Install coils in factory packaged air handling units or on a structural steel frame for field erected air
10 handling units as indicated on the drawings and/or as detailed. Pitch coils for proper drainage
11 according to the manufacturer's installation.
12

13 B. Comb out fins when bent or crushed before enclosing coils in housing. Clean dust and debris from
14 each coil to ensure its cleanliness.
15

16 C. Provide offsets in piping to facilitate coil removal. Unless otherwise specified, pipe coils for
17 counterflow arrangement.
18

19 **END OF SECTION**

Rating Sheet

MASTERS BUILDING SOLUTIONS INC

908 STEWART STREET / MADISON, WI 537130000

Phone # - 6082757001 / Fax # - 6082757002

Michel Robert

Customer: Hein Engineering Group
Quote #: 1000001

Job: Madison Water Utility
Item #: 1

12D26.25X97-10-6-W-F-R

CC-1

No. Coils:	2	Coil Type:	Direct Expansion
Fin Height (In.):	26.25	Fin Mat./Thickness/Type:	Aluminum/ 0.008/ Waffle
Fin Length (In.):	97	Tube Mat./Wall/OD:	Copper/ 0.017/ 1/2 Inch
Air Flow/Coil (ACFM/SCFM)	10459 / 10000 (S)	Tube Spacing:	1.25 x 1.0825
Totals (ACFM/SCFM):	20919 / 20000	Tube Surface:	Smooth
ACFM/SCFM Velocity (fpm):	591.5 / 565.5	Distributors per Coil:	2
EDB/EWB (°F):	78.5 / 64.6	Configuration:	Dual Circuit Intertwined
Suction Temperature (°F):	47.5	Casing Material:	304 SS
Liquid Temperature (°F):	110	Refrigerant:	R-410A
Rows/FPI:	6/10	Altitude (Feet):	800
SuperHeat:	8	FF Inside*:	0
Circuiting:	21/6/0/SE/Full	FF Outside*:	0

	Per Coil	Total All Coils
LDB/LWB (°F):	55.6 / 54.6	
Total Heat (BTUH):	303,650	607,300
Sensible. Heat (BTUH):	249,684	499,368
Circuit Load :	1.20	
Refrigerant Pressure Drop (psi):	2.46	
Air Pressure Drop (in W.G.):	1.05	
Connection Size (In.):	1.375	
Uncrated, Dry Coil Weight: 194.2		

Coil is outside of the scope of AHRI Standard 410.
Use of the Specified Fin Surface is NOT AHRI Certified.

Printed on 11/18/2020 using Total Package II; program version 9.23.2020.1 - DLL/Data 1.0.5.87/20200821.1

* (Hr*ft²*°F/Btu) Fouling Factor Units

We reserve the right to change or revise specifications and product design in connection with any feature of our products. Such changes do not entitle the buyer to corresponding changes, improvements, additions, or replacements for equipment previously sold or shipped.

Rating Sheet

MASTERS BUILDING SOLUTIONS INC

908 STEWART STREET / MADISON, WI 537130000

Phone # - 6082757001 / Fax # - 6082757002

Michel Robert

Customer: Hein Engineering Group
Quote #: 1000001

Job: Madison Water Utility
Item #: 2

12D25X37-10-6-W-Z-R

CC-2

No. Coils:	1	Coil Type:	Direct Expansion
Fin Height (In.):	25	Fin Mat./Thickness/Type:	Aluminum/ 0.008/ Waffle
Fin Length (In.):	37	Tube Mat./Wall/OD:	Copper/ 0.017/ 1/2 Inch
Air Flow/Coil (ACFM/SCFM):	3140 / 3000 (S)	Tube Spacing:	1.25 x 1.0825
ACFM/SCFM Velocity (fpm):	488.8 / 467	Tube Surface:	Smooth
EDB/EWB (°F):	78.9 / 64.5	Distributors per Coil:	2
Suction Temperature (°F):	47	Configuration:	Dual Circuit Intertwined
Liquid Temperature (°F):	110	Casing Material:	304 SS
Rows/FPI:	6/10	Refrigerant:	R-410A
SuperHeat:	8	Altitude (Feet):	800
Circuiting:	6/20/0/SE	FF Inside*:	0
		FF Outside*:	0

	Per Coil	Total All Coils
LDB/LWB (°F):	54.4 / 53.6	
Total Heat (BTUH):	98,148	98,148
Sensible. Heat (BTUH):	80,101	80,101
Circuit Load :	1.36	
Refrigerant Pressure Drop (psi):	4.82	
Air Pressure Drop (in W.G.):	0.78	
Connection Size (In.):	0.875	
Uncrated, Dry Coil Weight: 80.8		

Coil is outside of the scope of AHRI Standard 410.
Use of the Specified Fin Surface is NOT AHRI Certified.

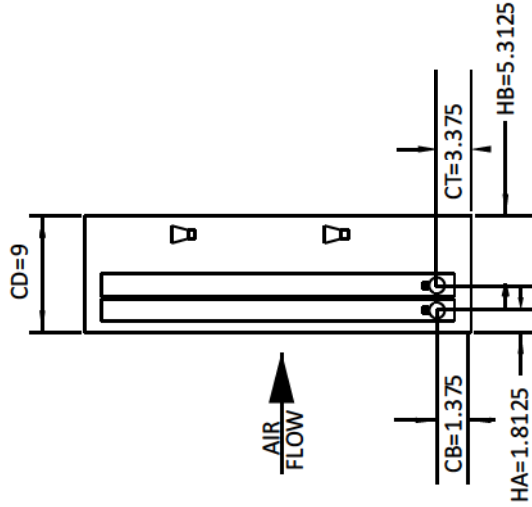
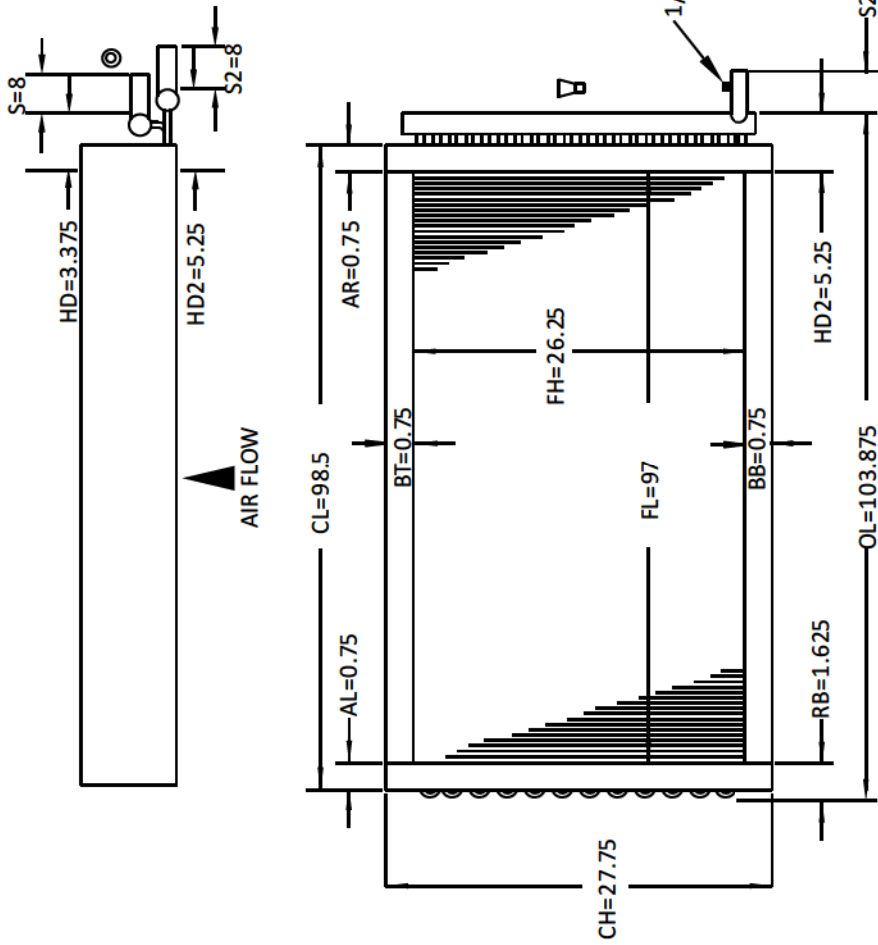
Printed on 11/18/2020 using Total Package II; program version 9.23.2020.1 - DLL/Data 1.0.5.87/20200821.1

* (Hr*ft²*°F/Btu) Fouling Factor Units

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MASTERS BUILDING SOLUTIONS INC

12D26.25X97-10-6-W-F-R
 Project: Madison Water Utility
 Tag: CC-1
 TP2 Number: 1000001 - 1 Qty(2)



Fin Type: Waffle
 Fin Material: Aluminum
 Fin Thickness: 0.008
 Rows/FPI: 6/10
 Circuiting: 2 1/6 0/SE/Full
 Tube Type: 1/2 Inch / Copper / Smooth
 Tube Thickness: 0.017
 Casing: 304 SS Gages: TS=16 / SP=16

Capacity = 303650 / Suction Temperature = 47.5 / Refrigerant = R-410A
 Tube Sheet Flange Standard
 Side Plate Flange: Stacking

Connection Material: Copper
 Liquid Connection Size: 0
 Suction Connection Size: 1.375
 Suction Header Dia.: 1.375
 Connection Type: ODS
 App. weight (Uncrated each) : 194.2

Date: 11/18/2020 12:24:47 PM Program Version: 9.23.2020.1 Sales Person: Michel Robert

4492 Hunt St Pryor, OK 74361 Phone 918.825.7222 Fax 1.800.264.5329

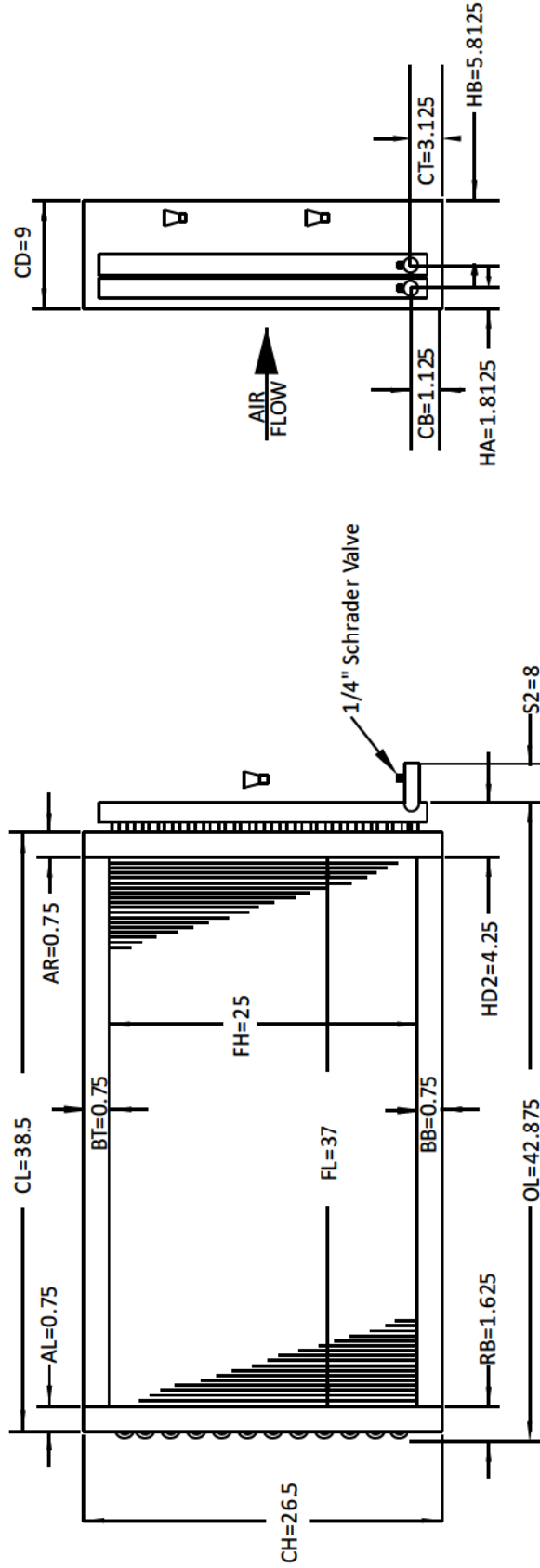
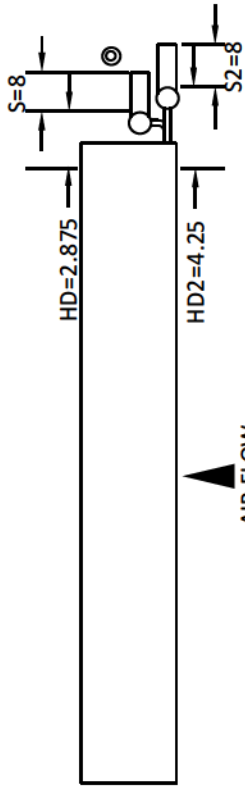
MASTERS BUILDING SOLUTIONS INC

12D25X37-10-6-W-Z-R

Project: Madison Water Utility

Tag: CC-2

TP2 Number: 1000001 - 2 Qty(1)



Fin Type: Waffle
 Fin Material: Aluminum
 Fin Thickness: 0.008
 Rows/FPI: 6/10
 Circuiting: 6/20/0/SE
 Tube Type: 1/2 Inch / Copper / Smooth
 Tube Thickness: 0.017
 Casing: 304 SS Gages: TS=16/SP=16

Capacity = 98148 / Suction Temperature = 47 / Refrigerant = R-410A
 Tube Sheet Flange Standard
 Side Plate Flange: Stacking

Connection Material: Copper
 Liquid Connection Size: 0
 Suction Connection Size: 0.875
 Suction Header Dia.: 0.875
 Connection Type: ODS
 App. weight (Uncrated each): 80.8

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**SECTION 23 95 00
CONTROL SEQUENCES**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Section 23 90 00 - Controls and Instrumentation, applies to the work of this section.

1.2 RELATED DOCUMENTS

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

B. Specified Elsewhere:

1. 23 95 10 DDC Point List

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Not Applicable.

PART 3 - EXECUTION

3.4 AIR HANDLER UNIT AH-1 & AH-2

- A. Occupied Mode: Modifications to the existing cooling control sequence:

Sequence on two(2) stages of mechanical cooling with modulating(0-5 VDV) signal to control each compressor capacity and maintain discharge air temperature set point. Rotate lead lag compressor operation.

END OF SECTION

SECTION 23 95 10
DDC POINT LIST

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Direct Digital Control (DDC) Point List.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Refer to schematic layout of control and HVAC equipment on HVAC drawings.
- C. Specified Elsewhere:
1. 23 95 10 Control Sequences

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Not Applicable.

PART 3 - EXECUTION

3.1 DDC POINT LIST

- A. Controls systems shall provide the DDC input/output control points and related as scheduled on the attached sheets 23 95 10 - 2.

END OF SECTION

DDC POINT LIST

<u>POINT DESCRIPTION</u>	<u>TYPE</u>	<u>OPERATION SCHEDULE</u>	<u>ALARM</u>	<u>HISTORY</u>	<u>FIELD DEVICE</u>
<i><u>AIR HANDLING UNIT AH-1</u></i>					
CU-1 Compressor A	ANALOG OUTPUT	CAPACITY	--	15 MIN.	0-5 VDC SIGNAL MOD COMP
CU-1 Compressor B	ANALOG OUTPUT	CAPACITY	--	15 MIN.	0-5 VDC SIGNAL MOD COMP
<i><u>AIR HANDLING UNIT AH-2</u></i>					
CU-1 Compressor A	ANALOG OUTPUT	CAPACITY	--	15 MIN.	0-5 VDC SIGNAL MOD COMP
CU-1 Compressor B	ANALOG OUTPUT	CAPACITY	--	15 MIN.	0-5 VDC SIGNAL MOD COMP
END OF SECTION					

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5 **SECTION 26 10 00**
6 **ELECTRICAL DEMOLITION AND ALTERATIONS**

7 **PART 1 - GENERAL**

8
9 **1.1 RELATED REQUIREMENTS**

- 10 A. Applicable requirements of Division 1 shall govern work in this section.

11 **1.2 JOB CONDITIONS**

- 12
13 A. The Electrical Contractor shall work with Owner to coordinate the disconnection of the all
14 electrical services to the building. It is the responsibility of the demolition contractor for
15 demolition of any interior electrical equipment. The Electrical Contractor shall verify for
16 demolition contractor that all electrical equipment is de-energized prior to demolition.
17
18 B. Prior to demolition or alteration of structures, the following shall be accomplished:
19
20 1. Owner release of such structure.
21 2. Disconnection of electrical power to equipment and circuits removed or affected by
22 demolition work.
23 3. Electrical services rerouted or shut off outside area of demolition.
24 4. Coordinate sequencing with Owner and other Contractors.
25 5. Survey and record condition of existing facilities to remain in place that may be
26 affected by demolition operations. After demolition operations are completed,
27 survey conditions again and restore existing facilities to their predemolition
28 condition.
29
30 C. Remove all and any unused materials not complying or reused with new electrical plan.
31
32 D. Contractor shall dispose of all obsolete material.
33
34 E. Contractor shall notify the Engineer of any existing code violations observed during the course
35 of performing his work. The Engineer will decide if corrective action needs to be taken.
36 Corrective actions that change the scope of the work will be considered a change order and will
37 be processed accordingly.
38
39

40 **PART 2 - PRODUCTS**

41 Not used.
42
43
44

45 **PART 3 - EXECUTION**

46
47 **3.1 ELECTRIC SERVICE**

- 48
49 A. De-energize existing electric service serving remodeled as required to install new equipment
50 with proper notice to General Contractor and Owner prior to starting shutdown.
51
52 1. Refer to Division 1 for further requirements regarding continuation of existing
53 services.
54

- 1 **3.2 REMOVAL**
2
3 A. Remove or relocate conduit, wire, boxes, and fixtures.
4
5 B. Remove electrical equipment released from service as a result of construction or as indicated
6 on drawings.
7
8 C. Do not reuse removed electrical equipment, unless specifically called out in the drawing
9 documents.
10
11 D. Where existing equipment is being removed, removal shall include all equipment associated
12 with the device. Associated equipment shall include but not be limited to coverplates,
13 backboxes, conduit, fittings, de-energized conductors, etc. When boxes are removed from
14 existing walls which will remain, it shall be the Electrical Contractor's responsibility to fill in
15 openings and sand as required flush with adjacent surfaces. The General Contractor shall be
16 responsible for final finish work unless specifically indicated otherwise on the plans.
17

18 **3.3 DISPOSAL**

- 19
20 A. Dispose of equipment that is removed unless specifically indicated on the drawings.
21
22 B. Raceway, conductors, boxes, cabinets and supporting devices shall become the property of
23 the Contractor and shall be removed from the site and disposed of by the Contractor.
24
25 C. The Contractor shall tour demolition areas with the Owner to determine the status of all other
26 equipment to be removed during demolition. All equipment that is to be salvaged for reuse
27 by the Owner shall be removed by the Contractor and transported to an owner designated
28 storage area on the site. The Owner shall be responsible for removal of salvaged equipment
29 from the storage area.
30

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END OF SECTION

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**SECTION 26 11 00
RACEWAY AND BOXES**

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide complete raceway system as specified for power systems.

1. Conduit, box and raceway systems.

1.2 RELATED DOCUMENTS

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

B. Specified Elsewhere:

1. 26 05 00 Electrical General Requirements
2. 26 12 00 Low Voltage Conductors and Cables
3. 26 19 00 Supporting Devices
4. 26 45 00 Grounding and Bonding

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. National Electrical Code, NEC: Comply with NEC/NFPA No. 71 as applicable to construction and installation of electrical conduit.
2. National Electrical Manufacturer's Association, NEMA: Comply with applicable portions of NEMA standards pertaining to non-metallic duct and fittings for underground installation.
3. Underwriters Laboratories: Provide electrical conduit listed and labeled by UL.

1.4 DELIVERY, STORAGE AND HANDLING

A. Provide color-coded end-cap thread protectors on exposed threads of threaded metal conduit.

B. Storage:

1. Store pipe and tubing inside and protect from weather.
2. When necessary to store outdoors, elevate well above grade and enclose with durable, watertight wrapping.

C. Handle conduit and tubing carefully to prevent bending and end damage and to avoid scarring the finish.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Conduit:

- 1 1. Allied Tube and Conduit Corporation.
- 2 2. Wheatland Tube Company.
- 3 3. Steelduct Conduit Products.

4
5

6 B. Couplings:

7
8

- 1. Appleton Electric Company.
- 2. Crouse-Hinds Company.
- 3. Killark Electric Manufacturing Company.

11
12

12 C. Flexible Conduit:

13
14

- 1. Anaconda Metal Hose.
- 2. I.B.C. Corporation.
- 3. Electri-Flex Company.

17
18

18 D. Boxes:

19
20

- 1. Appleton Electric Company.
- 2. Crouse-Hinds Company.
- 3. General Electric Company.
- 4. Killark Electric Manufacturing Company.
- 6. Lew Electric Fitting Company.
- 7. O.Z./Gedney Company.
- 8. Raco, Inc.
- 9. Square D Company.
- 10. Steel City Division.
- 11. Thomas and Betts Company, Inc.
- 12. Wiremold/Walker.

31
32

32 **2.2 CONDUIT MATERIAL**

33
34

34 A. RIGID METAL CONDUIT AND FITTINGS

35
36

- 1. Conduit: Heavy wall, galvanized steel, schedule 40, threaded.
- 2. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

38
39

39 B. INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

40
41

- 1. Conduit: Galvanized steel, threaded.
- 2. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

43
44

44 C. ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

45
46

- 1. Conduit: Steel, galvanized tubing.
- 2. Fittings: All steel, set screw, concrete tight. No push-on or indenter types permitted.
Conduit Bodies: All steel threaded conduit bodies.

49
50

50 D. FLEXIBLE METAL CONDUIT AND FITTINGS

51
52

- 1. Conduit: steel, galvanized, spiral strip.
- 2. Fittings and Conduit Bodies: All steel, galvanized, or malleable iron.

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E. LIQUIDTIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

1. Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.
2. Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

F. CONDUIT

1. Rigid Threaded: Steel, ANSI C80.1
2. Electrical Metallic Tubing: ANSI C80.3
3. Rigid Nonmetallic Tubing: Schedule 40 PVC; NEMA TC-2 & WC-1094

2.3 BOXES MATERIAL

A. OUTLET BOXES

1. Sheet Metal Outlet Boxes: galvanized steel, with stamped knockouts.
2. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.
3. Concrete Ceiling Boxes: Concrete type.
4. Cast Boxes: Cast ferroalloy, or aluminum type deep type, gasketed cover, threaded hubs.
5. Boxes:
 - a. Metallic hot-dipped galvanized, 1.25 oz. per square foot or cadmium plated.
 - b. Non-metallic, PVC thermoplastic or thermoset polyester.
6. Interior Boxes:
 - a. Pressed sheet steel, blanked for conduit.
 - b. Provide attached lugs for locating.
7. Exterior Boxes: Cast aluminum, deep type, corrosion proof fasteners, water tight, gasketed with threaded hubs.
8. For Ceiling: 4-inch octagon boxes for 1 fixture, including fixture studs and maximum 2 connecting conduits.
9. For Flush Mounting in Walls:
 - a. Boxes with matching plaster cover for single or two gang outlets.
 - b. Two-gang box or larger or deep masonry box for conductors, conductor joints, conduit terminations and wiring devices.
10. Surface Mounted: 4 inches square.

B. PULL AND JUNCTION BOXES

Pull boxes and junction boxes shall be minimum 4 inch square by 2-1/8th inches deep for use with 1 inch conduit and smaller. On conduit systems using 1-1/4 inch conduit or larger, pull and junction boxes shall be sized per NEC but not less than 4-11/16 inch square.

1. Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot welded joints and corners.
2. Sheet Metal Boxes Larger Than 12 Inches (300 mm) in any dimension shall have a hinged cover or a chain installed between box and cover.
3. Cast Metal Boxes for Outdoor and Wet Location Installations: Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast

- 1 iron or aluminum box and cover with ground flange, neoprene gasket, and stainless
2 steel cover screws.
- 3 4. Box extensions and adjacent boxes within 48" of each other are not allowed for the
4 purpose of creating more wire capacity.
- 5 5. Junction boxes 6" x 6" or larger size shall be without stamped knock-outs.
- 6 6. Wireways shall not be used in lieu of junction boxes.
- 7 7. Pull Boxes and Junction Boxes: NEC metal construction with screw or hinged
8 cover.

9
10 C. CONDUIT BODIES:

- 11 1. Galvanized or aluminum cast-metal of type, shape and size to fit each respective
12 location.
- 13 2. Constructed with threaded conduit ends, removable cover and corrosion-resistant
14 screws.

- 15
16
17 D. BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS: Provide corrosion-resistance
18 punched-steel box knockout closures, conduit locknuts and malleable iron conduit bushing,
19 type and size to suit respective use.

20
21
22 **PART 3 - EXECUTION**

23
24 **3.1 CONDUIT INSTALLATION**

- 25
26 A. Wiring: All wiring shall be installed in raceways as herein specified. All raceway runs
27 shown on the drawings are diagrammatic; exact locations shall be determined in the field.
- 28
29 1. Conceal all conduit in finished areas.
- 30 2. Concealed raceways shall be installed in the walls, above ceilings, below floors or in
31 furred out spaces so as to be completely concealed from view by occupants during
32 their normal activities in use of the space.
- 33 3. Exposed raceways shall be run in straight lines at right angles or parallel with walls,
34 beams and columns.
- 35 4. Provide raceways as required by the access control equipment controls for door
36 operating and monitoring.
- 37
38 B. Raceway Installation: All raceways, which are not buried or embedded in concrete shall be
39 supported by straps, suitable clamps or hangers to provide a rigid installation. Perforated
40 strap or wire hangers will not be acceptable. In no case shall raceways be supported or
41 fastened to other pipe. No raceway smaller than 1/2" shall be used, except that light fixture
42 switch legs may be 3/8".
- 43
44 1. Bends: Not more than three 90 degree bends will be allowed in one raceway run.
45 Where more bends are necessary, a conduit or pull box shall be installed. All bends
46 in 1" and smaller conduit or electrical metallic tubing shall be made with proper
47 bender. All other bends shall be machine made.
- 48 2. Joints: Joints in rigid metal shall be threaded type made up watertight with white
49 lead or compound applied to male threads only and all field joints shall be cut square,
50 reamed smooth and properly threaded to receive couplings. Electrical metallic tubing
51 systems shall utilize watertight compression type fittings throughout. No indenter
52 type fittings or running threads will be permitted.

- 1 3. Locknuts: Double locknuts shall be provided on all conduit terminations with the
2 exception of conduits terminating in threaded hubs and couplings. Locknuts shall be
3 of a type that have sharp beveled teeth that dig into the metal when tightened and will
4 not loosen through vibration.
- 5 4. Bushing: Bushing shall be provided on all conduits with the exception of conduits
6 terminating in hubs and couplings. Insulating bushings consisting of insulating
7 inserts in metal housing shall be provided on all installations. Insulating bushings
8 shall be grounding type where required by the National Electrical Code.
- 9 5. Heating Ducts and Pipes: Care shall be used to avoid proximity to heating duct and
10 hot water lines. Where such crossings are unavoidable, raceway shall clear covering
11 or line by at least 6".
- 12
- 13 C. Utilize rigid steel conduit or rigid nonmetallic conduit where exposed to moisture, buried in
14 earth or in concrete.
- 15
- 16 D. Utilize electrical metallic tubing(EMT) or intermediate metal conduit in other above-grade
17 locations.
- 18
- 19 E. For underground conduit: use PVC-coated rigid conduit or rigid non-metallic conduit.
- 20
- 21 F. Connections:
- 22
- 23 1. Motors and equipment: Minimum 1/2" size; PVC jacketed flexible conduit and
24 liquid-tight connectors.
- 25 2. Flexible conduit sufficient length to avoid vibration transmission.
- 26 3. Use 3/8" flexible conduit only for light fixture whips(72" max.)and control wiring.
- 27 4. Coordinate service conduit connections with location of service transformers.
- 28
- 29 G. Install conduit and tubing products as indicated, in accordance with manufacturers written
30 instructions and applicable requirements of NEC and NEMA Standard and Installation.
- 31
- 32 H. Install conduit concealed in all areas excluding mechanical, electrical and other unfinished
33 rooms, connections to motors and connections to surface cabinets.
- 34
- 35 I. Coordinate installation of conduit in masonry work.
- 36
- 37 J. Do not install conduit larger than 1" in concrete slabs.
- 38
- 39 K. Install conduit free from dents and bruises.
- 40
- 41 L. Plug conduit end to prevent entry of dirt or moisture.
- 42
- 43 M. Clean out conduit before installation of conductor.
- 44
- 45 N. Alter conduit routing to avoid structural obstructions, minimizing cross-overs.
- 46
- 47 O. Seal conduit with oakum or fiberglass where conduits leave heated area and enter unheated
48 area.
- 49
- 50 P. Roof Penetrations: Provide flashing and pitchpockets making watertight joints where
51 conduits pass through roof or waterproofing membrane.
- 52
- 53 Q. Building Expansion Joints:

- 1
- 2 1. Install UL listed expansion fittings complete with grounding jumpers where conduits
- 3 cross building expansion joints.
- 4 2. Provide bends or offsets in conduits adjacent to building expansion joints where
- 5 conduit is installed above suspended ceiling.
- 6
- 7 R. Route all exposed conduits parallel or perpendicular to building lines.
- 8
- 9 S. Allow minimum 6" clearance at flues, steam pipes and heat source.
- 10
- 11 T Underground Conduit: Direct burial minimum.
- 12
- 13 1. Support multiple runs vertically and horizontally with plastic spacers 8' on center.
- 14 2. Slope conduit to drainage point.
- 15 3. Adjust final layout to coordinate with existing utilities.
- 16 4. Trench and backfill as detailed on drawings.
- 17 5. Encase conduit with 3" concrete cover under driveways.
- 18
- 19 U. Cap all spare conduits.
- 20
- 21 V. Provide all empty raceways with a heavy duty nylon cord, full length of raceway. Tag cord
- 22 for identification.
- 23
- 24 W. Maintain safe clearances from hazardous adjacent equipment, hot water piping, flues, high
- 25 temperature piping, ductwork, etc.
- 26
- 27 **3.2 CONDUIT INSTALLATION SCHEDULE**
- 28
- 29 A. Concealed in Concrete and Block Walls: Rigid steel conduit. Electrical metallic tubing.
- 30 Schedule 40 PVC conduit. Electrical Nonmetallic Tubing (ENT).
- 31
- 32 B. Within Concrete Slab: Rigid steel conduit. Schedule 40 PVC conduit. Electrical Nonmetallic
- 33 Tubing (ENT).
- 34
- 35 C. Wet Interior Locations: Rigid steel conduit. Schedule 40 PVC conduit.
- 36
- 37 D. Concealed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical
- 38 metallic tubing.
- 39
- 40 E. Exposed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical
- 41 metallic tubing.
- 42
- 43 F. Motor and equipment connections: Flexible PVC coated metal conduit (all locations).
- 44 Minimum length shall be one foot (300 mm), maximum length shall be three feet (900 mm).
- 45 Conduit must be installed perpendicular to direction of equipment vibration to allow conduit
- 46 to freely flex.
- 47
- 48 G. Light fixtures: Direct box or conduit connection for surface mounted and recessed fixtures.
- 49 Flexible metal conduit from a J-box for recessed lay-in light fixtures. Conduit size shall be
- 50 3/8" minimum diameter and six foot (1.8 M) maximum length. Conduit length shall
- 51 allow movement of fixture for maintenance purposes.
- 52

- 1 F. In areas where the walls cannot be fished, the station cable serving these outlets shall be
2 covered with raceways. No exposed wire shall be permitted within offices, laboratories, and
3 conference rooms or like facilities.
4
- 5 G. The non-metallic raceway shall have a screw applied base. Both the base and cover shall be
6 manufactured of rigid PVC materials.
7
- 8 H. The raceway shall originate from a surface mounted box mounted adjacent to and at the
9 same height as existing electrical boxes in the room, be attached to the wall and terminate
10 above the ceiling.
11
- 12 I. All fittings including, but not limited to, extension boxes, elbows, tees, fixture bodies shall
13 match the color of the raceway.
14
- 15 J. The raceway and all systems devices shall be UL listed and exhibit nonflammable self
16 extinguishing characteristics, tested to specifications of UL94V-0.
17
- 18 K. The raceway and all systems devices shall adhere to the EIA/TIA Category 5e bend radius
19 standard.
20

21 **3.3 BOX INSTALLATION**

22

- 23 A. Pull Boxes and Junction Boxes: Locate pull boxes and junction boxes above removable
24 ceilings or in electrical rooms, utility rooms or storage areas.
25
- 26 B. Outlet Boxes:
27
- 28 1. Mount outlet boxes flush in area other than mechanical rooms, electrical rooms and
29 above removable ceilings.
 - 30 2. Adjust position of outlets in finished masonry walls to suit masonry course lines.
 - 31 3. Do not install boxes back-to-back in same wall.
 - 32 4. Masonry Walls:
 - 33 a. Coordinate cutting of masonry walls to achieve neat openings for boxes.
 - 34 b. Locate boxes in masonry walls so that only corner need be cut from masonry
35 walls.
 - 36 5. Do not use sectional or handy boxes unless specifically requested.
 - 37 6. For boxes mounted in exterior walls, make sure that there is insulation behind outlet
38 boxes.
 - 39 7. For outlets mounted above counters, benches or splashbacks, coordinate locations
40 and mounting heights with built-in units.
 - 41 8. Adjust outlet mounting height to agree with required location for equipment served.
42
- 43 C. Boxes supplied by others: Verify exact mounting location and type of mounting.
44
- 45 D. Provide knockout closures to cap unused knockout holes where blanks have been removed.
46
- 47 E. Support all boxes independently of conduit.
48
- ### 49 **3.4 COORDINATION OF BOX LOCATIONS**
- 50
- 51 A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire
52 pulling, equipment connections, and code compliance.
53

- 1 1. Electrical box locations shown on Contract Drawings are approximate unless
2 dimensioned. Verify location of floor boxes and outlets in offices and work areas
3 prior to rough-in.
4 2. No outlet, junction, or pull boxes shall be located where it will be obstructed by
5 other equipment, piping, lockers, benches, counters, etc.
6 3. Boxes shall not be fastened to the metal roof deck.
7
8 B. It shall be the Contractor's responsibility to study drawings pertaining to other trades, to
9 discuss location of outlets with workmen installing other piping and equipment and to fit all
10 electrical outlets to job conditions.
11
12 1. If any question arise over the location of an outlet, the Contractor shall
13 refer the matter to the Architect/Engineer and install outlet as instructed by the
14 Architect/Engineer.
15 2. The proper location of each outlet is considered a part of this contract and no
16 additional compensation will be paid to the Contractor for moving outlets which
17 were improperly located.
18
19 C. Locate and install boxes to allow access to them. Where installation is inaccessible,
20 coordinate locations and provide 12 inch by 12 inch access doors.
21
22 D. Locate and install to maintain headroom and to present a neat appearance.
23
24 E. Install boxes to preserve fire resistance rating of partitions and other elements, using
25 approved materials and methods.
26
27 **3.5 PULL AND JUNCTION BOX INSTALLATION**
28
29 A. Locate pull boxes and junction boxes above accessible ceilings, in unfinished areas or
30 furnish and install approved access panels in non-accessible ceilings where boxes are
31 installed. All boxes are to be readily-accessible.
32
33 B. Support pull and junction boxes independent of conduit.
34
35
36

END OF SECTION

- 1 **PART 2 - PRODUCTS**
2
3 **2.1 ACCEPTABLE MANUFACTURERS**
4
5 A. Wire and Cable:
6
7 1. Anaconda Wire and Cable Company.
8 2. Collyer Insulated Wire Company, Division.
9 3. Electrical Cable Division.
10 4. General Cable Corporation.
11 5. General Electric Company.
12 6. Phelps Dodge Cable and Wire Company.
13
14 B. Connectors:
15
16 1. AMP, Inc.
17 2. Burndy Corporation.
18 3. General Electric Company.
19 4. Ideal Industries, Inc.
20 5. 3M Company.
21 6. O.Z./Gedney Company.
22 7. Thomas and Betts Company.
23 8. Buchanon.
24
25 **2.2 MATERIALS**
26
27 A. Wire and Cable:
28
29 1. 98% conductivity copper.
30 2. 600 volt insulation.
31 3. Branch circuit wiring #10 and smaller shall be solid or stranded THWN or THHN.
32 Sizes #8 and larger stranded type THWN or THHN. Stranded wire shall be used for
33 all motor connections regardless of size. Lighting fixture wiring shall be 90 deg C
34 THHN.
35 4. Stranded conductors may only be terminated with UL OR ETL Listed type
36 terminations or methods.
37 5. Conductors smaller than No. 12 AWG gauge not permitted except for alarm and
38 signal circuits which may be #14 AWG minimum.
39 6. Color code and identify all wiring as specified in Section 16050.
40
41 B. Insulation: Type THHN/THWN, XHHW-2 insulation for feeders and branch circuits.
42 Type XHHW-2 insulation for feeders with aluminum conductors.
43
44 C. Exterior Wiring: Comply with NEC for wet location wiring.
45
46 D. Wiring for systems other than power:
47
48 1. Conform to system manufacturer standards as to size, type and coding, subject to
49 specified minimums.
50 2. Size conduit as required by system manufacturer, but no smaller than shown.
51 3. Provide copper XHHW for exterior services.
52
53 E. Armored Cable (AC) or Metal-Clad Cable (MC):

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1. Limit AC and MC usage to concealed only locations, branch-circuit wiring after the first junction box from the panelboards; where approved by NEC, state and local electrical inspecting authorities.
2. Not allowed for Panelboard feeders or service conduit.
3. Provide and install per NEC Articles 333 and 334 with grounding conductor.

2.3 WIRING CONNECTORS

- A. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment pads or terminals. Not approved for splicing.
- B. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers or copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.
- C. All wire connectors used in underground or exterior pull boxes shall be gel filled twist connectors or a connector designed for damp and wet locations.
- D. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.
- E. Split Bolt Connectors: Not acceptable.
- F. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic copper tubing; internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps.
- G. Splices: Splices and taps for No. 10 or smaller shall be with twist-on insulated connectors. Splices in wire No. 8 and larger shall be made with split-bolt or compression connectors equal to Burndy Hydent requiring a tool and die application. Tape all non-insulated compression connectors to achieve full 600V insulation.

PART 3 - EXECUTION

3.1 GENERAL WIRING METHODS

- A. All wire and cable shall be installed in conduit, unless specified
- B. Do not use wire smaller than 12 AWG for power and lighting circuits.
- C. Conductors size indicated on drawings indicates ampacity requirements using copper conductors and type THHN insulation unless otherwise noted.
 1. Provide XHHW for exterior services.
- D. All conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity. As a minimum use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 100 feet (30 m), and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet (61 m).

3.2 INSTALLATION

- 1 A. Make conductor length for parallel feeders identical.
2
3 B. Lace or clip groups of feeder conductors at new panel board.
4
5 C. Install wire and cable in NEC Code conforming raceway.
6
7 D. Pulling:
8
9 1. Use wire pulling lubricant for pulling No. 4 AWG and larger wire. Use special care
10 to avoid overstraining of conductors.
11 2. Pull conductors together where more than one is being installed in raceway.
12 3. Do not use pulling means, including fish tape, cable or rope which can damage
13 raceway.
14 4. All raceways shall be thoroughly swabbed out with a dry swab to remove moisture
15 and debris before conductors are drawn into place. All ends of raceways shall be
16 tightly plugged with tapered plugs or capped bushings until the conduits are pulled to
17 prevent water and debris from entering conduits. All conduits stubbed up through
18 floors shall be capped and aligned during construction by the use of spacers and caps.
19
20 E. Install wire in conduit runs after concrete and masonry work is complete, conduit shall be
21 clean and dry.
22
23 F. Splicing:
24
25 1. Splice only in accessible junction boxes.
26 2. Install splices and taps which have equivalent or better mechanical strength and
27 insulation as conductor.
28 3. Use splice and tap connectors which are compatible with conductor material.
29 4. No. 10 and smaller joints: Utilize connectors as hereinfore specified with PVC or
30 nylon covers.
31 5. No. 8 and larger joints: Clean and join with tool and die compression type fitting.
32
33 **3.3 WIRING INSTALLATION IN RACEWAYS**
34
35 A. Pull all conductors into a raceway at the same time. Use Listed wire pulling lubricant for
36 pulling 4 AWG and larger wires and for other conditions when necessary.
37
38 B. Install wire in raceway after interior of building has been physically protected from the
39 weather and all mechanical work likely to injure conductors has been completed.
40
41 C. Completely and thoroughly swab raceway system before installing conductors.
42
43 D. Place all conductors of a given circuit (this includes phase wires, neutral (if any), and ground
44 conductor) in the same raceway. If parallel phase and/or neutral wires are used, then place
45 an equal number of phase and neutral conductors in same raceway or cable.
46
47 **3.4 WIRING CONNECTIONS AND TERMINATIONS**
48
49 A. Splice only in accessible junction boxes.
50
51 B. Wire splices and taps shall be made firm, and adequate to carry the full current rating of the
52 respective wire without soldering and without perceptible temperature rise.
53

- 1 C. Use solderless spring type pressure connectors with insulating covers for wire splices and
2 taps, 10 AWG and smaller.
3
- 4 D. Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger.
5 Tape uninsulated conductors and connectors with electrical tape to 150 percent of the
6 insulation value of conductor.
7
- 8 E. Thoroughly clean wires before installing lugs and connectors.
9
- 10 F. At all splices and terminations, leave tails long enough to cut splice out and completely re-
11 splice.
12

13
14

END OF SECTION

SECTION 16 15 10
MOTORS AND MOTOR WIRING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide motor branch circuit wiring, motor starters, and disconnect switches to make a complete code complying motor branch circuit for each motor on project.
- B. Mounting of all equipment under this contract.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Specified Elsewhere:
 - 1. 26 11 00 Raceways and Boxes
 - 2. 26 15 50 Motor Starters
 - 3. 26 17 00 Motor and Circuit Disconnects
 - 4. 26 18 50 Equipment Connections
 - 5. Division 22 Plumbing Equipment
 - 6. Division 23 HVAC Equipment
- C. Each motor shall have an individual means of disconnect within equipment cabinet in finished area. Adjacent to motor in sight of and within 25'-0" of motor in all other areas.
- D. Disconnect shall be heavy-duty, horsepower-rated fused switch for three phase motors and fused toggle switch or manual fractional motor starter switch for single phase motors, unless noted otherwise in Motor Schedules or otherwise.
- E. Enclosures for outdoor locations and those marked "WP" shall be NEMA Type 3R elsewhere, unless otherwise noted, enclosures shall be NEMA Type 1.
- F. All controls shall be 120 volt or less. Control wiring shall have all controls wired in hot line (fused for three or more control devices and all fuel burners) with other side grounded. Control panel protected per NEC 430 and 440. Control wiring by contractor furnishing motor except as noted.
- G. Contractor who furnished and installed motor or other current using equipment shall furnish to Electrical Contractor all line voltage(greater than 100 volts) control devices for installation.
 - 1. Specified manual, automatic, local and remote motor and other control devices and switches, including thermostats, pressurestats, aquastats and other devices when specified as supplied by others.
 - 2. Detailed wiring diagrams, installation and operating instructions in form of reviewed shop drawings for complete wiring installations of above equipment.
 - 3. Motors will be set and aligned by contractor furnishing motor.

1.3 QUALITY ASSURANCE

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A. Motor and related equipment shall conform to NEMA standards for the type and application.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motors smaller than 1/2 HP: 120 V, single phase, 60-cycle current.

B. Motors 1/2 HP and larger:

1. In accordance with NEMA Standards, unless otherwise indicated.
2. 460V or 208V, 3-phases, 60-cycle current.

C. Characteristics: Quiet, non-overloading under operating conditions, 1.15 series factor, suitable for intended services, accessible for servicing and with oiling devices arranged for easy access.

D. Motor Protection:

1. Motor protection integral with motor starter, thermal overload type, including manual reset.
2. Automatic reset type overloads or built-in overload not acceptable.
3. Provide motor protection for each speed of multiple speed motors.

E. Factory Wired Panels:

1. Factory wired panels supplied as integral part of equipment provided by Division 22 & 23 Contractor.
2. Factory wired panel includes responsibility for totally wired control system as indicated on control drawings by Division 15 Contractor.
 - a. Furnished with completely integrated control panel, including switches, starters, certain disconnects, protective devices and control transformers mounted on associated mechanical equipment.
 - b. "Factory wired panel" does not mean wired at factory, but does mean provided by the Heating, Ventilating or Plumbing Contractor specified in Division 22 & 23.
 - c. In certain cases, as indicated, Electrical Contractor provides disconnect switch ahead of factory wired panel.

G. Temperature Control Panels: Electrical Contractor shall provide line voltage power to control panels as indicated on the Drawings and Schedules. Additional line voltage wiring requirements shall be the responsibility of the Temperature Control Contractor to retain an electrical trade to complete temperature control power requirements.

2.2 STARTERS - See Section 26 15 50 Motor Starters.

PART 3 - EXECUTION

3.1 INSTALLATION

- 1 A. Provide wiring, disconnect devices, final connection to all equipment noted.
2
3 B. Furnish, install and wire all such electrical devices, controls, interlocks, including main,
4 control and interlocking wiring, final connections and testing in full compliance with all
5 requirements of contract.
6
7 C. Perform all such work under direct supervision of Contractor who provided motor or
8 equipment. Latter Contractor shall have full responsibility for complete motor, current using
9 device, controls and wiring installations, including all work done by Electrical Contractor and
10 shall guarantee all such work as if he had installed it.
11
12 D. All conductors shall be stranded for motor feeders.
13
14 E. Provide liquid tight flexible conduits at motors and other vibrating equipment.
15
16 F. Grounding wire shall be provided in all flexible conduits. All motors shall be grounded per
17 NEC 250.
18
19 G. When a motor box serves more than one motor and motor branch wire size is smaller than
20 wire size in motor outlet box, motor branch shall be protected as required by NEC.
21
22 H. Examine the drawings and specifications covering all contracts to ascertain what equipment is
23 furnished by others. Furnish the necessary labor and materials to wire said equipment unless
24 material and wiring is called for under the specifications.
25
26 I. Locate and install control devices, as indicated. Coordinate requirements with all other
27 trades.
28
29 J. In finished areas, mount motor protection switches flush and install suitable coverplates.
30
31 K. Install overload heater or related with full load current of motors provided. Provide actual
32 field measurements of equipment operating under normal loads to verify proper heater
33 selection.
34
35 L. Set all protective devices to suit motors provided.
36
37 M. Mount and wire all controlling equipment furnished in Division 22 & 23.
38
39 N. Verify motor sizes for starters, including verification of required number of auxiliary
40 contacts.
41
42 O. Install all power and control wiring including conduit to and from starters to motors and to all
43 remote devices required for complete system operation as indicated on drawings.
44
45 P. Install all motor starter, pilot lights, pushbuttons, selector switches, thermal overloads and
46 local disconnect switches at motors, except those devices specified as part of integral factory
47 wired panels or as provided under Division 22 & 23.
48
49 Q. E.C. is responsible for connections, proper phase relationships and motor rotation.
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END OF SECTION

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SECTION 26 18 50
EQUIPMENT CONNECTIONS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Power and selected control wiring for all equipment including, but not limited to:
1. HVAC control panels.
- B. Coordinate all equipment requirements with the various contractors and the Owner. Review the complete set of drawings and specifications to determine the extent of wiring, starters, devices, etc., required.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Specified Elsewhere:
1. Div. 22 Plumbing
 2. Div. 23 HVAC
 3. 26 11 00 Raceways and Boxes
 4. 26 12 00 Low Voltage Conductors and Cables
 5. 26 15 10 Motors and Motor Wiring

PART 2 - PRODUCTS

- 2.1 SEE 1.2 ABOVE AND DRAWINGS.**

PART 3 - EXECUTION

3.1 HVAC AND PLUMBING CONNECTIONS

- A. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source through starters and disconnects to motors or to packaged control panels.
1. Packaged control panels may include disconnects and starters and overcurrent protection. Provide all wiring between packaged control panels and motors.
 2. Include starters disconnects and overload protection if not included in packaged control panels.
- B. Provide 120 volts circuits to each temperature control panel as indicated on the Drawings.
1. Line voltage wiring requirements for temperature control beyond the requirements shown on the drawings and schedules shall be the responsibility of the Temperature Control Contractor to retain the electrical trade and pay for such work.

- 1 C. Unless otherwise specified, all electrical motors and control devices such as aquastats, float
2 and pressure fan powered VAV boxes, switches, electropneumatic switches, solenoid valves
3 and damper motors requiring mechanical connections shall be furnished and installed and
4 wired for low-voltage connections (less than 100volts) by the Contractor supplying the
5 devices or the Temperature Control Contractor, as specified elsewhere.
6
- 7 D. Each motor terminal box shall be connected with a maximum 36" piece of flexible conduit to
8 a fixed junction box. A green wire run through the flexible conduit shall interconnect the
9 motor frame and the rigid conduit system. Use Liquid tight flexible metal conduit for all
10 motor connections.
11
- 12 E. Check for proper rotation of each motor.
13

14 **END OF SECTION**
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SECTION 26 19 00
SUPPORTING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Conduit and equipment supports.

1.2 RELATED DOCUMENTS

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

B. Specified Elsewhere:

1. 26 11 00 Raceways and Boxes

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. National Electrical Code, NEC: Comply with NEC/NFPA No. 70, as applicable to supports.
2. Underwriters Laboratories, UL: Supports listed and labeled by UL.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Support Channel: Steel, Galvanized, Enameled or other corrosion resistant.
B. Hardware: Corrosion resistant.
C. Minimum sized threaded rod for supports shall be 3/8" for trapezes and single conduits 1-1/4" and larger, and 1/4" for single conduits 1" and smaller.
D. Conduit clamps, straps, supports, etc., shall be steel or malleable iron. One-hole straps shall be heavy duty type. All straps shall have steel or malleable backing plates when rigid steel conduit is installed on the interior or exterior surface of any exterior building wall.

2.2 CONDUIT SUPPORTS

A. Material:

1. Single Runs:
a. Galvanized two-hole conduit straps or ring-bolt type hangers with specialty spring clips.
b. *Do not use plumber's perforated straps.*
2. Multiple Runs: Conduit rack with 25% spare capacity.
3. Vertical Runs: Channel support with conduit fittings.
a. 25-ft intervals.

- 1 B. Anchor Methods:
2
3 1. Hollow Masonry: Toggle bolts or spike type expansion anchors.
4 2. Solid Masonry: Lead expansion anchors or preset inserts.
5 3. Metal Surfaces: Machine screws, bolts or welded studs.
6 4. Wood Surfaces: Wood screws.
7 5. Concrete Surfaces: Self-drilling anchors or power driven studs.
8
9 C. Light Fixtures:
10
11 1. Provide grid troffer clips in accordance with NEC 410-16.
12
13 D. Mounting Racks and Supports:
14
15 1. Provide rack and supports of galvanized or painted steel channel sections with bolted
16 or welded fittings.
17 2. Provide exterior treated 3/4" plywood mounting surface with gray paint finish on
18 both sides and edges.
19
20

21 **PART 3 - EXECUTION**

22 **3.1 GENERAL**

- 23
24
25 A. Maintain headroom, neat mechanical appearance and to support equipment loads.
26
27 B. Suspend, support from and attach only to the structural elements at intervals required by
28 code, with threaded rod, channels, "stand-off" and other clips and NECA approved devices.
29
30 C. To the fullest extent possible, group several conduits together and run parallel, supporting
31 with rod and channel.
32

33 **3.2 INSTALLATION**

- 34
35 A. Fasten hanger rods, conduit clamps, outlet, junction and pull boxes to building structure
36 using pre-cast insert system, preset inserts, beam clamps, expansion anchors, or spring
37 steel clips (interior metal stud walls only).
38
39 1. Do not use "stand-off" clips for attachment to walls and partitions.
40 2. Install raceways tight to walls.
41
42 B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board
43 partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling
44 anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs
45 and wood screws in wood construction. If nail-in anchors are used, they must be removable
46 type anchors.
47
48 C. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit. Do
49 not fasten to suspended ceiling grid system.
50
51 D. Fabricate supports from galvanized structural steel or steel channel, rigidly welded or bolted
52 to present a neat appearance. Use hexagon head bolts with spring lock washers under all
53 nuts.

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- E. In wet locations, mechanical rooms and electrical rooms install free-standing electrical equipment on 3.5 inch (89 mm) concrete pads.
- F. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide steel channel supports to stand cabinet one inch (25 mm) off wall (7/8" Uni-strut or 3/4" painted, fire-retardant plywood is acceptable).
- G. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- H. Furnish and install all supports as required to fasten all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.

END OF SECTION

SECTION 26 45 00
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide and install materials for a complete grounding system integral with the power distribution in accordance with the National Electrical Code.
- B. Distribution grounding system.
- C. Equipment grounding system.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Specified Elsewhere:
 - 1. 26 11 00 Raceways and Boxes
 - 2. 26 12 00 Low Voltage Conductors and Cables

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. ANSI/IEEE 142 (Latest edition) - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 2. National Electrical Code, NEC: Comply with NEC/NFPA No. 70, as applicable to materials and installation of electrical grounding systems and associated equipment and wiring.
 - 3. Underwriters Laboratories:
 - a. Comply with UL Standards pertaining to electrical grounding and bonding.
 - b. UL 467: Grounding and Bonding Equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials used for grounding conductors shall be as called for in National Electrical Code Article #250-81.
- B. Ground Fittings:
 - 1. OZ Company:
 - a. Type BF
 - b. Type OG
 - c. Type LG
 - d. Type MG

- 1 **2.2 MECHANICAL CONNECTORS**
2
3 A. The mechanical connector bodies shall be manufactured from high strength, high
4 conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made
5 of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt
6 type.
7
8 B. Split bolt connector types are NOT allowed. Exception: the use of split bolts is acceptable
9 for grounding of wire-basket type cable tray, and for cable shields/straps of medium voltage
10 cable.
11
12 C. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number,
13 conductor size and manufacturer.
14

15 **2.3 COMPRESSION CONNECTORS**
16

- 17 A. The compression connectors shall be manufactured from pure wrought copper. The
18 conductivity of this material shall be no less than 99% by IACS standards.
19
20 B. The connectors shall meet or exceed the performance requirements of IEEE 837, latest
21 revision.
22
23 C. The installation of the connectors shall be made with a compression, tool and die system, as
24 recommended by the manufacturer of the connectors.
25
26 D. The connectors shall be clearly marked with the manufacturer, catalog number, conductor
27 size and the required compression tool settings.
28
29 E. Each connector shall be factory filled with an oxide-inhibiting compound.
30

31 **2.4 WIRE**
32

- 33 A. Material: Stranded copper (aluminum not permitted).
34
35 B. Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications or
36 as required by NFPA 70, whichever is larger. Differentiate between the normal ground and
37 the isolated ground when both are used on the same facility.
38
39

40 **PART 3 - EXECUTION**
41

42 **2.1 GENERAL**
43

- 44 A. Install Products in accordance with manufacturer's instructions.
45
46 B. Mechanical connections shall be accessible for inspection and checking. No insulation shall
47 be installed over mechanical ground connections.
48
49 C. Ground connection surfaces shall be cleaned and all connections shall be made so that it is
50 impossible to move them.
51
52 D. Attach grounds permanently before permanent building service is energized.
53

- 1 **2.2 LESS THAN 600 VOLT SYSTEM GROUNDING**
2
3 A. Bond together system neutrals, service equipment enclosures, exposed non-current carrying
4 metal parts of electrical equipment, metal raceway systems, grounding conductor in
5 raceways and cables, receptacle ground connectors, and plumbing systems.
6
7 B. Equipment Grounding Conductor: Provide separate, insulated equipment grounding
8 conductor within each raceway. Terminate each end on suitable lug, bus, enclosure or
9 bushing. Provide a ground wire from each device to the respective enclosure.
10
11 **3.3 INSTALLATION**
12
13 A. Electrical service, electrical equipment enclosures and associated metallic raceway system
14 shall be permanently grounded and bonded together by a grounding electrode conductor as
15 per NEC requirements with a ground clamp to a 1-1/4 inch or larger cold water metallic pipe
16 on street side of water meter and ground rod electrodes.
17
18 1. Provide water meter shunt; cable to pipe connections copper cable shunt.
19
20 B. Bond main switches, ground rods, foundation reinforcement rebar and water service entrance
21 together with ground electrodes sized per code.
22
23 1. Ground connection surfaces shall be clean.
24 2. Bond structural steel frame to grounding electrode conductor.
25
26 C. Damp Locations: All convenience outlets, switches, fixtures, boxes and plates in damp
27 locations or outdoors shall be fully grounded by a separate green grounding conductor.
28
29 D. Panelboard Grounding: Install grounding conductor from main service to each panelboard
30 and ground bar as indicated on Drawings:
31
32 1. Provide separate circuit grounding conductors to dedicated ground circuits, surge
33 suppression receptacles (computers), and GFI receptacles.
34
35 E. Bonding Jumpers:
36
37 1. Maintain ground continuity by separate insulated green ground wire in fixture cords,
38 flexible connections or similar location where raceway system is interrupted.
39 2. Light Fixtures: Provide separate green wire grounded from fixture housing to nearest
40 conduit system box, where flexible conduit is used.
41 3. Receptacles: Provide green wire bonding jumper from all new receptacles to metal
42 back box.
43
44 F. Motors: Provide insulated grounding conductor from motor connection to distribution panel
45 grounding bus for all motors.
46
47 1. Where motors are connected to conduit systems with flexible conduit section, install
48 greenfield grounding conductor in flexible conduit section.
49
50 G. Equipment Grounding Conductors: Provide separate, insulated grounding conductor within
51 each feeder raceway.
52
53 1. Ground cable tray at intervals not exceeding 100 feet.

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- H. Device Boxes: Provide new green wire ground from panel ground bar to all new devices located in the raceway systems.
 - 1. Provide dedicated ground wire to GFI and surge suppression receptacles.

END OF SECTION