

1 **BASIC HVAC REQUIREMENTS**

2 **PART 1 – GENERAL**

3 1.01 RELATED DOCUMENTS

4
5 A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and
6 Division 01 Specification Sections, apply to this Section.

7 B. Specifications throughout all Divisions to the Project Manual are directly applicable to this Section, and
8 this Section is directly applicable to them.

9 1.02 SUMMARY

10
11 A. Basic and supplemental requirements common to HVAC Work.

12 1.03 REFERENCE STANDARDS

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14 A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific
15 edition date.

16 B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this
17 Project.

18 C. Disagreement between the Drawings and Specifications or within the Drawings or Specifications shall be
19 estimated using the better quality or greater quantity of material or installation, and a request for
20 information shall be made to the Design Professional.

21
22 D. All materials, installation and workmanship shall comply with the applicable requirements and standards
23 addressed within the Contract Documents.

24 E. The following codes form the basis for minimum requirements for the Project:

- 25 1. Building Code – 2012 IBC with City of Houston Amendments
- 26 2. Electrical Code - National Electrical Code, 2017 Edition
- 27 3. Mechanical Code - 2012 UMC with City of Houston Amendments
- 28 4. Plumbing Code - 2012 UPC with City of Houston Amendments
- 29 5. Fire Code – 2012 International Fire Code with City of Houston Amendments
- 30 6. 2015 International Energy Code
- 31 7. NFPA 13, 14, 99 & 101
- 32 8. Texas Department of State Health Services (TDSHS) Hospital Licensing Standards
- 33 9. Federal Department of Justice Americans with Disabilities Act and Texas Accessibility Standards.

34
35 1.04 DEFINITIONS

36 A. These definitions are included to clarify the direction and intention of these Specifications. For further
37 clarification contact the Design Professional.

38 1. Concealed/Exposed: “Concealed” areas are those areas that cannot be seen by the building
39 occupants. “Exposed” areas are all areas, which are exposed to view by the building occupants,
40 including under counters, inside cabinets and closets, plus all mechanical rooms. “Exterior” areas
41 are those outside the building exterior envelope and exposed to the outdoors.

42 2. Furnish: The term “furnish” is used to mean “supply and deliver to the Project Site, ready for
43 unloading, unpacking, assembly, installation and similar operations”.

1 3. Install” The term “install” is used to describe operations at Project Site including the actual
2 “unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension,
3 finishing, curing, protecting, cleaning, and similar operations.”

4 4. Provide: The term “provide” means “to furnish and install, complete and ready for the intended
5 use”.

6 1.05 QUALITY ASSURANCE

7 A. HVAC systems shall be coordinated with other systems and trades to include but not be limited to:
8 Plumbing systems, fire suppression systems, electrical systems, fire alarm, security systems, transport
9 systems, telephone and data systems.

10 B. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of
11 Contractor’s Work to the building structure and to the Work of all trades. The Contractor shall visit the
12 premises and become thoroughly familiar with all details of the Work and working conditions, to verify all
13 dimensions in the field, and to advise the Design Professional of any discrepancy before performing and
14 Work. Adjustments to the Work required in order to facilitate a coordinated installation shall be made at no
15 additional cost to the Owner or the Design Professional.

16 C. All dimensional information related to new structures shall be taken from the appropriate Drawings. All
17 dimensional information related to existing facilities shall be taken from actual measurements made by the
18 Contractor on the Site.

19 D. The Drawings are subject to the requirements of Reference Standards and structural and architectural
20 conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate
21 the separate trades in order to avoid interference between the various phases of Work. Work shall be
22 organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished
23 portions of the building, unless specifically noted to be exposed. All exposed Work shall be installed
24 parallel or perpendicular to the lines of the building unless otherwise noted.

25 E. When the Drawings do not give exact details as to the elevation of pipe and ducts, the Contractor shall
26 physically arrange the systems to fit in the space available at the elevations intended with proper grades for
27 the functioning of the system involved. Piping and duct systems are generally intended to be installed true
28 and square to the building construction, and located as high as possible against the structure in a neat and
29 workmanlike manner. The Drawings do not show all required offsets, control lines, pilot lines and other
30 location details. Work shall be concealed in all finished areas.

31 F. Where core drilling of floor or wall penetrations is required, Work shall be performed in accordance with
32 Division 03 Specifications. Where applicable Division 03 Specifications are not included in the Project,
33 core drilling shall be in accordance with generally accepted standards, and be performed by licensed
34 personnel where applicable.

35 G. Certify in writing that neither the Contractor nor any of Contractor’s subcontractors or suppliers will supply
36 any materials that contain any asbestos in any form for this Project.

37 1.06 DELIVERY, STORAGE AND HANDLING

38
39 A. All equipment, ductwork, and materials shall be delivered to the Project Site clean and sealed for
40 protection.

41 B. Take particular care not to damage the existing construction in performing Work. All finished floors, step
42 treads and finished surfaces shall be covered to prevent any damage by workers or their tools and
43 equipment during construction of the Project.

- 1 C. Equipment and materials shall be protected from rust and dust/debris both before and after installation.
2 Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of
3 rust and repainted as specified elsewhere in these Specifications.
- 4 D. All material affected by weather shall be covered and protected to keep the material free from damage
5 while material is being transported to the Site and while stored at the Project Site.
- 6 E. During the execution of the Work, open ends of all piping and all openings in equipment shall be closed
7 when Work is not in progress, and shall be capped and sealed prior to completion of final connections, so
8 as to prevent the entrance of foreign matter.
- 9 F. All equipment shall be protected during the execution of the Work. All ductwork and equipment shall be
10 sealed with heavy plastic and tape to prevent build-up of dust and debris.
- 11 G. All ductwork and air handling equipment shall be wiped down with a damp cloth immediately before
12 installation to ensure complete removal of accumulated dusts and foreign matter. In health care
13 occupancies, all ductwork and air handling equipment shall be thoroughly disinfected with a biocidal agent
14 EPA approved for HVAC systems immediately prior to sealing ductwork and equipment airstream
15 openings.

16 PART 2 – PRODUCTS

17 2.01 GENERAL

- 18
- 19 A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements,
20 and conform to codes and ordinances of authorities having jurisdiction.
- 21 B. All equipment installed shall have local representation; local factory authorized service, and a local stock of
22 repair parts.
- 23 C. Responsibility for furnishing proper equipment and/or material and ensuring that equipment and/or material
24 is installed as intended by the manufacturer, rests entirely upon the Contractor. Contractor shall request
25 advice and supervisory assistance from the representative of specific manufacturers during the installation.
- 26 D. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use
27 and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance
28 with the manufacturer's recommendations and the best standard practice for the type of Work involved.
29 All Work shall be executed by mechanics skilled in their respective trades, and the installations shall
30 provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise
31 damaged prior to installation shall not be repaired at the job Site but shall be replaced with new materials
32 and/or equipment.
- 33 E. Materials and equipment manufactured domestically are preferred when possible. Materials and equipment
34 that are not available from a domestic manufacturer may be by a non-domestic manufacturer provided they
35 fully comply with Contract Documents.
- 36 F. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number;
37 otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating.

38 2.02 NAMEPLATES

- 39
- 40 A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a
41 plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of
42 Final Inspection.
- 43 B. Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 1
44 inch high by 3 inches long with 3/16-inch high engraved letters.

1 C. Nameplate fasteners: Fasten nameplates to the front of equipment only by means of stainless steel self-
2 tapping screws. Stick-ons or adhesives will not be allowed unless the enclosure rating is compromised
3 then; only epoxy adhesive shall be used to attach nameplates.

4 2.03 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS)

5
6 A. Except as otherwise noted, provide stainless steel or chrome plated brass floor and ceiling plates around all
7 pipes, ducts, conduits, etc., passing exposed through walls, floors or ceilings, in any spaces except under-
8 floor and plenum spaces.

9 B. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines that are
10 insulated and positively secured to such pipe or insulation.

11 C. For finished ceiling installation, secure escutcheons to ceiling with escutcheon fasteners.

12 D. Plates will not be required for piping where pipe sleeves extend ¾-inch or more above finished floor.

13 E. Round and rectangular ducts shall have closure plates (not chrome plated) made to fit accurately at all
14 floor, wall and ceiling penetrations.

15 2.04 ROOF PENETRATIONS AND FLASHING

16
17 A. Pipe, conduit and duct sleeves, pitch pockets and flashings compatible with the roofing installation shall be
18 provided and installed for all roof penetrations by a Contractor qualified in such Work. Where working on
19 existing buildings with warranties in place, coordinate the work required with the warranting contractor to
20 assure no warranty breach occurs. Installation shall comply with the Contract Documents.

21 **PART 3 – EXECUTION**

22 3.01 PREPARATION

23
24 A. Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing
25 continuations of this Work in order to effect timely and accurate placing of Work and to coordinate, in
26 proper and correct sequence, the Work of such trades.

27 B. The size of equipment indicated on the Drawings is based on the dimensions of a particular manufacturer.
28 While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine that the
29 equipment proposed will fit in the space. Fabrication Drawings shall be prepared, when required by the
30 Design Professional or Owner, to indicate a suitable arrangement.

31 C. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives,
32 filters, and other accessory items shall be installed in a position to allow removal for service without
33 disassembly of another part.

34 D. Space Requirements:

35 1. Consider space limitations imposed by contiguous Work in location of equipment and material. Do
36 not provide equipment or material which is not suitable in this respect.

37 2. Make changes in material and equipment locations of up to five (5) feet, to allow for field conditions
38 prior to actual installation, and as directed by the Design Professional at no additional cost to the
39 Owner.

40 E. Contractor shall verify the arrangement, location and space requirements of all equipment, using
41 manufacturer certified shop drawings and make any necessary adjustments in equipment placement and
42 connection in order to accommodate the exact equipment installed. Should major changes be required for
43 any reason, the contractor shall notify the Design Professional in a timely manner to minimize any remedial

1 costs to the Owner. Any resulting changes to the HVAC design required, due to failure to provide such
2 timely notification, shall be made at no additional cost to the Owner.

3 F. Connections for equipment other than Division 23:

4 1. Provide all ductwork, transition pieces, etc., required for a complete installation of vent hoods, fume
5 hoods, etc.

6 3.02 INSTALLATION

7
8 A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards
9 and conform to codes and ordinances of authorities having jurisdiction.

10 B. All installation shall be in accordance with manufacturer's published recommendations.

11 C. Piping may be run exposed in rooms typically without ceilings such as mechanical rooms, janitor's closets,
12 tight against pan soffits in exposed "tee" structures, or storage spaces, but only where necessary. Shutoff
13 and isolation valves shall be easily accessible.

14 D. All pipe, ducts, etc., shall be cut accurately to measurements established at the building and shall be worked
15 into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and
16 equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain
17 the proper pitch. Piping and ducts run in furred ceilings, etc., shall be similarly installed, except as
18 otherwise shown. All pipe openings shall be kept closed until the systems are closed with final
19 connections.

20 E. Prior to the installation of any ceiling material, gypsum, plaster or acoustical board, the Contractor shall
21 notify the Owner's Project Manager so that arrangements can be made for an inspection of the above-
22 ceiling area about to be "sealed" off. The Contractor shall provide written notification to the Owner at least
23 five (5) calendar days prior to the inspection.

24 F. Precedence of Materials:

25 1. The Specifications determine the nature and setting of materials and equipment. The Drawings
26 establish quantities, dimensions and details.

27 2. If interference is encountered, the following installation precedence of materials shall guide the
28 Contractor to determine which trade shall be given the "Right of Way":

29 Building lines

30 Structural members

31 Structural support frames supporting ceiling equipment

32 Electric tracked vehicle system

33 Pneumatic trash and linen system

34 Pneumatic tube system

35 Soil and drain piping

36 Vent piping

37 Supply, return and outside air ductwork

38 Exhaust ductwork

- 1 HVAC water and steam piping
- 2 Condensate piping
- 3 Fire protection piping
- 4 Natural gas piping
- 5 Medical/Laboratory gases
- 6 Domestic water (cold and hot, softened, treated)
- 7 Refrigerant piping
- 8 Electrical conduit
- 9 3. Coordinate fire suppression, plumbing and HVAC systems with transport systems as required to
- 10 maintain transport system right-of-way.

11 3.03 TESTING

- 12 A. When existing systems are to be tied into to serve portions of a new project, or if existing systems are likely
- 13 to be affected by the new project, testing shall be conducted to establish the current performance and
- 14 operating capacity of the existing systems. The test should be designed such that a similar test if necessary
- 15 can be performed after construction to verify that air supplies to spaces or cooling/heating supplies to
- 16 existing equipment have not been adversely affected. Submit test report of results of pre-design testing to
- 17 the Design Engineer.
- 18 B. When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate
- 19 the equipment, Contractor may do so, provided that Contractor properly supervises the operation, and has
- 20 the Owner's written permission to do so. The warranty period shall, however, not commence until such
- 21 time as the equipment is operated for the beneficial use of the Owner, or date of Substantial Completion,
- 22 whichever occurs first. For HVAC systems serving Clean Rooms, Operating Rooms, Procedure Rooms,
- 23 Cardiac Catheterization Labs, Critical Care Units and other Patient Care areas, the HVAC system serving
- 24 such areas ***will not be operated without all permanent filter systems in place*** and the return ducts for such
- 25 systems will not be utilized until the space has been "final cleaned" by the Hospital personnel. In such
- 26 cases, the units shall be operated in 100% outside air mode, using local negative pressure units to effect the
- 27 required pressure balance to the construction area, until such cleaning has taken place. Refer to Section 23
- 28 31 00 for details on duct cleaning should the systems be operated in violation of this requirement.
- 29 C. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly
- 30 clean the equipment, install clean filter media (refer to Section 23 41 00 for additional requirements),
- 31 properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of
- 32 acceptance and performance certification will be the same date.
- 33 D. Before the Work is accepted, and authorized representative of the manufacturer of the installed materials
- 34 and/or equipment shall personally inspect the installation and operation of manufacturer's materials and/or
- 35 equipment to determine that materials and/or equipment are properly installed and in proper operating
- 36 order. The qualifications of the manufacturer's representative shall be appropriate to the technical
- 37 requirements of the installation. The qualifications of the manufacturer's representative shall be submitted
- 38 to the Owner for approval. The decision of the Owner concerning the appropriateness of the
- 39 manufacturer's representative shall be final. Testing and checking shall be accomplished during the course
- 40 of the work where required by work being concealed, and at the completion of the work. In addition, the
- 41 Contractor shall submit to the Design Professional a signed statement from each manufacturer's
- 42 representative certifying as follows: **"I certify that the materials and/or equipment listed below have**
- 43 **been personally inspected by the undersigned authorized manufacturer's representative and is**
- 44 **properly installed and operating in accordance with the manufacturer's recommendations."**

- 1 E. Check inspections shall include hydronic and condensate piping, equipment, heating, air conditioning,
2 insulation, ventilating equipment, controls, mechanical equipment and such other items hereinafter
3 specified or specifically designated by the Design Professional.

- 4 F. The Contractor shall execute, at no additional cost to the Owner, any tests required by the Owner or the
5 National Fire Protection Association, ASTM, etc. The Contractor shall provide all equipment, materials
6 and labor for making such tests. The Owner will pay reasonable amounts of fuel and electrical energy costs
7 for system tests. Fuel and electrical energy costs for system adjustments and tests, which follow
8 Substantial Completion by the Owner, will be borne by the Owner.

- 9 G. Notify the Owner's Project Manager and the Design Professional in writing at least seven (7) calendar days
10 prior to each test and prior to other Specification requirements requiring Owner and Design Professional to
11 observe and/or approve tests.

- 12 H. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date,
13 time, personnel performing, observing and inspecting, description of the test and extend of system tested,
14 test conditions, test results, specified results and other pertinent data. Data shall be delivered to the Design
15 Professional as specified under "Requirements for Final Acceptance". The Contractor or Contractor's
16 authorized job superintendent shall legibly signal all Test Log entries.

- 17 I. System shall exhibit no objectionable noise when operated within normal parameters, as specified within
18 the construction documentation. Should any portion of the system exhibit noise levels that are deemed
19 objectionable by either the Owner or the Design Professional, a solution shall be agreed upon and necessary
20 modifications made to eliminate or attenuate the noise to within an acceptable range. Such changes shall be
21 made at no additional cost to the Project or Owner.

22 3.04 TRAINING

- 23 A. Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01
24 Section entitled "Project Closeout Procedures".

- 25 B. Specific training and operating instructions for individual equipment components shall be as specified in
26 the individual Specification Sections.

- 27 C. All equipment, piping, conduit, ductwork, grilles, insulation, etc., furnished and installed in exposed areas
28 shall be cleaned, prepared and painted as specified in Division 09.

29 **END OF SECTION**

1 **SUPPORTS AND SLEEVES FOR HVAC PIPING AND EQUIPMENT**

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PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to the.

1.02 SUMMARY

- A. Perform all Work required to provide and install supports, hangers, anchors, sleeves, and bases for all HVAC pipe, duct, equipment, system components and accessories, indicated by the Contract Documents with all supplementary items necessary for complete, code compliant and approved installation.

1.03 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references.
 - 1. International Mechanical Code.
 - 2. ASME B31.9 – Building Services Piping.
 - 3. ASTM F708 – Design and Installation of Rigid Pipe Hangers.
 - 4. MSS SP58 – Pipe Hangers and Supports – Materials, Design and Manufacturer.
 - 5. MSS SP69 – Pipe Hangers and Supports – Selection and Application.
 - 6. MSS SP89 - Pipe Hangers and Supports – Fabrication and Installation Practices.
 - 7. MSS SP90 – Guidelines on Terminology for Pipe Hangers and Supports.
 - 8. NFPA 99 – Standard for Health Care Facilities.
 - 9. SMACNA – HVAC Duct Construction Standards.
 - 10. Underwriters Laboratories Standards and Listings.

- 1 1.04 QUALITY ASSURANCE
- 2
- 3 A. Materials and application of pipe hangers and supports shall be in accordance with MSS SP58 and SP69
- 4 unless noted otherwise.
- 5
- 6 B. Support and sleeve materials and installation shall not interfere with the proper functioning of equipment.
- 7
- 8 C. Contractor shall be responsible for structural integrity of all hangers, supports, anchors, guides, inserts and
- 9 sleeves. All structural hanging materials shall have a minimum safety factor of five.
- 10
- 11 D. Installer Qualifications: Utilize an installer experienced in performing Work of this Section who is
- 12 experienced in installation of Work similar to that required for this Project and per the minimum
- 13 requirements of MSS SP89. Field welding of supports shall be by certified welders qualified in accordance
- 14 with ASME Boiler and Pressure Vessel Code, Section IX using welding procedures per the minimum
- 15 requirements of MSS SP58.

16 1.05 SUBMITTALS

- 17 A. Product Data: Provide manufacturer’s catalog data including code compliance, load capacity, and intended
- 18 application.
- 19
- 20 B. Manufacturer’s Installation Instructions: Indicate special procedures and assembly of components.
- 21
- 22 C. Shop Drawings: Submit detailed Drawings of all shop or field fabricated supports, anchors and sleeves,
- 23 signed and sealed by a qualified State of Texas registered professional engineer. Indicate size and
- 24 characteristics of components and fabrication details and all loads, exceeding 250 pounds imposed on the
- 25 base building structure.
- 26
- 27
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29 1.06 DELIVERY, STORAGE AND HANDLING

- 30
- 31 A. Comply with manufacturer’s ordering instructions and lead time requirements to avoid construction delays.
- 32
- 33 B. Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels
- 34 intact. Maintain in place until installation.
- 35
- 36 C. Store materials protected from exposure to harmful weather conditions.
- 37

38 PART 2 – PRODUCTS

39 2.01 GENERAL

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- 42 A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements,
- 43 and conform to codes and ordinances of authorities having jurisdiction.
- 44

45 2.02 MANUFACTURERS

- 46
- 47 A. Hangers and Supports:
- 48
- 49 1. Anvil International.
- 50
- 51 2. Kinder.
- 52
- 53 3. Cooper B-Line (Dura-Blok).
- 54
- 55 4. C&S Mfg. Corp.
- 56

1 5. Hubbard Enterprises/Holdrite

2
3 6. National Pipe Hanger Corporation.

4
5 7. Power Strut.

6
7 8. Portable Pipe Hangers

8
9 2.03 HANGERS AND SUPPORTS

10
11 A. General:

12
13 1. Refer to individual system and equipment Specification Sections for additional support
14 requirements. Comply with MSS SP69 for support selections and applications that are not addressed
15 within these Specifications.

16
17 2. Utilize hangers and supports to support systems under all conditions of operation, allowing free
18 expansion and contraction, and to prevent excessive stresses from being introduced into the
19 structure, piping or connected equipment.

20
21 3. All pipe supports shall be of the type and arrangement to prevent excessive deflection, to avoid
22 excessive bending stresses between supports, and to eliminate transmission of vibration.

23
24 4. Design hangers to impede disengagement by movement of supported pipe.

25
26 5. Install building attachments within concrete slabs or attach to structural steel. Space attachments
27 within maximum piping span length indicated in MSS SP69. Install additional attachments at
28 concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes
29 in direction of piping.

30
31 6. Wire or perforated strap iron will not be acceptable as hanger material.

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33 7. Hanger rods shall be threaded on both ends, threaded one end, or continuous threaded, complete with
34 adjusting and lock nuts.

35
36 8. Fasteners requiring explosive powder (shooting) or pneumatic-driven actuation will not be
37 acceptable under any circumstances.

38
39 9. Plastic anchors or plastic expansion shields will not be permitted under any circumstances.

40
41 10. Hangers and clamps supporting and contacting individual non-insulated brass or copper lines shall
42 be copper or copper plated. Where non-insulated brass or copper lines are supported on trapeze
43 hangers or channels, the pipes shall be isolated from these supports with approved flexible
44 elastomeric/thermoplastic isolated cushion material to completely encircle the piping and avoid
45 contact with the channel or stamp. **Plastic tape is not acceptable.**

46
47 11. Hangers and clamps supporting and contracting plastic piping shall be in accordance with the piping
48 manufacturer's published recommendations and shall be factory coated or padded to prevent damage
49 to piping.

50
51 12. Field fabricated supports shall be constructed from ASTM A36/A36M, steel shapes selected for
52 loads being supported. Weld steel according to AWS D-1.1.

53
54 B. Finishes: All ferrous hangers, rods, inserts, clamps, stanchions, and brackets on piping within interior non-
55 corrosive environments, shall be dipped in Zinc Chromium Primer before installation. Rods may be
56 galvanized or cadmium plated after threading, in lieu of dipping in zinc chromate. All hangers and

1 supports exposed to the weather, including roofs and building crawl space areas, shall be galvanized or
2 manufactured from materials that will not rust or corrode due to moisture. All hangers and supports
3 located within corrosive environments shall be constructed from or coated with materials manufactured for
4 installation within the particular environment.
5

6 C. Vertical Piping: Supports for vertical riser piping in concealed areas shall utilize double bolt riser clamps,
7 with each end having equal bearing on the building structure at each floor level. Two-hole rigid pipe
8 clamps or four-hole socket clamps with washers may be used to support pipe directly from adequate
9 structural members where floor-to-floor distance exceeds required vertical support spacing and lines are not
10 subject to expansion and contraction. Supports for vertical riser piping at floor levels in exposed areas
11 (such as fire protection standpipe in stairwells) shall be attached to the underside of the penetrated structure
12 utilizing drilled anchors, two hanger rods (sized as specified), and socket clamp with washers.
13

14 D. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be
15 supported on manufactured channel, suspended on rods or pipes. Trapeze members including suspension
16 rods shall be properly sized for the quantity, diameters, and loaded weight of the lines they are to support.
17

18 E. Ductwork: All ductwork shall be supported in accordance with SMACNA recommendations for the
19 service involved. Horizontal ducts supported using galvanized steel bands shall extend up both sides and
20 onto the construction above, where they shall turn over and be secured with bolts and nuts fitted in inserts
21 set in the concrete, bolted to angles secured to the construction above, or secured in another approved
22 manner.
23

24 F. Terminal Units:

- 25 1. Terminal units weighing up to 150 pounds shall be supported by four (4) 1 inch wide sheet metal
26 straps with ends turned under bottom of unit at corners.
27
- 28 2. Each band shall be secured by not over $\frac{3}{4}$ inch in length, $\frac{1}{4}$ inch diameter sheet metal screws – two
29 (2) on bottom of unit and one (1) on each side.
30
- 31 3. The other strap end shall be attached to the structure by $\frac{1}{4}$ inch diameter threaded bolt into the
32 concrete insert or into drilled-hole threaded concrete expansion anchor.
33
- 34 4. Where interference occurs, overhead of the box, not allowing direct vertical support by straps,
35 provide trapeze channels suspended by $\frac{1}{4}$ inch diameter galvanized threaded rods providing such
36 channels do not block access panels of units.
37
- 38 5. Terminal units weighing more than 150 pounds shall be supported per the terminal unit
39 manufacturer's installation instructions using threaded rod and hanger brackets located per
40 manufacturer's drawings.
41

42 G. Equipment Service Piping:

- 43 1. Piping at local connections to equipment shall be supported to prevent the weight of the piping from
44 being transmitted to the equipment.
45
- 46 2. Supports within chases and partitions shall be corrosion resistant metal plate, clamps, angles or
47 channels, and aligned with structure in the vertical or horizontal position. Plastic supports are not
48 allowed unless approved by Design Professional.
49
- 50 3. Horizontal supports within chases and partitions that are attached to studs shall be attached at both
51 ends. Drywall shall not be relied upon to support the piping.
52
- 53 4. Piping exposed on the face of drywall shall be supported with corrosion resistant metal channels that
54 are attached to wall studs. Drywall shall not be relied upon to support the piping.
55

- 1
- 2 5. Piping supported from the floor shall utilize corrosion resistant metal channels or brackets that are
- 3 anchored to the floor slab.
- 4
- 5 6. All water piping shall be isolated from building components to prevent the transmission of sound.
- 6
- 7 7. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent
- 8 electrolytic action. Plastic tape is not an acceptable isolation material.
- 9

10 H. Inserts:

- 11
- 12 1. Cast-in-place concrete inserts shall comply with MSS-SP-69, U.L. and F.M. approved, and sized to
- 13 suit threaded hanger rods.
- 14
- 15 2. Inserts shall have malleable iron case with galvanized steel shell and expander plug for threaded
- 16 connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size
- 17 inserts to suit threaded hanger rods. Suitable concrete inserts for pipe and equipment hangers shall
- 18 be set and properly located for all pipe and equipment to be suspended from concrete construction.
- 19 If the inserts are later found not to be in the proper location for the placement of hangers, then drilled
- 20 anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for approval.
- 21
- 22 3. Manufactured inserts for metal deck construction shall have legs custom fit to rest in form valleys.
- 23
- 24 4. Shop fabricated inserts shall be submitted and approved by Owner prior to installation.
- 25
- 26 5. Inserts shall be of a type that will not interfere with structural reinforcing and that will not displace
- 27 excessive amounts of structural concrete.
- 28

29 I. Pipe Shields: Refer to Section 23 07 19.

30 J. Housekeeping Pads:

- 31
- 32
- 33 1. Provide minimum 4 inch reinforced concrete pads with chamfered corners and equipment bases for
- 34 all outdoor equipment on grade, floor mounted equipment in main central plant area, mechanical
- 35 rooms, areas with floors below grade, penthouse equipment rooms, floor mounted air handling units,
- 36 and where shown on Drawings.
- 37
- 38 2. Housekeeping pads shall extend minimum of 4 inch on all sides beyond the limits of the mounted
- 39 equipment unless otherwise noted.
- 40
- 41 3. Provide galvanized anchor bolts for all equipment placed on concrete pads or on concrete slabs of
- 42 the size and number recommended by the equipment manufacturer.
- 43

44 2.04 PIPE AND DUCT PENETRATIONS

45 A. General:

- 46
- 47
- 48 1. Seal penetrations through all rated partitions, walls and floors with U. L. tested assemblies to provide
- 49 and maintain a rating equal to or greater than the partition, wall or floor.
- 50
- 51 2. Inside diameter of all sleeves or cored holes shall provide sufficient annular space between outside
- 52 diameter of pipe, duct or insulation to allow proper installation of required fire and water proofing
- 53 materials and allow for movement due to expansion and contraction.
- 54
- 55 3. Exposed ceiling, floor and wall pipe penetrations within finished areas (including exterior wall
- 56 faces) shall be provided with chrome plated, brass or stamped steel, hinged, split-ring escutcheon

1 with set screw or snap-on type. Inside diameter shall closely fit pipe outside diameter or outside of
2 pie insulation where pipe is insulated. Outside diameter shall completely cover the opening in
3 floors, walls, or ceilings. In exterior, damp, or corrosive environments, use Type 302 stainless steel
4 escutcheons.

5
6 B. Floor Pipe Penetrations:

- 7
8 1. Seal penetrations through all floors to provide and maintain a watertight installation.
9
10 2. Sleeves cast in slab for pipe penetrations shall be Schedule 40 steel, ASTM A53, with 2 inch wide
11 annular fin water-stop continuously welded at mid-point. Entire assembly shall be hot-dipped
12 galvanized after fabrication. Water-stop shall be same thickness as sleeve.
13
14 3. Cored holes in the slab for pipe penetrations shall be provided with Schedule 40 steel, ASTM A53
15 sleeve with 2 inch wide annular fin water-stop continuously welded at point on sleeve to allow
16 countersinking into slab and waterproofing. Entire sleeve assembly shall be hot-dipped galvanized
17 after fabrication. Water-stop shall be same thickness as sleeve.
18
19 4. All sleeves shall extend a minimum of two inches above finished floor.
20
21 5. Where job conditions prevent the use of a sleeve that extends two inches above the slab, Link-Seal
22 mechanical casing seals manufactured by Thunderline Corporation may be installed to provide a
23 watertight penetration. Mechanical casing seals can be used only for relatively small diameter pipe
24 penetrations. Verify that slab thickness allows proper installation of the link-seal assembly and the
25 required fire stopping prior to applying this exception.
26

27 C. Wall Penetrations:

- 28
29 1. Where piping or ductwork passes through non-rated partition, close off space between pipe or duct
30 and construction with gypsum wallboard and repair plaster smoothed and finished to match adjacent
31 wall area.
32
33 2. Pipe penetrations through interior rated partitions shall be provided with adjustable pre-fabricated
34 U.L. Listed fire rated galvanized sheet metal sleeves having gauge thickness as required by wall fire
35 rating, 20 gauge minimum.
36
37 3. Pipe penetrations through exterior walls and walls below grade shall be provided with "Link-Seal"
38 mechanical casing seal manufactured by Thunderline Corporation.
39
40 4. Ductwork penetrations through rated partitions, walls and floors shall be provided with sleeves that
41 are manufactured integral with the damper assembly installed.
42

43 D. Flashing:

- 44
45 1. Coordinate flashing material and installation required for pipe and duct roof penetrations with
46 Owner and roofing Contractor.
47
48 2. Provide flexible flashing and metal counter-flashing where ductwork penetrates exterior walls. Seal
49 penetration water and air-tight.
50
51 3. Provide acoustical flashing around ducts and pipes penetrating equipment rooms, with materials and
52 installation in accordance with manufacturer's instructions for sound control.
53

- 54 E. Roof Curbs: Coordinate roof curb material and installation with Owner and roofing Contractor.
55

56 **PART 3 – EXECUTION**

- 1
2 3.01 PREPARATION
3
4 A. Conduct a pre-installation meeting prior to commencing Work of this Section to verify Project
5 requirements, coordinate with other trades, establish condition and completeness of substrate, review
6 manufacturer's installation instructions and manufacturer's warranty requirements.
7
8 B. Application, sizing and installation of piping, supports, anchors and sleeves shall be in accordance with
9 manufacturer's printed installation instructions.
10
11 C. Provide for vertical adjustments after erection and during commissioning, where feasible, to ensure pipe is
12 at design elevation and slope.
13
14 D. Install hangers and supports to allow controlled thermal movement of piping systems, permitting freedom
15 of movement between pipe anchors and to facilitate action of expansion joints, expansion loops, expansion
16 bends, and similar units.
17
18 E. Install hanger so that rod is vertical under operating conditions.
19
20 F. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the
21 structure is capable of restraining the forces in the piping system.
22
23 G. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any
24 component of the support system, including the concrete that holds the inserts. Reinforcement at inserts
25 shall be provided as required to develop the strength required. Contractor shall be responsible for engaging
26 a Structural Engineer as required for design and review at support systems.
27
28 H. Do not hang pipe, duct or any mechanical item directly from a metal deck or locate on the bottom chord of
29 any truss or joist unless approved by the Structural Engineer of Record.
30
31 I. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts,
32 electrical conduit, supports, building structures, equipment, etc.
33
34 J. Piping supports shall be independent from ductwork supports. Combining supports is not permitted.
35
36 K. Provide all supporting steel required for the installation of mechanical equipment and materials, including
37 angles, channels, beams, etc. to floor supported or suspended tanks and equipment. All of this steel may
38 not be specifically indicated on the Drawings.
39
40 L. All piping and ductwork supports shall be designed and installed to allow the insulation to be continuous
41 through the hangers.
42
43 M. Adjustable clevis hangers shall be supported at rods with a nut above and below the hanger.
44
45 N. All hanger rods shall be trimmed neatly so that 1 inch of excess hanger rod protrudes beyond the hanger
46 nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines
47 for example), the Contractor shall take appropriate measures to protect the pipe or other materials from
48 damage.
49
50 O. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent structures,
51 materials, etc.
52
53 P. Horizontal and vertical piping in chases and partitions shall be supported to prevent movement and isolated
54 from the supports to prevent transmission of sound.
55
56 Q. Locate hangers within 12 inches of each horizontal elbow.

- 1
2 R. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
3
4 S. Support riser piping independently of connected horizontal piping. Riser piping is defined as vertical
5 piping extending through more than one floor level.
6
7 T. Support vertical piping with clamps secured to the piping and resting on the building structure or secured to
8 the building structure below at each floor. Use method of securing the vertical risers to the building
9 structure below in stairwells and exposed locations. Installation of riser clamps and welded steel riser
10 supports shall not allow weight of piping to be transmitted to floor sleeves. Exception: Schedule 40 steel
11 floor sleeves with continuously welded 2 inch minimum water-stop ring.
12
13 U. Steel Bar Joists: Hanger rods shall be secured to angle irons of adequate size; each angle shall span across
14 two or more joists as required to distribute the weight properly and shall be welded or otherwise
15 permanently fixed to the top of joists.
16
17 V. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be
18 used.
19
20 W. Pre-Cast Tee Structural Concrete: Hanger supports, anchors, etc. attached to the pre-cast double tee,
21 structural concrete system shall be installed in accordance with approved Shop Drawings only. Holes
22 required for hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are
23 not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed.
24 Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4 inch larger than the
25 diameter of the hanger rod. Hanger rods shall be supported by means of bearing plates of size and shape
26 acceptable to the Design Professional, with welded double nuts on the hanger rod above the bearing plate.
27 Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under
28 any circumstances in the lower 15 inches of each stem and in the "shadow" of the stem on the top side of
29 the "double tees".
30
31 X. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material
32 and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space
33 between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and
34 make watertight seal.
35
36 Y. Inserts:
37
38 1. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete
39 beams.
40
41 2. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
42
43 3. Install anchors in concrete after concrete is placed and completely cured. Install anchors according
44 to manufacturer's written instructions.
45
46 Z. Flashing:
47
48 1. Coordinate all roof flashing with requirements of Division 07.
49
50 AA. Equipment Anchor Bolts:
51
52 1. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly
53 located by means of templates. Each bolt shall be set in a sleeve of sufficient size to provide 1/2
54 inch clearance around bolt.
55
56

June 6, 2019

SUPPORTS AND SLEEVES FOR HVAC PIPING AND EQUIPMENT 23 05 29
9 of 9

1

END OF SECTION

1 **IDENTIFICATION OF HVAC PIPING AND EQUIPMENT**

2

3 **PART 1 – GENERAL**

4

5 1.01 RELATED DOCUMENTS

6

7 A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of
8 Division 01 Specification Sections, apply to this Section.

9

10 B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and
11 this Section is directly applicable to them.

12

13 1.02 SUMMARY

14

15 A. Perform all Work required to provide and install nameplates, tags, stencils, and pipe markers indicated by
16 the Contract Documents with supplementary items necessary for proper installation.

17

18 B. Contractor shall make it possible for personnel operating and maintaining the equipment and systems in
19 this Project to readily identify the various pieces of equipment, valves, piping, ductwork, etc., by marking
20 them.

21

22 C. All items of equipment such as fans, pumps, etc., shall be clearly marked using engraved nameplates as
23 hereinafter specified. The marked item of equipment shall correspond to the same number as shown on the
24 Drawings.

25

26 1.03 REFERENCE STANDARDS

27

28 A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific
29 edition date.

30

31 B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this
32 Project.

33

34 C. All materials, installation and Workmanship shall comply with the applicable requirements and standards
35 addressed within the following references.

36

37 1. ASME A13.1 – Scheme for the Identification of Piping Systems.

38

39 2. NFPA 99 – Standard for Health Care Facilities.

40

41 1.04 SUBMITTALS

42

43 A. Product Data:

44

45 1. Provide manufacturer's catalog literature for each product.

46

47 B. Record Documents:

48

49 1. Submit valve schedule complete with valve tag numbering system, valve function, valve type, area
50 served, year installed, manufacturer, model number, size, rated pressure, temperature rating and
51 normal position.

52

53

1 C. Operation and Maintenance Data:

2

3 1. Manufacturer's Installation Instructions: Indicate special procedures and installation.

4

5 **PART 2 – PRODUCTS**

6

7 2.01 GENERAL

8

9 A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements,
10 and conform to codes and ordinances of authorities having jurisdiction.

11

12 2.02 MANUFACTURERS

13

14 A. Nameplates, Tags, Markers and Tacks:

15

16 1. Marking Systems, Inc.

17

18 2. Seton Name Plate Company.

19

20 3. W. H. Brady Company.

21

22 4. Graphic Products, Inc.

23

24 2.03 NAMEPLATES

25

26 A. Description: Laminated three-layer plastic with engraved white letters on black contrasting background
27 color.

28

29 B. General:

30

31 1. All items of mechanical equipment shall be identified by the attachment of engraved nameplates
32 constructed from laminated phenolic plastic, at least 1/16 inch thick, 3-ply, with black surfaces and
33 white core using an approved plastic laminate glue. Engraving shall be condensed Gothic, at least
34 1/2 inch high, appropriately spaced.

35

36 2. Nomenclature on the label shall include the name of the item, its mark number, area, space, or
37 equipment served and other pertinent information.

38

39 3. Motor nameplate information shall include manufacturer, horsepower, amperage, voltage, rpm and
40 service factor.

41

42 4. All fans shall have manufacturer's name, flow (cfm) and static pressure,.

43

44 5. All scheduled equipment shall be labeled.

45

46 2.04 VALVE TAGS

47

48 A. All valve tags shall conform to ANSI A13.1 – 1981 "Scheme for the Identification of Piping Systems".

49

50 B. Valve tags shall be ABS plastic tags: Injected molded ABS plastic, 3.375" X 4.75" with self adhesive vinyl
51 label, similar to DuraLabel Pro, affixed to valve tag. Each tag shall be attached to its valve with one tie
52 strap.

53

54 C. Vinyl Label: 3.0 Mil self-adhesive vinyl similar to DuraLabel Pro. Label color shall be as per the standard
55 designated colors listed in the attachment to this specification.

56

- 1 D. Contractor shall prepare and install in a suitable glazed (with Plexiglas or polycarbonate glazing, not glass)
2 frame, typewritten valve charts giving the number, location and function of each line valve installed under
3 this Contract.
4
- 5 E. Each valve shall be numbered on these charts in accordance with the system of which it is a part of its
6 location. For example, valves in different systems would be designed as follows:
7
- 8 1. HWS-1-3 Heating Water Supply: 1st Level – Valve No. 3
9
10 2. CHS-2-4 Chilled Water Supply: 2nd Level – Valve No. 4

11 2.05 PIPE AND DUCT MARKERS

- 12 A. Round Pipe and Duct Markers shall conform to ANSI A13.1-2007 “Scheme for the Identification of Piping
13 Systems.” Arrow markers must have same ANSI background colors as their companion pipe markers, or
14 be incorporated into the pipe identification marker.
15
16 B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, pre-formed to fit around pipe or pipe
17 covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
18 Verify with Drawings for all HVAC systems for sizes.
19
20 C. Plastic Tape Pipe Markers: Heat sealed or heat shrink, spring fasteners, clips or snap-on, are acceptable.
21
22 D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6
23 inches wide by 4 mil thick manufactured for direct burial service.
24
25 E. Pipe markers and arrow markers also shall be provided for all piping systems.
26
27 F. Use Seton Setmark Type SNA or Brady snap-on type identification for all piping systems, 3/4 inch through
28 6 inch. For piping systems larger than 6 inches, use Seton or Brady strap-on markers or similar by Marking
29 Services, Inc.
30
31

32 2.06 CEILING EQUIPMENT LOCATER TACKS

- 33 A. Description: Steel with 3/4-inch diameter color-coded head.
34
35 B. Color code as follows:
36
37 1. Yellow – HVAC equipment
38
39 2. Red – Fire dampers/smoke dampers
40
41 3. Blue – Heating/cooling valves.
42
43
44

45 PART 3 – EXECUTION

46 3.01 INSTALLATION

- 47 A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards
48 and conform to codes and ordinances of authorities having jurisdiction.
49
50 B. All installation shall be in accordance with manufacturer’s published recommendations.
51
52 C. Install plastic nameplates with corrosive-resistant mechanical fasteners or adhesive. Apply with sufficient
53 adhesive to ensure permanent adhesion and seal with clear lacquer.
54
55
56

- 1 D. Install tags with corrosion resistant chain.
- 2
- 3 E. Install plastic tape and pipe markers completely around pipe in accordance with manufacturer's
- 4 instructions.
- 5
- 6 F. Locate markers on the two (2) lower quarters of the pipe where view is unobstructed.
- 7
- 8 G. Locate tacks on the ceiling grid.
- 9

10 3.02 VALVE TAGS

- 11
- 12 A. Contractor shall provide and install identification tags lettered and numbered to correspond to the
- 13 information shown herein.
- 14
- 15 B. Tags shall be affixed to all valves except simple service and drain valves located within 10 feet and within
- 16 sight of the device or equipment served. For example, it would not be expected that valves at a pressure
- 17 reducing station in a machine room would be tagged.
- 18
- 19 C. Tags shall be 1/8 inch thick brass discs, 1-1/2 inches in diameter. Each tag shall be attached to its valve
- 20 with chains of a material compatible with the valve.
- 21
- 22

23 3.03 APPLICATION OF MARKERS

- 24
- 25 A. Piping runs throughout the Project including those above lift-out ceilings, under floor and those exposed to
- 26 view when access doors or access panels are opened shall be identified by means of pipe markers.
- 27 Concealed areas, for purposes of this identification section, are those areas that cannot be seen except by
- 28 demolition of the building elements. In addition to pipe markers, arrow markers shall be used to indicate
- 29 direction of flow.
- 30
- 31 B. As a minimum, locate pipe markers as follows:
- 32
- 33 1. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several
- 34 valves exist on one (1) header, it is necessary to mark only the header.
- 35
- 36 2. Every 20 feet and at each change of direction in exposed and concealed areas on all piping systems.
- 37 Provide at least one (1) pipe marker in each room on all piping systems.
- 38
- 39 3. At each branch or riser take off on piping systems, excluding short takeoffs for fixtures and terminal
- 40 units.
- 41
- 42 4. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where the pipe
- 43 penetrates a wall, floor, service column or enclosures.
- 44
- 45 5. At access doors, manholes and similar access points that permit view of concealed piping.
- 46
- 47 6. Near major equipment items and other points of origination and termination.
- 48
- 49 C. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of
- 50 flow.
- 51
- 52 D. Provide a double-ended arrow marker when flow can be in either or both directions.
- 53
- 54 E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- 55
- 56 F. Identify control panels and major control components outside panels with plastic nameplates.

- 1
- 2 G. Identify valves in main and branch piping with tags.
- 3
- 4 H. Identify air terminal units and radiator valves with plastic nameplates.
- 5
- 6 I. Tag automatic controls, instruments and relays. Key to control schematic.
- 7
- 8 J. Provide ceiling tacks to locate valves, fan coil units, dampers or other concealed equipment above T-bar
- 9 type panel ceilings. Locate in corner of panel closest to equipment.
- 10

END OF SECTION

1 **CONTRACTOR COORDINATION WITH TESTING, ADJUSTING AND BALANCING**

2

3 **PART 1 – GENERAL**

4 1.01 RELATED DOCUMENTS

5 A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and
6 Division 01 Specification Sections, apply to this Section.

7 B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and
8 this Section is directly applicable to them.

9 1.02 SUMMARY

10 A. Perform all work required to prepare the building HVAC systems for testing, adjusting, and balancing
11 (TAB) Work indicated by the Contract Documents, including the following:

12 1. Preparation of air systems for testing, adjusting and balancing.

13 2. Preparation of hydronic systems for testing, adjusting and balancing.

14 3. Providing materials and labor to assist TAB Firm in meeting testing, adjusting and balancing
15 requirements.

16 B. Testing, adjusting and balancing of the air conditioning systems and related ancillary equipment will be
17 performed by a technically qualified TAB Firm. The preparation for and corrections necessary for the
18 testing, adjusting and balancing of these systems, as described herein, are the responsibility of this
19 Contractor.

20 C. Make any changes or replacements to the sheaves, belts, dampers, valves, etc., required for correct balance
21 as advised by the TAB Firm at no additional cost to the Owner.

22 1.03 REFERENCE STANDARDS

23 A. The latest published edition of a reference shall be applicable to this Project unless identified by a specified
24 edition date.

25 B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this
26 Project.

27 C. All materials, installation and workmanship shall comply with the applicable requirements and standards
28 addressed within the following references:

29 1. AABC: National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning
30 Systems.

31 2. AABC: Testing and Balancing Procedures.

32 3. ASHRAE HVAC Applications Chapter 37: Testing, Adjusting and Balancing.

33 4. ANSI/ASHRAE Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of
34 Buildings, Heating, Ventilation, Air Conditioning, and Refrigeration Systems.

1 5. NEBB – National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting,
2 Balancing of Environmental Systems.

3

4 1.04 QUALITY ASSURANCE

5 A. Provide and coordinate the services of qualified, responsible Subcontractors, suppliers and personnel as
6 required for correct, repair, and/or replace any and all deficient items or conditions found during the course
7 of this project, including during the testing, adjusting and balancing period.

8 B. In order that systems may be properly tested, adjusted, and balanced, the Contractor shall operate systems
9 at Contractor’s expense for the length of time necessary to properly verify the systems’ completion and
10 readiness for TAB.

11 C. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB
12 services prior to Owner occupancy. Allow adequate time for the testing and balancing activities during the
13 construction period and prior to Substantial Completion.

14 **PART 2 – PRODUCTS**

15 2.01 GENERAL

16 A. Not applicable.

17 **PART 3 – EXECUTION**

18 3.01 PREPARATION

19 A. Contractor shall be responsible to prepare the building heating, ventilating, and air conditioning systems
20 ready for TAB when scheduled.

21 B. Operational readiness requires that construction status of the building will permit the closing of doors,
22 windows, ceilings installed, etc., to obtain simulated or projected operating conditions.

23 C. Notification of system readiness:

24 1. Upon completion of the system installation Work, the Contractor shall notify the Owner and TAB
25 Firm in writing, certifying that the Work has been accomplished and that the air conditioning
26 systems are in operational readiness for testing, adjusting and balancing.

27 2. TAB Firm shall notify the Contractor of TAB Firm’s readiness for balancing.

28 3. Should the TAB Firm be notified as described above, and the TAB Work commenced and the
29 systems are found NOT to be in readiness or a dispute occurs as to the readiness of the systems, the
30 Contractor shall request an inspection be made by a duly appointed representative of the Design
31 Professional, TAB Firm and the Contractor. This inspection will establish to the satisfaction of the
32 represented parties whether or not the systems meet the basic requirements for TAB services.
33 Should the inspection reveal the TAB services notification to have been premature, all cost of the
34 inspection and wasted Work accomplished by the TAB Firm shall be the responsibility of the
35 Contractor.

36 3.02 INSTALLATION

- 1 A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards
2 and conform to codes and ordinances of authorities having jurisdiction.
- 3 B. All installation shall be in accordance with manufacturer's published recommendations.
- 4 C. Allow sufficient time for the TAB Firm to perform TAB Firm's Work within the Project schedule.
5 Complete installation Work by system or floor, whichever is the most efficient for scheduling. Develop the
6 project schedule in close coordination with the TAB Firm.
- 7 D. The Drawings and Specifications indicate valves, dampers and miscellaneous adjustment devices for the
8 purpose of adjustment to obtain optimum operating conditions. Install these devices in a manner that will
9 leave the devices accessible and readily able to be adjusted. Immediately correct any malfunction
10 encountered that the TAB Firm reports so that the balancing Work can proceed with minimal delay.
- 11 E. Contractor shall promptly correct deficiencies of materials and workmanship identified as delaying
12 completion of TAB Work.
- 13 3.03 SYSTEM VERIFICATION
- 14 A. Air Distribution Systems:
- 15 1. Verify installation for conformity to the Contract Documents. All supply, return, and exhaust ducts
16 shall be terminated and pressure tested for leakage as required by the Contract Documents.
- 17 2. All volume, smoke and fire/smoke dampers are properly located and functional. Dampers serving
18 requirements of minimum and maximum outside, return and relief air shall provide tight closure and
19 full opening, smooth and free operation.
- 20 3. All supply, return, exhaust and transfer grilles, registers, diffusers and terminal devices are installed
21 and airflow at each device shall be verified.
- 22 4. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter
23 sections, access doors, etc., shall be sealed or blanked off to eliminate excessive uncontrolled bypass
24 or leakage of air.
- 25 5. All fans (supply, return and exhaust) operating and verified for freedom from vibration, with proper
26 fan rotation and belt tension. Heater elements in motor starters are of proper size and rating. Record
27 motor amperage and voltage on each phase at start-up and running, and verify they do not exceed
28 nameplate ratings.
- 29 6. All single and/or double duct variable and constant volume terminal units ("mixing boxes") shall be
30 installed and functional (i.e. controls functioning).
- 31 7. Duct systems and air handling units and coils are clean and free of debris.
- 32 8. Air systems are pressure independent and can be tested by floor, riser, system, etc., but once all the
33 systems are installed, the total flows and system tracking will require final testing, adjusting and
34 balancing.
- 35 B. Water Circulating Systems:
- 36 1. Check and verify pump alignment and rotation.

1 **SYSTEM TESTING, ADJUSTING AND BALANCING FOR HVAC**

2 **PART 1 – GENERAL**

3 1.01 RELATED DOCUMENTS

4 A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and
5 Division 01 Specification Sections, apply to this Section.

6 B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and
7 this Section is directly applicable to them.

8 1.02 SUMMARY

9 A. Testing, adjusting and balancing (TAB) of the air conditioning (supply, return and exhaust) systems and
10 related ancillary equipment will be performed by a technically qualified TAB Firm.

11 B. Testing, adjusting and balancing (TAB) of the air conditioning (supply, return and exhaust) systems and
12 related ancillary equipment will be performed by a technically qualified TAB Firm (with a current
13 certification of the firm and person doing the work by either NEBB or AABC).

14 C. TAB Firm shall check, adjust, and balance components of the domestic hot water plumbing systems which
15 will result in optimal flow, temperature control, and quality conditions in these systems. This is intended to
16 be accomplished after the system components are installed and operating as specified in the Contract
17 Documents, but before piping system sterilization is performed. If, for some reason the piping system TAB
18 work cannot be accomplished prior to the sterilization process, all testing equipment (gauges, flow meters,
19 etc.) that come into contact with the system shall be certified to be cleaned and sterilized and not have been
20 used for testing of other, non-potable water systems. It is the responsibility of the Plumbing Contractor to
21 place the equipment into service. Coordinate all TAB work with Plumbing Contractor and General
22 Contractor to facilitate the abovementioned scheduling of work.

23 D. Air systems shall be balanced in accordance with AABC Standard, Latest Edition or NEBB Standards for
24 Testing, Adjusting, Balancing of Environmental Systems (Latest Edition).

25 E. TAB Firm shall check, adjust, and balance all hydronic systems including pumps, water distribution
26 systems, coils, and related equipment.

27 F. Liaison and Early Field Inspection:

28 1. TAB Firm shall act as a liaison between the Owner, Design Professional and Contractor. TAB Firm
29 shall perform the following reviews (observations) and tests.

30 a. During construction, review all HVAC submittals such as control diagrams, air handling
31 devices, etc., that pertain to the ability to satisfactorily balance systems.

32 2. During the balancing process, as the TAB Firm discovers abnormalities and malfunctions of
33 equipment or components, the TAB Firm shall advise the Contractor in writing so that the condition
34 can be corrected by the Contractor prior to finishing the TAB Scope of Work. Data from
35 malfunctioning equipment shall not be recorded in the final TAB report.

36 1.03 REFERENCE STANDARDS

37 A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific
38 edition date.

39 B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this
40 Project.

1 C. All materials, installation and workmanship shall comply with the applicable requirements and standards
2 addressed within the following references:

3 1. AABC – National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning
4 Systems.

5 2. NEBB – National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting,
6 Balancing of Environmental Systems.

7 3. ASHRAE HVAC Applications Chapter 37: Testing, Adjusting and Balancing.

8 4. ANSI/ASHRAE Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of
9 Buildings, Heating, Ventilation, Air Conditioning and Refrigeration Systems.

10 5. CTI – Cooling Technology Institute CODE ATC-105.

11 1.04 QUALITY ASSURANCE

12 A. TAB Firm shall be independent from the Mechanical Contractor and any other sub-contractor associated
13 with the project.

14 B. TAB Firm shall be contracted through the General Contractor.

15 C. TAB Firm shall have operated a minimum of five (5) years under TAB Firm's current name and shall be in
16 good standing with the State of Texas, Franchise Tax Board. TAB Firm shall submit full incorporated
17 name, Charter Number, and Taxpayer's I.D. Number for proper verification of TAB Firm's status.

18 D. TAB Firm's personnel performing Work at the Project Site shall be either Professional Engineers or
19 certified air and water balance technicians, who shall have been permanent, full time employees of the
20 TAB Firm for a minimum of six (6) months prior to the start of Work for this Project.

21 E. TAB Firm shall have a background record of at least five (5) years of specialized experience in the field of
22 air and hydronic system balancing and shall possess properly calibrated instrumentation.

23 1.05 SUBMITTALS

24 A. The activities described in this Section shall culminate in a report to be provided in quadruplicate (4)
25 individually bound and also provided electronically to the Contractor to be presented to the Owner at the
26 Project close-out. Neatly type and arrange data. Include with the data, the dates, tested, personnel present,
27 weather conditions, nameplate record of test instrument and list all measurements taken after all corrections
28 are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The
29 intent of the report is to provide a reference of actual operating conditions for the Owner's operations
30 personnel.

31 B. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the report must have
32 been made at the Project Site by the permanently employed technicians or engineers of the TAB Firm.

33 C. Submit reports on electronic forms approved by the Design Professional which will include the following
34 information as a minimum:

35 1. Title Page:

36 a. Company name.

37 b. Company address.

38 c. Company telephone number.

- 1 d. Project name.
- 2 e. Project location.
- 3 f. Project Manager.
- 4 g. Project Engineer.
- 5 h. Project Contractor.
- 6 i. Project identification number.
- 7 2. Instrument List:
- 8 a. Instrument.
- 9 b. Manufacturer.
- 10 c. Model.
- 11 d. Serial number.
- 12 e. Range.
- 13 f. Calibration date.
- 14 g. What test instrument was used for
- 15 3. Fan Data (Supply and Exhaust):
- 16 a. Identification and location.
- 17 b. Manufacturer.
- 18 c. Model.
- 19 d. Air flow, specified and actual.
- 20 e. Total static pressure (total external), specified and actual.
- 21 f. Inlet pressure.
- 22 g. Discharge pressure.
- 23 h. Fan RPM.
- 24 4. Air Handler Return Air/Outside Air Data (if fans are used, provide fan data as noted above):
- 25 a. Identification and location.
- 26 b. Design return air flow.
- 27 c. Actual return air flow.
- 28 d. Design outside air flow.
- 29 e. Return air temperature.
- 30 f. Outside air temperature.

- 1 g. Required mixed air temperature.
- 2 h. Actual mixed air temperature.
- 3 5. Electric Motors:
- 4 a. Manufacturer.
- 5 b. Horsepower/brake horsepower.
- 6 c. Phase, voltage, amperage, nameplate, actual.
- 7 d. RPM.
- 8 e. Service factor.
- 9 f. Starter size, heater elements, rating.
- 10 6. V-Belt Drive:
- 11 a. Identification and location.
- 12 b. Required driven RPM.
- 13 c. Driven sheave, diameter and RPM.
- 14 d. Belt, size and quantity.
- 15 e. Motor sheave, diameter and RPM.
- 16 f. Center-to-center distance, maximum, minimum and actual.
- 17 7. Duct Traverse:
- 18 a. System zone/branch.
- 19 b. Duct size.
- 20 c. Area.
- 21 d. Design velocity.
- 22 e. Design air flow.
- 23 f. Test velocity.
- 24 g. Test air flow.
- 25 h. Duct static pressure.
- 26 i. Air temperature.
- 27 j. Air correction factor.
- 28 8. Air Monitoring Station Data:
- 29 a. Identification and location.
- 30 b. System.

- 1 c. Size.
- 2 d. Area.
- 3 e. Design velocity.
- 4 f. Design air flow.
- 5 g. Test velocity.
- 6 h. Test air flow.
- 7 9. Cooling Coil Data:
- 8 a. Identification number.
- 9 b. Location.
- 10 c. Service.
- 11 d. Manufacturer.
- 12 e. Entering air DB temperature, design and actual.
- 13 f. Entering air WB temperature, design and actual.
- 14 g. Leaving air DB temperature, design and actual.
- 15 h. Leaving air WB temperature, design and actual.
- 16 i. Air quantity CFM design, and CFM actual.
- 17 j. Air pressure drop, design and actual.
- 18 k. Sensible BTU/hr, design and actual.
- 19 l. Total BTU/hr design, and actual.
- 20 10. Sound Level Report:
- 21 a. Location (Location established by the Design Professional).
- 22 b. Baseline background NC curve for eight (8) bands – with equipment off.
- 23 c. Operating NC curve for eight (8) bands – with equipment on.
- 24 11. Control verification indicating date performed and any abnormalities identified:
- 25 a. Point location/description.
- 26 b. EMS Readout (setpoint and actual).
- 27 c. Actual readout.
- 28 d. Interlocks
- 29 e. Safeties
- 30 1) VSD Normal Operation.

1 2) VSD Bypass Operation.

2 f. Alarms.

3 g. Sequences of Operation.

4 12. Include in the Appendix all submittals for air handling units, pumps, fans, heat exchangers, energy
5 recovery units control system, etc.

6 **PART 2 – PRODUCTS**

7 Not used

8 **PART 3 – EXECUTION**

9 3.01 AIR BALANCE

10 A. When systems are installed and ready for operation, the TAB Firm shall perform an air balance for all air
11 systems and record the results. The outside, supply, exhaust and return air volume for each air handling
12 unit, supply fan and exhaust fan and the supply, exhaust or return air volume for each distribution device
13 shall be adjusted to the following criteria;

14 1. Supply diffusers: 0 to +10% of design value.

15 2. Return grilles & louvers: +/- 5% of design value.

16 3. Exhaust Grilles or louvers: 0 to -10% of design value

17 4. In all cases regardless of compliance with the above listed values, required pressure differentials
18 between adjacent spaces shall be maintained as specified (refer to sub-paragraph 3.01B (8) below).

19 B. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers
20 associated with the unit. Air distribution device volume shall be adjusted using the spin-in tap damper for
21 flexible duct connected devices and the device opposed blade damper (OBD) for duct connected devices.
22 Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be
23 adjusted to provide air volume to branch ducts where such dampers are shown.

24 C. The general scope of balancing by the TAB Firm shall include, but is not limited to, the following:

25 1. Filters: Check air filters and filter media and balance only systems with essentially clean filters and
26 filter media. The Contractor shall install new filters and filter media prior to the final air balance.

27 2. Blower Speed: Measure RPM at each fan or blower to design requirements. Where a speed
28 adjustment is required, the Contractor shall make any required changes.

29 3. Ampere Readings: Measure and record full load amperes for motors.

30 4. Static Pressure: Static pressure gains or losses shall be measured across each supply fan, cooling
31 coil, heating coil, return air fan, air handling unit filter and exhaust fan. These readings shall be
32 measured and recorded for this report at the furthest air device or terminal unit from the air handler
33 supplying that device. Static pressure readings shall also be provided for systems, which do not
34 perform as designed.

35 5. Equipment Air Flow: Adjust and record exhaust, return, outside and supply air CFM(s) and
36 temperatures, as applicable, at each fan, blower and coil.

37 6. Coil Temperatures: Set controls for full cooling and for full heating loads. Read and record entering
38 and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil and

- 1 reheat coil at each VAV terminal unit. At the time of reading record water flow and entering and
2 leaving water temperatures (in variable flow systems adjust the water flow to design for all the above
3 readings).
- 4 7. Zone Air Flow: Adjust each HVAC VAV terminal unit and VAV air handling unit within a range of
5 0 to +5% of design flow. The TAB firm shall compare the sum of the CAV/VAV box diffuser
6 readings with the flow indicated by the box's controller prior to calibrating the box's controller. If
7 the two readings agree within +/- 5%, the factory calibration factors shall not be changed. If the
8 readings are not within +/-5%, a documented trouble shooting procedure consisting of checking and
9 resolving the following shall be conducted prior to calibrating the controller to verify the final
10 calibration.
- 11 8. Outlet Air Flow: Adjust each exhaust inlet and supply diffuser, register and grille to within +/- 5
12 percent of design air CFM. Include all terminal points of air supply and all points of exhaust. Note:
13 For Labs and rooms that are negative exhaust air flow shall be set to design +10 percent and supply
14 to design -5 percent. Positive areas will have opposite tolerances.
- 15 9. Pitot Tube Traverses: For use in future troubleshooting by Owner, all exhaust ducts, main supply
16 ducts and return ducts shall have air velocity and volume measured and recorded by the traverse
17 method. Locations of these traverse test stations shall be described on the sheet containing the data.
- 18 10. Maximum and minimum air flow on terminal units.
- 19 11. The TAB report shall include a static profile of each AHU with the supply fan controlling to the
20 minimum sensed duct static pressure necessary for the system terminal units to achieve maximum
21 cooling design flow simultaneously. This static pressure shall be documented in the report and shall
22 become the duct static pressure set point.
- 23 12. The TAB report shall record the VFD speed for all supply and return fan measurements included in
24 the report.
- 25 13. The TAB contractor shall verify building and space pressure relationships in all modes of operation.
- 26 3.02 HYDRONIC SYSTEM BALANCE
- 27 A. When systems are installed and ready for operation, the TAB Firm shall perform water balance for each
28 chilled water and heating hot water system.
- 29 B. The general scope of balancing by the TAB Firm shall include, but not be limited to, the following:
- 30 1. Adjusted System Tests: Adjust balancing valves at each coil and heat exchanger to within a range of
31 0 to +10% of design flow. Adjust balancing valves at pumps to obtain design water flow within a
32 range of 0 to +10% of design flow. Record pressure rise across pumps and GPM flow from pump
33 curve. Permanently mark the balanced position for each valve. (Note: If discharge valves on the
34 pumps are used for balancing record the head being restricted by the valves).
- 35 2. Temperature Readings: Read and record entering and leaving water temperature at each water coil,
36 converter and heat exchanger. Adjust as necessary to design conditions. Provide final readings at all
37 thermometer well locations.
- 38 3. Pressure Readings: Water pressure shall be recorded at all gauge connections. Pressure readings at
39 coils and pumps shall be related to coil and pump curves in terms of GPM flow through flow
40 measuring status, if provided and installed, at each air handler. The flow of water through all water
41 coils shall be adjusted by manipulating valves until the rated pressure drops across each coil is
42 obtained and total water flow is verified by flow measuring status. For coils equipped with 3-way
43 valves, the rated pressure drop shall first be adjusted through the coils. The bypass valve shall then

1 be adjusted on each coil until an equal pressure drop between supply and return connections is the
2 same as with the flow through the coil.

3 4. Ampere Readings: Reading and record full load amperes for each pump motor.

4 3.03 SOUND VIBRATION AND ALIGNMENT

5 A. Sound: Read and record sound levels at up to fifteen (15) locations per floor in the building as designated
6 by the Design Professional. All measurements shall be made using an Octave Band Analyzer. All tests
7 shall be conducted when the building is quiet and in the presence of the Design Professional, at the Design
8 Professional's option.

9 B. Vibration: Read and record vibration for all water circulating pumps, air handling units, and fans which
10 have motors larger than 10 horsepower. Include equipment vibration, bearing housing vibration,
11 foundation vibration, building structure vibration, and other tests as directed by the Design Professional.
12 Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various
13 unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above, or
14 specified, shall not exceed one mil on fans and one mil on pumps unless otherwise specified. Equipment
15 manufacturer shall rectify all systems exceeding vibration tolerances.

16 3.04 BUILDING AUTOMATION SYSTEMS

17 A. In the process of performing the TAB Work, the Contractor shall:

18 1. Work with the Building Automation System (BAS) Provider and Owner to ensure the most effective
19 total system operation within the design limitations, and to obtain mutual understanding of intended
20 control performance.

21 2. Verify that all control devices are properly connected.

22 3. Verify that the intended controllers operate all dampers, valves and other controlled devices.

23 4. Verify that all dampers and valves are in the position indicated by the controller; open, closed, or
24 modulating.

25 5. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions.
26 This includes all duct mounted dampers, dampers in terminal units, and fire/smoke dampers.

27 6. Observe that all valves are properly installed in the piping system in relation to direction of flow and
28 location.

29 7. Observe the calibration and operation of all controllers.

30 8. Verify the proper application of all normally open and normally closed valves.

31 9. Observe the locations of all thermostats and humidistats for potential erratic operation from outside
32 influences such as sunlight, drafts, or cold walls.

33 10. Observe the locations of all sensors to determine whether their position will allow them to sense only
34 the intended temperatures or pressures of the media. BAS Provider will relocate sensors as deemed
35 necessary by the TAB Firm or Contractor.

36 11. Verify that the sequence of operation for any control mode is in accordance with approved Shop
37 Drawings and Specifications. Verify that no demand for simultaneous heating and cooling occurs at
38 the terminal units.

39 12. Verify that all controller set points meet the Contract Documents.

1 **DUCTWORK INSULATION**

2 **PART 1 – GENERAL**

3 1.01 RELATED DOCUMENTS

4 A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and
5 Division 01 Specification Sections, apply to this Section.

6 B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and
7 this Section is directly applicable to them.

8 1.02 SUMMARY

9 A. Perform all work required to provide and install ductwork insulation and jackets indicated by the Contract
10 Documents with supplementary items necessary for proper insulation.

11 1.03 REFERENCE STANDARDS

12 A. The latest published edition of a reference shall be applicable to this Project unless identified by a specified
13 edition date.

14 B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this
15 Project.

16 C. All materials, installation and workmanship shall comply with the applicable requirements and standards
17 addressed within the following references:

18 1. International Energy Conservation Code – 2015 Edition

19 2. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate.

20 3. ASTM C168 – Terminology Relating to Thermal Insulation Materials.

21 4. ASTM C518 – Steady-State Thermal Transmission Properties by means of the Heat Flow Meter
22 Apparatus.

23 5. ASTM C553 – Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial
24 Applications.

25 6. ASTM C612 – Mineral Fiber Block and Board Thermal Insulation.

26 7. ASTM C1071 – Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and
27 Sound Absorbing Material)

28 8. ASTM C1104 – Standard Test Method for Determining the Water Vapor Sorption of Un-Faced
29 Mineral Fiber Insulation.

30 9. ASTM C1290 – Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to
31 Externally Insulate HVAC Ducts.

32 10. ASTM C1136 – Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal
33 Insulation.

- 1 11. ASTM C1338 – Standard Test Method for Determining Fungi Resistance of Insulation Materials and
2 Facings.
- 3 12. ASTM E84 – Surface Burning Characteristics of Building Materials.
- 4 13. ASTM E96 – Water Vapor Transmission of Materials.
- 5 14. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
- 6 15. ASTM G21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to
7 Fungi.
- 8 16. NFPA 255 – Surface Burning Characteristics of Building Materials.
- 9 17. SMACNA – HVAC Duct Construction Standards – Metal and Flexible.
- 10 18. UL 181 – Standard for Factory-Made Air Ducts and Air Connectors.
- 11 19. UL 723 – Surface Burning Characteristics of Building Materials.
- 12 20. ASTM E2336 – Standard for Grease Ducts.

13 1.04 QUALITY ASSURANCE

- 14 A. All ductwork requiring insulation shall be insulated as specified herein and as required for a complete
15 system. In each case, the insulation shall be equivalent to that specified and materials applied and finished
16 as described in these Specifications.
- 17 B. All insulation, jacket, adhesives, mastics, tapes, sealers, etc., utilized in the fabrication of these systems
18 shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings)
19 and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into
20 their insulation system, unless a specific product is specified for a specific application and is stated as an
21 exception to this requirement. Certificates to this effect shall be submitted along with Contractor's
22 submittal data for this Section of the Specifications. No material may be used that, when tested by the
23 ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the
24 flame front is destroyed, thereby resulting in an artificially low flame spread rating.
- 25 C. Application Company Qualifications: Company performing the Work of this Section must have minimum
26 three (3) years of experience, specializing in the trade.
- 27 D. All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such
28 occupation.
- 29 E. All insulation shall be applied in strict accordance with these Specifications and with factory printed
30 recommendations on items not herein mentioned. Unsightly, inadequate or sloppy Work will not be
31 acceptable.

32 1.05 SUBMITTALS

- 33 A. Product Data:
- 34 1. Provide product description, list of materials, "k" value, "R" value, mean temperature range, and
35 thickness for each service and location.
- 36 B. Record Documents:

- 1 1. Submit under provisions of Division 1.
- 2 C. Operation and Maintenance Data:
- 3 1. Samples: When requested, submit three (3) samples of any representative size illustrating each
4 insulation type.
- 5 2. Manufacturer's Installation Instructions: Indicate procedures that ensure acceptable standards will
6 be achieved. Submit certificates to this effect.

7 1.06 DELIVERY, STORAGE AND HANDLING

- 8 A. Deliver, store, protect and handle products to the Project Site under provisions of Division 01.
- 9 B. Deliver materials to Site in original factory packaging, labeled with manufacturer's identification including
10 product thermal ratings and thickness.
- 11 C. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation
12 against dirt, water, chemical and mechanical damage.
- 13 D. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and
14 insulation cements.

15 **PART 2 – PRODUCTS**

16 2.01 GENERAL

- 17 A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements,
18 and conform to codes and ordinances of authorities having jurisdiction.

19 2.02 MANUFACTURERS

- 20 A. CertainTeed Corporation.
- 21 B. Johns Manville Corporation.
- 22 C. Knauf Corporation.
- 23 D. Owens-Corning.
- 24 E. Armacell, LLC North America.
- 25 F. Unifrax 1 LLC (FyreWrap)
- 26 G. ITW Insulation Systems
- 27 H. Venture Clad Jacketing Systems

28 2.03 INSULATION MATERIALS

- 29 A. Type D1: Flexible glass fiber; ASTM C553 and ASTM C1290; commercial grade; "k" value of 0.25 at 75
30 degrees F; 1.5 lb/cu ft. minimum density; 0.002 inch foil scrim kraft facing for air ducts.
- 31 B. Type D2: Rigid glass fiber; ASTM C612, Class 1; "k" value of 0.23 at 75 degrees F; 3.0 lb/cu ft. minimum
32 density; 0.002 inch foil scrim kraft facing for air ducts.

1 2.04 INSULATION ACCESSORIES

2 A. Adhesives: Waterproof vapor barrier type, meeting requirements of ASTM C916; Chillers CP-82.

3 B. Finish: Vapor barrier finish coating, Childers CP-11.

4 C. Jacket: Pre-sized glass cloth, minimum 7.8 oz/sq. yd.

5 D. Type D4 Insulation Adhesive: Fire resistive to ASTM E84, Childers CP-82.

6 E. Impale Anchors: Galvanized steel, 12 gauge self-adhesive pad.

7 F. Joint Tape:

8 1. UL 181 A-P/B-FX approved aluminum foil tape with pressure sensitive adhesive.

9 2. Glass fiber cloth, open mesh with adhesive and finish as listed above.

10 G. Tie Wire and Wire Mesh: Annealed steel, 16 gauge.

11 H. Stainless Steel Banding: 3/4 inch wide, minimum 22 gauge, 304 stainless.

12 I. Armaflex 520 or 520 BLV contact adhesive.

13 J. Armatuff seal seam tape.

14 **PART 3 – EXECUTION**

15 3.01 PREPARATION

16 A. Verify that ductwork has been tested before applying insulation materials.

17 B. Verify that surfaces are clean, foreign material removed, and dry.

18 C. Maintain required ambient temperature during and after installation for a minimum period of 24 hours.

19 3.02 INSTALLATION

20 A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards
21 and conform to codes and ordinances of authorities having jurisdiction.

22 B. All installation shall be in accordance with manufacturer's published recommendations.

23 C. Extend duct insulation without interruption through walls, floors and similar penetrations, except where
24 otherwise indicated.25 D. Provide external insulation on all round ductwork connectors to ceiling diffusers and on top of diffusers as
26 indicated in the Ductwork Insulation Application and Thickness Schedule and the Drawings. Secure
27 insulation to the top of ceiling diffusers with adhesive that meets NFPA 90A and 90B 25/50 requirements
28 and vapor barrier or tape to match jacket to form a complete vapor seal. Do not insulate top of ceiling
29 diffuser if it is used in ceiling return air plenum or in an open space with no ceiling

30 E. Flexible and Rigid fiberglass insulation (Types D1 and D2) application for exterior of duct:

- 1 1. Insulation shall be cut slightly longer than the circumference of the duct to insure full thickness at
2 the corner.
- 3 2. All insulation shall be applied with edges tightly stitched with staples on 3" centers.
- 4 3. Install without sag on underside of ductwork. The insulation shall be additionally secured to the
5 bottom of all square or rectangular ducts 24" or wider by means of welded pins or speed clips on 12"
6 centers.
- 7 4. Seal vapor barrier penetrations by mechanical fasteners with 2.5" wide, 0.002" thick, UL 181 A-P/B-
8 FX approved aluminum foil tape with pressure sensitive adhesive or one coat of vapor barrier
9 coating reinforced with 20 x 20 glass cloth. Stop and point insulation around access doors and
10 damper operators to allow operation without disturbing wrapping.
- 11 5. Insulate standing seams and stiffeners that protrude through the insulation with 1-1/2 inch thick, un-
12 faced, flexible blanket insulation. Cover with 2.5" wide 0.002" thick, UL 181 A-P/B-FX approved,
13 aluminum foil tape with pressure sensitive adhesive or one coat of vapor barrier coating reinforced
14 with 20 x 20 glass cloth.
- 15 6. Cover seams, joints, pin penetrations and other breaks with 2.5" wide 0.002" thick, UL 181 A-P/B-
16 FX approved aluminum foil tape with pressure sensitive adhesive or one coat of vapor barrier
17 coating reinforced with 20 x 20 glass cloth.
- 18 F. All ductwork, accessories, and all plenums including metal and masonry construction, etc., shall be
19 insulated as indicated on the Drawings, as specified herein and as required for a complete system. In each
20 case, the insulation shall be equal to that specified and materials applied and finished as described in these
21 Specifications.
- 22 G. Flexible ductwork connections to equipment shall not be insulated.
- 23 H. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken
24 that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier
25 terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated.
26 Ends shall not be left raw.
- 27 I. Extreme care shall be taken in insulating high and medium pressure ductwork including all ductwork
28 between the fan discharge and all mixing boxes to ensure the duct is not pierced with sheet metal screws or
29 other fasteners. All high and medium pressure ducts in these Specifications are classified as high velocity
30 ductwork.
- 31 J. Where canvas finish is specified use lagging adhesive to prevent mildew in securing canvas. Do not use
32 wheat paste. In addition, cover all canvas insulation with a fire retardant coating.
- 33 K. All ductwork in the Project except toilet exhaust and fume hood exhaust ductwork, shall be insulated
34 externally unless specifically excluded.
- 35 L. Flexible round ducts shall be factory insulated.
- 36 3.03 INSPECTION
- 37 A. Visually inspect the completed insulation installation per manufacturers recommended materials,
38 procedures and repair or replace any improperly sealed joints.
- 39 B. Where there is evidence of vapor barrier failure or "wet" insulation after installation, the damaged
40 insulation shall be removed, duct surface shall be cleaned and dried and new insulation shall be installed.

Ductwork System	Application	Insulation Type	Insulation Thickness
Supply Air 50°F & Above (Hot, Cold, Combination)	Outside of Mechanical Rooms	D1	2"
	Inside of Mechanical Rooms Where Installed Below 7'-0" AFF	D2	2"
Return Air, Relief Air, and Exhaust Air	All	D1	2"
Supply Air Diffusers	Top of Diffuser	D1	2"

1

2

END OF SECTION

1 **HVAC PIPING INSULATION**

2 **PART 1 – GENERAL**

3 1.01 RELATED DOCUMENTS

- 4
- 5 A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and
- 6 Division 01 Specification Sections, apply to this Section.
- 7 B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and
- 8 this Section is directly applicable to them.

9 1.02 SUMMARY

- 10 A. Perform all Work required to provide and install HVAC piping insulation, jackets and accessories indicated
- 11 by the Contract Documents with supplementary items necessary for proper installation.

12 1.03 REFERENCE STANDARDS

- 13 A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific
- 14 edition date.
- 15 B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this
- 16 Project.
- 17 C. All materials, installation and Workmanship shall comply with the applicable requirements and standards
- 18 addressed within the following references:

- 19 1. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate.
- 20 2. ASTM C168 – Terminology Relating to Thermal Insulation Materials.
- 21 3. ASTM C177 – Steady-State Heat Flux Measurements and Thermal Transmission Properties by
- 22 Means of the Guarded – Hot – Plate Apparatus.
- 23 4. ASTM C195 – Mineral Fiber Thermal Insulating Cement.
- 24 5. ASTM C335 – Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
- 25 6. ASTM C449 – Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- 26 7. ASTM C518 – Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter
- 27 Apparatus.
- 28 8. ASTM C534 – Pre-formed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular
- 29 Form.
- 30 9. ASTM C547 – Mineral Fiber Pipe Insulation.
- 31 10. ASTM C552 – Cellular Glass Thermal Insulation.
- 32 11. ASTM C578 – Rigid, Cellular Polystyrene Thermal Insulation.
- 33 12. ASTM C585 – Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe
- 34 and Tubing (NPS System).
- 35 13. ASTM C591 – Un-faced Pre-formed Rigid Cellular Poly-isocyanurate Thermal Insulation.
- 36 14. ASTM C610 – Molded Expanded Perlite Block and Pipe Thermal Insulation.

- 1 15. ASTM C921 – Jackets for Thermal Insulation.
- 2 16. ASTM C1126 – Faced or Un-faced Rigid Cellular Phenolic Thermal Insulation.
- 3 17. ASTM D1056 – Flexible Cellular Materials – Sponge or Expanded Rubber.
- 4 18. ASTM C1667 – Flexible Cellular Materials – Vinyl Chloride Polymers and Copolymers (Closed
- 5 Cell Foam).
- 6 19. ASTM D2842 – Water Absorption of Rigid Cellular Plastics.
- 7 20. ASTM C795 – Insulation for Use in Contact with Austenitic Steel.
- 8 21. ASTM E84 – Surface Burning Characteristics of Building Materials.
- 9 22. ASTM E96 – Water Vapor Transmission of Materials.
- 10 23. NFPA 255 – Surface Burning Characteristics of Building Materials.
- 11 24. UL 723 – Surface Burning Characteristics of Building Materials.

12 1.04 DEFINITIONS

- 13 A. Concealed: Areas that cannot be seen by the building occupants.
- 14 B. Interior Exposed: Areas that are exposed to view by the building occupants, including underneath
- 15 countertops, inside cabinets and closets, and all equipment rooms.
- 16 C. Exterior: Areas outside the building exterior envelope that are exposed to the outdoors, including building
- 17 crawl spaces.

18 1.05 QUALITY ASSURANCE

- 19 A. All piping requiring insulation shall be insulated as specified herein and as required for a complete system.
- 20 In each case, the insulation shall be equivalent to that specified and materials applied and finished as
- 21 described in these Specifications.
- 22 B. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet
- 23 NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be
- 24 approved by the insulation manufacturer for guaranteed performances when incorporated into their
- 25 insulation systems, unless a specific product is specified for a specific application and is stated as an
- 26 exception to this requirement.
- 27 1. Certificates to this effect shall be submitted along with Contractor’s submittal data for this Section of
- 28 the Specifications.
- 29 2. No material shall be used that, when tested by the ASTM E84-89 test method, is found to melt, drip
- 30 or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in
- 31 an artificially low flame spread rating.
- 32 C. Application Company Qualifications: Company performing the Work of this Section must have minimum
- 33 three (3) years experience specializing in the trade.
- 34 D. All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such
- 35 occupation.
- 36 E. All insulation shall be applied in strict accordance with these Specifications and with factory printed
- 37 recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy Work will not be
- 38 acceptable.

1 1.06 SUBMITTALS

2 A. Product Data:

- 3 1. Provide product description, list of materials “k” value, “R” value, mean temperature range, and
4 thickness for each service and location.
- 5 2. Samples: When requested, submit three (3) samples of any representative size illustrating each
6 insulation type.

7 B. Operation and Maintenance Data:

- 8 1. Indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this
9 effect.

10 1.07 DELIVERY, STORAGE AND HANDLING

11 A. Deliver materials to the Project Site in original factory packaging, labeled with manufacturer’s
12 identification including product thermal ratings and thickness.

13 B. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation
14 against dirt, water, chemical and mechanical damage.

15 C. Maintain ambient temperature and conditions required by manufacturers of adhesives, mastics and
16 insulation cements.

17 **PART 2 – PRODUCTS**

18 2.01 GENERAL

19 A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements,
20 and conform to codes and ordinances of authorities having jurisdiction.

21 2.02 MANUFACTURERS

22 A. Insulation:

- 23 1. Owens-Corning (Type P1).
24 2. Certainteed Corporation (Type P1).
25 3. Johns Manville Corporation (Type P1).
26 4. Knauf Corporation (Type P1).
27 5. Dow Chemical Company (Type P2).
28 6. Armstrong/Armacell (Armaflex) (Type P3).
29 7. RBX Industries/Rubatex (Type P3).
30 8. Johns-Manville Minwool-1200 (Type P4).
31 9. Resolco International by (Insul-Phen) (Type P5).
32 10. FOAMGLAS (Cellular Glass) by Pittsburgh Corning (Type P6).
33 11. Johns-Manville Thermo-12 Gold Calcium Silicate (Type P7).

- 1 B. Jackets:
- 2 1. Childers Products Company.
- 3 2. PABCO.
- 4 3. RPR Products, Inc.
- 5 4. Alpha.
- 6 5. Venture Tape Corporation.
- 7 6. Pittsburgh Corning - FOAMGLAS

8 2.03 INSULATION

- 9 A. Type P1: Fiberglass preformed insulation; ASTM C 547; minimum 3.0 lb/cu ft density, ASTM C335, 'k'
10 value of 0.23 at 75 degrees F; noncombustible.
- 11 B. Type P2: Molded closed cell polyisocyanurate insulation; ASTM E96, maximum water vapor
12 transmission rating of 0.005 Perm-In; ASTM C518, 'k' value of 0.20 at 75 degrees F; ASTM D2842,
13 water absorption value of 0.05 lb/ft2.
- 14 C. Type P3: Closed cell elastomeric, flexible, insulation; ASTM E96; maximum vapor transmission rating
15 of 0.20 perms; ASTM C 518; 'k' value of 0.27 at 75 degrees F.
- 16 D. Type P4: Mineral Wool; ASTM C 547; preformed, high temperature insulation; 'k' value of 0.34 at 300
17 degrees F.
- 18 E. Type P5: Phenolic closed cell, ASTM C1126 rigid foam, 2.2 lbs. nominal density, CFC free; ASTM
19 C518, 'k' value of 0.13 at 75 degrees F. (Note material thickness limit is 3 inches as tested in accordance
20 with ASTM E84).
- 21 F. Type P6: Cellular Glass, ASTM C552, 7.5 lbs./cu.ft, density, ASTM E96 (Wet Cup Method) 0.00 water
22 vapor perm , ASTM C518 'k' value of 0.29 at 75 degrees F.
- 23 G. Type P7: Type P7: Hydrous Calcium Silicate, ASTM C533, Type I, 14.5 lbs./cu. ft. density, ASTM
24 C585 and C795, 'k' value of 0.40 at 100°F. Compressive strength of 100 PSI per ASTM C165.

25 2.04 JACKETS

- 26 A. Factory Applied Jackets:
- 27 1. White kraft bonded to reinforced foil vapor barrier with self-sealing adhesive joints.
- 28 2. ASJ White, triple-ply laminate polypropylene, mold resistant, metalized polyester vapor barrier
29 film backing: Venture 1555U or Insulrap 30 Vapor Barrier I-30.
- 30 B. Field Applied Jackets:
- 31 1. PVC Jackets: UL listed 25/50 rated per ASTM E 84, UV resistant, minimum insulation thickness
32 0.020 inches for pipe outside diameters up to 18 inches and 0.030 inches for pipe outside
33 diameters 18 inches and above. Standard manufactured PVC cover fittings cover system
34 consisting of one-piece, pre-molded, PVC covers with fiberglass inserts manufactured from 20-
35 mills thick, high-impact, ultraviolet-resistant. Use ultraviolet resistant adhesive as recommended by
36 the manufacturer.
- 37 2. Reinforcing Mesh: Glass Fiber Childers Chil-Glas #10 or synthetic 9X8 mesh with minimum
38 weight of 0.9 ounces per square yard.

- 1 3. Aluminum Jackets: ASTM B 209; 0.020 inch thick; smooth finish with factory applied moisture
2 barrier.
- 3 4. Stainless Steel Jackets: Type 304 stainless steel; 0.010 inch thick; smooth finish.
- 4 5. VentureClad 1577CW or Foster Vapor Fas 62-05, zero permeability and mold resistant jacket
5 material, 5-ply laminate with 5-6 mil film with adhesive on one side. Jacketing laminated film
6 must have UV coating for additional exterior protection.
- 7 2.05 COATINGS, SEALANTS, TAPES AND ADHESIVES
- 8 A. Insulating Cement: ASTM C 195; hydraulic setting mineral wool; Ryder One-Coat.
- 9 B. Sealants: Foster 95-50; Childers CP-70 or CP-76
- 10 1. Apply at valves, fittings and where insulation is terminated. Brush-apply sealant to end of
11 insulation and continue along pipe surface.
- 12 2. Below-ambient closed cell pipe insulation (Type P5, P5A, P5B): apply sealant on all longitudinal
13 and butt insulation joints to prevent moisture transmission.
- 14 C. Lap Seal Tape: Self-adhering 2' wide tape specifically engineered to cover end joints of AP Armaflex
15 Black Lap Seal tube material for use on end seams and butt joints that have already been sealed with
16 Armaflex 520 adhesive. Not to be used on longitudinal seams.
- 17 D. Adhesives: Use to adhere the longitudinal lap seam of vapor barrier jackets and at butt joints between
18 insulation or fitting covers. Provide Childers CP-82 or Foster 85-20/85-60 as general purpose adhesive.
19 For use with calcium silicate or expanded perlite insulation, use Childers CP-97 or Foster 81-27 fibrous
20 adhesive when adhering pipe saddles and shields to the insulation.
- 21 E. Primers: For proper bonding with lagging adhesive/canvas provide light coat of Childers CP-50 AMV1
22 or Foster 30-36 diluted 50 percent with water over insulation or Pittcoat 300 primer thinned with mineral
23 spirits to cover insulating cements prior to finish coating.
- 24 F. Coatings and Mastics:
- 25 1. Vapor barrier coating for indoor, below-ambient applications: Foster 30-80 or Childers CP-38 on
26 all elbows, fittings, and valves. Coating shall adhere to MIL-C-19565C, Type II and shall be QPL
27 listed.
- 28 2. Weather barrier/breather mastics for above-ambient piping applications: Childers CP-10/CP-11 or
29 Foster 46-50.
- 30 3. High humidity applications: Foster 30-80 AF or Childers CP-137 AF fungus/mold resistant
31 coating that meets ASTM D 5590 with zero growth rating.
- 32 4. Exterior applications: Childers CP 30LO (must be covered by metal jacketing), Childers CP-45
33 Encacel V, or Foster 60-95 Monolar for insulated elbows/fittings, longitudinal seams, and butt
34 joints of vapor barrier jackets or glass cloth jackets.
- 35 5. Finish coat over closed cell elastomeric: Foster 30-64 or Armstrong "Finish" acrylic finish.
- 36 6. Canvas Finishes:
- 37 a. Apply lagging adhesive to prevent mildew for securing canvas. Apply anti-fungal lagging
38 adhesive that adheres to ASTM D 5590 with zero growth rating. (Foster 30-36AF, Childers
39 CP-137AF) Do not use wheat paste.

1 b. Exterior Applications: cover all canvas insulation with a fire-retardant weather barrier
2 mastic. On canvas jacketed systems where seam joints at fittings are rough, cover with an
3 application of insulating cement and smooth with a trowel before the canvas is applied with
4 adhesive. Canvas shall be free of wrinkles and have a smooth, neat appearance.

5 G. Reinforcing Mesh: Childers Chil-Glas #10 or Foster Mast-a-Fab 9x8 reinforcing mesh with coatings and
6 mastics.

7 H. Lagging Adhesives/Coatings: Childers CP-50A HV2 or Foster 30-36 for adhering canvas and glass
8 cloths over thermal insulation installed indoors. Adhesive shall adhere to MIL-A-3316C Class I, Grade
9 A.

10 1. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF
11 fungus/mold resistant coating that meets ASTM D 5590 with zero growth rating. Coating shall
12 adhere to MIL-C-19565C, Type II and must be QPL listed.

13 2.06 INSERTS, SUPPORTS AND SHIELDS
14

15 A. Application: Piping ½ inch diameter or larger for all systems except direct buried.

16 B. Shields shall be made of galvanized steel or made of black iron painted on both sides with a minimum
17 two coats of aluminum paint. Required metal shield sizes are as follows:

Nominal IPS (inches)	Metal Thickness (gauge)	Minimum Lengths of Shield (inches)
½ to 1½	18	12
2	14	12
2-½ to 6	12	16
8 and above	10	20

18
19 C. Inserts for shields shall be manufactured of 7.5 lb/cu. ft. density cellular glass or 5.0 lb/cu. ft. density
20 cellular, phenolic insulating material suitable for the planned temperature range. Provide factory
21 fabricated inserts with integral galvanized pipe saddles. Inserts shall be the same thickness as the adjacent
22 insulation.

23 D. When installing elastomeric insulation, Armafix IPH or Armafix NPH shall be used to prevent
24 compression of insulation at standard split, clevis hangers or other pipe support systems. A pair of non-
25 skid pads shall be adhered to the clamps to prevent axial movement of the insulation. In addition, to
26 prevent loosening of the clamps, an anti-vibratory fastener, such as a nylon-locking nut, shall be used.

27 E. Depending on the type of pipe support design, stainless steel bands or aluminum bands may be required
28 to keep shield material next to the jacketing material.

29 2.07 INSULATION ACCESSORIES

30 A. Insulation Bands: ¾ inch wide; 0.007 inch thick galvanized steel when exposed to interior environment,
31 0.010 inch thick stainless steel or 0.015 inch thick aluminum when exposed to humid interior environment
32 or outside environment.

33
34 B. Metal Jacket Bands: ⅜ inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel to match
35 jacket.

- 1
2 C. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum to match jacket.
- 3 D. Sealants: Use at valves, fittings and where insulation is terminated. Brush apply sealant to end of
4 insulation and continue along pipe surface.
- 5 E. Adhesives: Use to adhere the longitudinal lap seam of vapor barrier jackets and at butt joints between
6 insulation or fitting covers. Provide Childers CP-82 or approved equal as general purpose adhesive. Use
7 Childers CP-97 fibrous adhesive for calcium silicate or when adhering pipe saddles and shields to the
8 insulation.
9
- 10 F. Primers: Provide Childers CP-50 diluted 50 percent with water or Pittcoat 300 primer thinned with mineral
11 spirits to cover insulating cements prior to finish coating.
12
- 13 G. Finish: Provide Childers CP-30 L.O. as a general purpose finish to coat the longitudinal seams and butt
14 joints of vapor barrier jackets or glass cloth jackets. Use Childers CP-50 reinforced with glass cloth as an
15 adhesive and sizing for canvas and in other locations as indicated.
16

17 PART 3 – EXECUTION

18 3.01 INSTALLATION

- 19 A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards
20 and conform to codes and ordinances of authorities having jurisdiction.
- 21 B. Installation of insulation and jacket materials shall be in accordance with manufacturer's published
22 instructions.
- 23 C. Handle and install materials in accordance with manufacturer's instructions in the absence of specific
24 instructions herein.
- 25 D. On exposed piping, locate insulation cover seams with the ridge of the lap joint is directed down.
- 26 E. Exposed insulated piping within six feet of the floor shall be protected with an aluminum or stainless jacket
27 material to protect the insulation.
- 28 F. Continue insulation through walls, sleeves, pipe hangers, floors and other pipe penetrations.
- 29 G. Provide dams in insulation at intervals not to exceed 20 feet on cold piping systems to prevent migration of
30 condensation or fluid leaks. Indicate visually where the dams are located for maintenance personnel to
31 identify and also provide dams at butt joints of insulation at fittings, flanges, valves, and hangers.
- 32 H. Insulate entire system including fittings, valves, flanges and strainers.
- 33 I. Use closed cell insulation on cold piping system flexible connections, expansion joints and unions and on
34 all refrigerant lines where passing vertically through interior partitions for sound abatement. Bevel and seal
35 ends of insulation and continue sealant a minimum of 4 inches along the piping, unless stated otherwise.
36 Install insulation by "pushing" only, to result in a slightly compressed state, using Armaflex 520 or
37 Armaflex 520 BLV adhesive to seal all joints and seams (cloth tape is not allowed to be used to seal joints
38 or seams). On cold piping, insulation shall be adhered directly to the piping at the high end of the run using
39 a two-inch strip of Armaflex 520 or 520 BLV adhesive on the I.D. of the insulation and on the pipe. All
40 penetrations through the insulation and termination points must be adhered to the substrate to prevent
41 condensation migration. Where exposed to view or sunlight, coat exposed closed cell elastomeric insulation
42 with two coats of Armacell "WB" or K-Flex "374". Where exposed to physical abuse, provide stainless
43 steel or aluminum jacketing as specified above. All exposed piping shall have the seams located on the
44 lower half of the pipe.

- 1 J. On heating piping systems conveying fluids over 180°F with unions, flanges, valves, strainers and
2 equipment that is anticipated to be removed for maintenance, the insulation shall terminate (beveled to
3 pipe) just prior to the flange or union with vapor barrier sealed to pipe. The tapered segment of insulation
4 shall not interfere with the removal of unions flange bolts or equipment. The unions, flanges, valves and
5 strainers shall be insulated with removable insulated covers with toggle catches or Velcro straps.
- 6 K. Insulate fittings, joints and valves with molded insulation of the same material and thickness as adjoining
7 pipe. Open voids and cracks in insulation shall be kept at a minimum when placing insulation on abnormal
8 or irregular shapes. Use closed cell or recommended fill material as instructed by the insulation
9 manufacturer to close openings. At ball valves, provide Nibco “NibSeal” (or approved equal, if supplied
10 valve is from a different manufacturer, such as Milwaukee Valve “Insulator”) handle extension/vapor
11 barrier sealing system. Fiberglass batt insulation shall not be used as a fill material on chilled water piping
12 or fittings.
- 13 L. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is
14 applied, it shall lap the adjoining section of insulation by at least three inches (3 inches). Where insulation
15 terminates, it shall be neatly beveled and finished. All materials used shall be fire retardant or non-
16 flammable.
- 17 M. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken
18 that the vapor barrier is unbroken. Joints, etc., shall be sealed. Where insulation with a vapor barrier
19 terminates, seal off with vapor barrier continuous to the surface being insulated. Ends shall not be left raw.
- 20 N. Where pipe chases are tight, adequate provision shall be made at the rough-in stage using offset fittings or
21 other means (except springing the pipe) to ensure that insulation can be applied throughout the length of the
22 pipe.
- 23 O. Where canvas finish is specified, use lagging adhesive to prevent mildew in securing canvas. Do not use
24 wheat paste. In addition, cover all canvas insulation with a fire-retardant coating.
- 25 1. On canvas jacketed systems where seam joints at fittings are rough, they shall be covered with an
26 application of insulating cement and smoothed with a trowel before the canvas is applied with
27 adhesive. The canvas must be free of wrinkles and have a smooth, neat appearance.
- 28 P. INSERTS, SUPPORTS AND SHIELDS
- 29 1. Shields
- 30 a. Install between pipe hangers or pipe hanger rolls and inserts. Curved metal shields shall be
31 used between the hangers or support points and at the bottom of insulated pipe.
- 32 b. Hangers shall support the load of the insulated pipe section on the outside of the insulation
33 and shall not be in direct contact with the pipe.
- 34 c. Manufacturer shall be responsible to size the length of shield required to prevent insulation
35 from breaking.
- 36 d. Provide rigid insulation at each support point, a minimum of 2 inches longer than shield
37 length.
- 38 e. Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi
39 and shall be curved to fit up to mid-perimeter of the insulated pipe.
- 40
- 41 2. When installing phenolic insulation provide a 5 lb. density insert of same thickness and contour as
42 adjoining 3.75 lb. density insulation, between the support shield and piping, and under the finish
43 jacket, on piping 1-1/2 inch diameter or larger, to prevent insulation from sagging at support points.
44 Provide inserts for the full circumference of the pipe and not less than 2 inches more than the length

- 1 of the pipe support shield or minimum 12 inches long (whichever is greater). Adhere the pipe
2 support shield to insulation with a UL approved adhesive that meets E-84 requirements.
- 3 3. When installing elastomeric insulation, Armafix IPH or Armafix NPH shall be used to prevent
4 compression of insulation at standard split, clevis hangers or other pipe support systems. A pair of
5 non-skid pads shall be adhered to the clamps to prevent axial movement of the insulation. In
6 addition, to prevent loosening of the clamps, an anti-vibratory fastener, such as a nylon-locking nut,
7 shall be used.
- 8 4. Seal all insulation at supports, protrusions and interruptions. Maintain vapor barrier with finish coat.

9 3.02 PIPING INSULATION APPLICATION AND THICKNESS SCHEDULE

- 10 A. In no case shall installed piping insulation have insulation thicknesses that are less than what is required by
11 local energy codes and ASHRAE 90.1 (whichever is more stringent), based on comparable insulation
12 conductivity values at the specified mean rating temperature.
13

14

Piping Systems	Location	Type	Pipe Size	Insulation Thickness
Cold Condensate Drain Lines	Interior	P5	All Sizes	3/4"
		P6	4" and Smaller	1"
	6" & Larger		1-1/2"	
	Interior Concealed	P3	All Sizes	3/4"
P6		All Sizes	1"	
Refrigerant Suction Piping (35°F – Nominal)	All	P3	4" & Smaller	1"
Refrigerant Liquid Piping	Within walls for noise abatement	P3	2' & Smaller	1"

15
16 **END OF SECTION**

1 **HYDRONIC PIPING**

2

3 **PART 1 – GENERAL**

4 1.01 **RELATED DOCUMENTS**

5 A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and
6 Division 01 Specification Sections, apply to this Section.

7 B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and
8 this Section is directly applicable to them.

9 1.02 **SUMMARY**

10 A. Furnish and install all labor, materials, equipment, tools and services and perform all the operations
11 required in connection with, or associated with the construction of complete hydronic piping systems,
12 including chilled and heating hot water piping, condenser water piping process chilled or hot water piping,
13 condensate drain piping and generator cooling water piping systems as indicated on the Drawings.

14 1.03 **REFERENCE STANDARDS**

15 A. The latest published edition of a reference shall be applicable to this Project unless identified by a specified
16 edition date.

17 B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this
18 Project.

19 C. All materials, installation and workmanship shall comply with the applicable requirements and standards
20 addressed within the following references:

21 1. ANSI/ASME Sec 9 – Welding and Brazing Qualifications.

22 2. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded
23 and Seamless.

24 3. ANSI/ASME B16.3 – Malleable Iron Threaded Fittings Class 150 and 300.

25 4. ANSI/ASME B16.9 – Factory-Made Wrought Butt Welding Fittings.

26 5. ANSI/ASME B16.23 – Cast Copper Alloy Solder Drainage Fitting – DWV.

27 6. ANSI/ASME B16.29 – Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings
28 – DWV.

29 7. ANSI/ASME B31.9 – Building Services Piping.

30 8. ANSI/AWS D1.1 – Structural Welding Code.

31 9. ASTM A53 – Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless,
32 or Ordinary Uses.

33 10. ASTM A105 – Standard Specification for Carbon Steel Forgings for Pipe Applications.

- 1 11. ASTM A234 – Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated
2 Temperatures.
- 3 12. ASTM A312 – Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
- 4 13. ASTM A536 – Standard Specification for Ductile Iron Castings.
- 5 14. ASTM B88 – Standard Specification for Seamless Copper Water Tube.

6 1.04 QUALITY ASSURANCE

- 7 A. Valves: Manufacturer’s name and pressure rating shall be clearly marked on the outside of the valve body.
- 8 B. All grooved joint couplings, fittings, flanges, valves, and specialties of the same type shall be the products
9 of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- 10 C. Welding Materials and Procedures: Conform to Chapter V, ASME/ANSI B31.9 and applicable state labor
11 regulations.
- 12 D. Welders Certification: Furnish in accordance with AWS D10.12 and ASME B31.9.
- 13 E. Each threaded fitting shall be stamped as specified by ANSI B16.3.
- 14 F. Each welded fitting shall be stamped as specified by ANSI B31.9.

15 1.05 SUBMITTALS

- 16 A. Product Data:
- 17 1. Submit product data on pipe materials, pipe fittings, valves and accessories. Clearly indicate make,
18 model, type, size and pressure rating for each device.
- 19 2. Submittal data for all fittings shall include a letter signed by an official of the manufacturing
20 company certifying compliance with these Specifications.
- 21 B. Record Documents:
- 22 1. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be
23 specifically identified with the applicable Victaulic style or series designation.
- 24 2. Include Welder’s Certification of compliance in accordance with Chapter V, ASME/ANSI B31.9.

25 **PART 2 – PRODUCTS**

26 2.01 GENERAL

- 27 A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements,
28 and conform to codes and ordinances of authorities having jurisdiction.
- 29 B. Wall, Floor and Ceiling Plates:
- 30 1. Provide chrome-plated brass floor and ceiling plates.
- 31 C. Threaded Fittings:

1 1. All threaded fittings shall be USA factory made, wrought carbon or alloy steel threaded fittings
2 conforming to ASTM A234 or malleable iron threaded fittings conforming to ASME B16.3.

3 2. Acceptable manufacturers: Grinnell, Tube Turns, Hackney Ladish Company, or Taylor Forge.

4 D. Grooved Fittings:

5 1. All grooved joint couplings, fittings, valves and specialties shall be the products of a single
6 manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
7 Fittings shall comply with ASTM A536; ASTM A234; or factory fabricated from carbon steel piping
8 conforming to ASTM A53.

9 2. Acceptable manufacturers: Victaulic Company of America.

10 3. Gaskets shall be verified as suitable for the intended system service, a minimum temperature of 250
11 degrees, fluid chemistry, and system pressure prior to installation. Gaskets shall be molded and
12 produced by the coupling manufacturer.

13 E. Welded Fittings:

14 1. All welded fittings shall be USA factory made wrought carbon steel butt welding fittings conforming
15 to ASTM Spec. A234 or ASME B16.9.

16 2. Acceptable manufacturers: Grinnell, Tube Turns, Hackney Ladish Company, or Taylor Forge.

17 F. Flanges:

18 1. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured,
19 forged carbon steel, conforming to ANSI B16.5 and ASTM A-191 Grade I or II or A-105 as made
20 by Tube Turns, Hackney Ladish Company. Slip on flanges shall not be used. Complete test reports
21 may be required for any fitting selected at random.

22 2. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS
23 SP-25. Contractor shall submit data for firm certifying compliance with these Specifications.

24 3. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard heavy
25 dimensions. All-thread rods will not be an acceptable substitute for flange bolts. Bolts shall have a
26 tensile strength of 60,000 psi and an elastic limit of 30,000 psi.

27 4. All flanges shall be gasketed. Place gasket between flanges of flanged joints. Gaskets shall fit
28 within the bolt circle on raised face flanges and shall be full face on flat face flanges. Gaskets shall
29 be cut from 1/16 inch thick, non-metallic, non-asbestos gasket material suitable for operating
30 temperatures from -150 degrees F to +750 degrees F, KLINGERsil C-4400, Johns-Manville Style 60
31 service sheet packing or accepted substitution. Gaskets must be compatible with flowing fluid,
32 temperature and pressure of system.

33 G. Copper Fittings:

34 1. Mechanically formed, drilled and extruded tee-branch connections shall not be permitted.

35 2. For piping 4" and smaller, the use of Viega "Pro-Press" or Nibco compression type fittings will be
36 accepted. Coupling fittings shall include a positive stop to assure proper pipe seating on both sides of
37 the coupling. Nibco fittings shall be furnished with EPDM leak detection O-rings.

38 2.02 PIPE

1 B. Building Chilled Water and Heating Water Piping – 150 psi and below:

2 1. Steel:

3 a. Pipe 2-1/2 inches and smaller: Black steel ASTM A53, Grade A or B, seamless, Schedule 40.

4 1) Fittings: Screwed, AAR malleable iron, Class 150.

5 2) Joints: Screwed.

6 3) Unions: Forged steel, ASTM A105, screwed with stainless steel seats.

7 b. Pipe 3 inches and larger: Black steel ASTM A53, Grade B, seamless:

8 1) 3 inches through 6 inches – Schedule 40.

9 2) 8 inches through 16 inches – Schedule 30.

10 3) 18 inches through 20 inches – 0.375 inch wall thickness.

11 4) 24 inches – 0.500 inch wall thickness.

12 5) Fittings:

13 a) ASTM A234 carbon steel welding type, long radius type elbows unless specified
14 otherwise on the Drawings.15 b) ASTM A536 ductile iron; A234 carbon steel; or factory fabricated A53; grooved
16 end long radius type elbows unless specified otherwise on the Drawings.

17 6) Joints:

18 a) Butt welded.

19 b) Grooved mechanical couplings.

20 7) Flange: ANSI B16.5 Class 150, forged carbon steel.

21 2. Copper:

22 a. Pipe 4 inches and smaller; Copper Tubing: ASTM B88, Type L, hard drawn. All brass and
23 bronze piping components shall have no more than 15 percent zinc content.

24 1) Fittings: ASTM B16.18, cast bronze, or ASME B16.22 wrought copper and bronze.

25 2) Joints: ASTM B32, solder, Grade 95TA (lead free).

26 3) Viega “Pro-Press” or Nibco compression type fittings. . Coupling fittings shall include
27 a positive stop to assure proper pipe seating on both sides of the coupling. Nibco
28 fittings shall be furnished with EPDM leak detection O-rings.

29 C. Equipment Drains and Overflows:

30 1. Pipe: Galvanized steel ASTM A53, Schedule 40.

- 1 a. Fittings: Galvanized cast iron, ductile iron, steel, or ASTM B16.3 malleable iron.
- 2 b. Joints: Screwed, or grooved mechanical couplings.
- 3 2. Tubing: Copper ASTM B88, Type L, hard drawn.
- 4 a. Fittings: ASME B16.23 cast brass, or ASME B16.29 solder wrought copper.
- 5 b. Joints: ASTM B32, solder, Grade 95TA or grooved mechanical couplings.
- 6 D. Cooling Coil Condensate Recovery:
- 7 1. Pipe: Galvanized steel ASTM A53, Schedule 40.
- 8 a. Fittings: Galvanized cast iron, ductile iron, steel, or ATM B16.3 malleable iron.
- 9 b. Joints: Screwed, or grooved mechanical couplings.
- 10 2. Tubing: Copper ASTM B88, Type L, hard drawn.
- 11 a. Fittings: ASME B16.23 cast brass, or ASME B16.29 solder wrought copper.
- 12 b. Joints: ASTM B32, solder, Grade 95TA or grooved mechanical couplings.
- 13 c. As a no increase in cost alternate, Viega “ProPress” or Nibco press fittings may be used.
- 14 2.03 GROOVED MECHANICAL COUPLINGS AND FITTINGS
- 15 A. Grooved mechanical couplings shall consist of two ductile iron housing segments conforming to ASTM
- 16 A536, with pressure responsive elastomer gasket, and zinc electroplated carbon steel bolts and nuts.
- 17 1. Sizes 2-1/2 inches through 8 inches:
- 18 a. Rigid Type Couplings: Housings cast with offsetting, angle-pattern bolt pads to provide
- 19 rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.
- 20 Victaulic Style 107 Quick-Vic™.
- 21 b. Flexible type couplings: Use in locations where vibration attenuation and stress relief are
- 22 required. Victaulic Style 77 or 177 Quick-Vic™.
- 23 c. Flange Adapters: Flat face, for direct connection to ANSI Class 125 or 1590 flanged
- 24 components. Victaulic Style 741.
- 25 2. Sizes 10 inches through 12 inches:
- 26 a. Rigid Type Couplings: Housings cast with offsetting, angle-pattern bolt pads to provide
- 27 rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.
- 28 Victaulic Style 07.
- 29 b. Flexible Type Couplings: Use in locations where vibration attenuation and stress relief are
- 30 required. Victaulic Style 77.
- 31 c. Flange Adapters: Flat face, for direct connection to ANSI Class 125 or 150 flanged
- 32 components. Victaulic Style 741.

- 1 3. Sizes 14 inches through 24 inches: AGS ‘W’ series couplings shall include a widened gasket and
2 wide profile housings.
- 3 a. Rigid Type Couplings: Housing key with lead-in chamfer, with key designed to fill the
4 wedge shaped AGS groove to provide rigidity and system support and hanging in accordance
5 with ANSI B31.1 and B31.9. Victaulic Style W07.
- 6 b. Flexible Type Couplings: Housing key with lead-in chamfer, with key designed to fit into the
7 wedge shaped AGS groove to allow for linear and angular movement. Victaulic Style W77.
- 8 c. AGS couplings shall be installed to full metal-to-metal bolt pad contact at the required torque.
- 9 B. Grooved mechanical fittings shall be manufactured of ductile iron conforming to ASTM A536; forged
10 carbon steel conforming to ASTM A234; or fabricated from carbon steel pipe conforming to ASTM A53.
- 11 1. Sizes 14 inches through 24 inches with wedge shaped ‘AGS’ grooved ends:
- 12 a. Install AGS fittings with AGS couplings. Installing AGS products with standard grooved
13 fittings and couplings will result in installation difficulties and could lead to joint separation
14 and leakage.
- 15 2.04 VALVES
- 16 A. General:
- 17 1. All valves used in 150 psi circulating systems shall be ANSI Class 150. All valves in 300 psi
18 systems shall be Class 300 valves and shall be constructed of all ASTM B-61 composition. All
19 globe and angle valves shall be screw-over bonnet design. Metal used in the stems of all bronze ball,
20 globe and angle valves shall conform to ASTM B371 Alloy 694, ASTM B99 Alloy 651 or other
21 corrosion resistant equivalents. Secure written approvals by Owner for the use of alternative
22 materials.
- 23 2. The following manufacturers are acceptable: NIBCO, Keystone, Crane, Jamesbury, Dezurik,
24 Daniels, Williams, Velan or Vogt.
- 25 3. All iron body valves shall have the pressure containing parts constructed of ASTM designed of 126
26 Class B iron. Stem material shall meet ASTM B16 Alloy 360 or ASTM 371 Alloy 876 silicon
27 bronze or its approved equivalent model by listed manufacturers.
- 28 4. All cast steel body valves shall have the pressure containing parts constructed of ASTM designation
29 A-216-GR-WCB carbon steel. Stems shall meet ASTM designation A-186-F6 chromium stainless
30 steel. Seat ring shall be hard faced carbon steel or 13^ chromium A-182-F6 stainless. Hand wheels
31 shall be A47 grade 35018 malleable iron or ductile iron ASTM A536.
- 32 5. All forged steel body valve shall have the pressure containing parts constructed of ASTM 105,
33 Grade 2 forged carbon steel. Seat and wedges shall meet ASTM-A-182-F6 chromium stainless steel.
34 Seat rings shall be hard faced. Valves shall conform to ANSI B16-34 pressure-temperature rating.
- 35 6. All globe valves, angle valves and shutoff valves shall have malleable iron hand wheels, except iron
36 body valves 2-1/2 inches and larger which may have either malleable iron or ASTM A-126 Class B,
37 gray iron hand wheels.
- 38 7. Packing for all valves shall be free of asbestos fibers and selected for the pressure-temperature
39 service of the valve. It is incumbent upon the manufacturer to select the best quality, standard
40 packing for the intended valve service.

- 1 8. Provide stem extensions on all insulated valves.
- 2 9. Valve chain operators shall be of cast iron or malleable iron and designed to provide positive grip on
3 wheel. Provide chain guide to prevent chain from slipping or jumping on wheel. Employ rustproof
4 chain complete with closing link of sufficient length to operate at 6 feet-6 inches above floor level.
- 5 10. Provide valve suitable for connection to adjoining pipe as specified for pipe joints above. Use
6 valves that are full size of pipe in which installed.
- 7 B. Globe Valves:
- 8 1. 150 Pound Class Valves:
- 9 a. Threaded pipe 2 inches and smaller; NIBCO T235-Y, 150-pound screwed, inside screw,
10 rising stem, bronze body, union Bonnet.
- 11 b. Welded pipe 2-1/2 inches and larger: NIBCO F-718-B, Cast Iron with Brass trim.
- 12 2. 300 Pound Class Valves:
- 13 a. Threaded pipe 2 inches and smaller: NIBCO T276-AP, Class 300 screwed, inside screw rising
14 stem, bronze body, union bonnet, stainless steel disc.
- 15 b. Welded pipe 2-1/2 inches and larger. NIBCO F-768-B, Class 250 iron body, flanged, bolted
16 bonnet, brass trim.
- 17 C. Soft Seated Butterfly Valves:
- 18 1. 200 Pound Soft Seated:
- 19 a. NIBCO LD-2000 or approved equal.
- 20 b. Ductile iron body with aluminum bronze disc, 400 series stainless steel stem.
- 21 c. Valves 6 inches and smaller shall have lever operators; 8 inches and larger shall have gear
22 operators.
- 23 d. All butterfly valves shall be suitable for bi-directional dead-end service without the need for a
24 downstream flange.
- 25 D. High Performance Butterfly Valves:
- 26 1. A 150 Pound Class Valve:
- 27 a. NIBCO LCS-6822, carbon steel lug body valve, ANSI rated Class150.
- 28 b. Valves to provide shutoff to 285 psi.
- 29 c. Provide 316 or UNS-S31803 stainless shaft, cast stainless steel disc, stainless steel seat and
30 PTFE seat ring.
- 31 2. 300 Pound Class Valves: NIBCO LCS-7822 300 lb. ANSI class raised face, lug body, carbon steel
32 body, stainless steel pin and shaft and disc, stainless steel seat and PRFE seat ring, gear operated.
- 33 E. Check Valves:

- 1 1. 150 Pound Class Valves:
- 2 a. Threaded pipe 2 inches and smaller. NIBCO T453-B, bronze body, Class 200, screwed
3 connection, regrinding disc and seat with screw in cap.
- 4 b. Welded pipe 2-1/2 inches and larger. NIBCO F910-B. Flanged style, spring-loaded type.
5 Rate for 150 psig working pressure; Cast Iron Body, Bronze plates and 316 Stainless Steel
6 springs.
- 7 F. Plug Valves:
- 8 1. 150 Pound Class Valves:
- 9 a. Threaded pipe 2 inches and smaller: Dezurik 128 S 1 RS 26, Keystone 542, 150-pound
10 screwed, eccentric plug valve, carbon steel or semi-steel body, Buna-N faced plug, lever
11 operated, non-lubricated, short pattern plug valve.
- 12 b. Welded pipe 2-1/2 inches and larger: Dezurik 128 F 1 RS 26, Homestead 583. 150-pound
13 flanged eccentric carbon steel or semi-steel, Hycar or Buna-N faced plug manually operated,
14 non-lubricated, short pattern plug.
- 15 2. 300 Pound Class Valves:
- 16 a. Threaded pipe 2 inches and smaller: Tuflin 066, PoweII 3058, 300 psi working pressure,
17 cast carbon steel body and plug, threaded end valve, bolted bonnet, non-lubricated or
18 lubricated with lubricant suitable for water -20°F to 450°F temperature, wrench operated.
- 19 b. Flanged piping 2-1/2 inches, cast carbon steel body and plug conforming to ASTM A216, Gr.
20 WCB. Gear operated, bolted gland. Flanged per ANSI B16.5. Pipe sizes 4 inches through 12
21 inches. Non-lubricated or lubricated with lubricant suitable for water -20°F to 450°F
22 temperature, 100 percent port.
- 23 G. Ball Valves:
- 24 1. Threaded pipe 2 inches and smaller: NIBCO T 585-70-66. For threaded pipe 2-1/2 inches to 3
25 inches: Crane 9301-S or approved equivalent model by listed manufacturers.
- 26 a. Threaded full port two-piece bronze body ASTM-B584 Alloy 844, ASTM B61, or ASTM
27 B62 (No brass containing more than 15 percent Zink will be acceptable).
- 28 b. Stainless steel ball and stem, blowout proof stem with stem extension made of non-thermal
29 conducting material and having an adjustable memory stop after insulation is installed.
- 30 2. Welded pipe 2-1/2 inches and larger: NIBCO F-515-CS-66FS or accepted substitute for 150 pound
31 Class; NIBCO F-535-CS-66FS for 300 pound class, split steel body, full bore, blowout proof stem,
32 flanged.

33 PART 3 – EXECUTION**34 3.01 PREPARATION**

- 35 A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- 36 B. Remove scale and dirt, on inside and outside, before assembly.

- 1 C. Prepare piping connections to equipment with flanges or unions.
- 2 D. After completion, fill, clean, and treat systems.
- 3 3.02 INSTALLATION
- 4 A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards
5 and conform to codes and ordinances of authorities having jurisdiction.
- 6 B. All installation shall be in accordance with manufacturer's published recommendations.
- 7 C. Pipe Installation:
- 8 1. All the various piping systems shall be made up straight and true and run in orderly manner, plumb
9 and parallel to building structure. Install piping to conserve building space. Coordinate location
10 with other trades and so not interfere with use of space for other work.
- 11 2. Piping shall follow as closely as possible the routes shown on Drawings which take into
12 consideration conditions to be met at the site.
- 13 3. Should any unforeseen conditions arise, lines shall be changed or rerouted after proper approval has
14 been obtained.
- 15 4. All piping shall be installed with due regard to expansion and contraction and so as to prevent
16 excessive strain and stress in the piping, in connections, or in equipment to which the lines are
17 connected.
- 18 5. Group piping whenever practical at common elevations.
- 19 6. Slope piping and arrange system to drain at low points. Use eccentric reducers where applicable to
20 maintain the bottom of pipe level.
- 21 7. Bench tap connections are to be from the top to horizontal position of pipe run.
- 22 8. Where pipe support members are welded to structural building framing, scrape, brush clean, and
23 apply one coat of zinc rich primer to welding.
- 24 9. Provide and install Pete's plugs adjacent to thermo wells for electronic temperature sensors, to
25 electronic pressure sensors and install Pete's plugs adjacent where shown or noted on piping
26 drawings or drawing details.
- 27 10. Provide clearance for installation of insulation, and access to valves and fittings.
- 28 11. Prepare pipe, fittings, supports and accessories for finish painting. Chilled water piping insulated
29 with cellular glass does not require finish painting.
- 30 12. All piping shall be clean when it is installed. Before installation it shall be checked, upended,
31 swabbed if necessary, and all rust or dirt from storage or from laying on the ground shall be
32 removed.
- 33 13. Where leaks occur, the pipe shall be repaired and the tests repeated. No leaks shall be corrected by
34 peening. Defective piping and joints shall be removed and replaced.
- 35 14. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads,
36 properly cut. Joints shall be made tight with Teflon™ tape or Teflon™-based compound appropriate

1 to the medium, material and temperature range of the system. Compound shall be applied to the
2 pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully
3 reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of
4 pipe shall be upended and hammered to remove all shavings and foreign material.

5 D. Valve Installation:

- 6 1. Locate all valves such that the removal of their bonnets is possible. All flanged valves shown in
7 horizontal lines with the valve stem in a horizontal position shall be positioned so the valve stem is
8 inclined one bolt hole above the horizontal position.
- 9 2. Screw pattern valves placed in horizontal lines shall be installed with their valve stems at an angle of
10 a minimum of 30 degrees above the horizontal position.
- 11 3. All valves must be true and straight at the time the system is tested and inspected for final
12 acceptance.
- 13 4. Valves shall be installed as nearly as possible to the locations indicated in the Drawings. Any
14 change in valve location must be so indicated on the Record As-Built Drawings.
- 15 5. All valves must be of threaded or flanged type. No solder connected or grooved fitting valves shall
16 be used on this Project.
- 17 6. Equipment, valves, expansion joints, relief devices, strainers, etc., must be removed or isolated
18 during the test if the pressure/force ratings of the devices are not as high as that specified for the test.
19 Piping shall be drained and protected any time ambient temperature is below freezing.
- 20 7. Where leaks occur, the pipe shall be repaired and the tests repeated. No leaks shall be corrected by
21 peening. Defective piping and joints shall be removed and replaced.
- 22 8. All threaded valves installed in copper piping shall be provided with copper or bronze male adapters
23 on each side of valves. Sweat solder adapters to pipe before installing valves.
- 24 9. Provide access where valves and fittings are not exposed. Coordinate size and location of access
25 doors with architectural drawings.
- 26 10. Install valves with stems upright or horizontal, not inverted.
- 27 11. All manually operated shutoff valves located 8 feet (bottom of pipe) or higher above finished floor
28 or stationary platform in mechanical rooms, accessible pipe chases or as noted on Project Drawings
29 shall be chain wheel operated. Chains shall be installed and secured to allow clear passage at walk
30 through areas.

31 3.03 TESTING

- 32 A. All welds are subject to inspection, visual and/or x-ray, for compliance with Specifications. The Contractor
33 shall be responsible for all labor, material and travel expenses involved in the re-inspection and re-testing
34 of any welds found to be unacceptable. In addition, the Contractor shall be responsible for the costs
35 involved in any and all additional testing required or recommended by ASME/ANSI Standards B31.9 due
36 to the discovery of poor, unacceptable or rejected welds.
- 37 B. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any
38 reason, must be removed and replaced with an original quality weld as specified herein. All qualifying
39 tests, welding and stress relieving procedures shall, moreover, be in accordance with Standard Qualification

1 for Welding Procedures, Welders and Welding Operators,, Appendix A, Section 6 of the Code, current
2 edition.

3 C. System Pressure Tests:

Line	Testing Medium	Testing Pressure (psig)	Time (hours)
Chilled Water and Condenser Water	Water	1-1/2 times working pressure, minimum 125	24
Heating Water and Generator Cooling Water	Water	1-1/2 times working pressure, minimum 125	24

4

5 1. Refer to the Drawings for system design pressure

6 3.04 TRAINING

7 A. Victaulic Company shall provide on-site training for Contractor’s field personnel in the use of grooving
8 tools, application of groove, and installation of grooved end couplings. The manufacturer’s representative
9 shall periodically visit the jobsite and provide the Contractor information concerning the best recommended
10 practices in grooved product installation. A distributor’s sales representative is not considered qualified to
11 conduct the training or jobsite visit(s).

12 B. Installers of Viega or Nibco press fittings shall have been trained by a factory representative in the proper
13 techniques for installation and crimping to assure leak-proof system sealing. It is the contactor’s
14 responsibility to show proof of such training to the Design Professional upon request.

15 3.05 APPLICATION

16 A. Install valves and unions at equipment connections. Install unions on equipment side of valves. Provide
17 dielectric isolation only where non-ferrous components connect to ferrous components.

18 B. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

19 C. Install ball valves in piping 3 inches and smaller and butterfly valves in piping 4 inches and larger for shut-
20 off and to isolate equipment, parts of systems, or vertical risers.

21 D. Install ball valves in piping 2 inches and smaller and butterfly valves in piping 2-1/2 inches and larger for
22 throttling, bypass or manual flow control services. Under this application, throttling valves are not to be
23 used for shutoff, and additional valves shall be installed for application.

24 E. Use plug valves for throttling service where indicated on Drawings.

25 F. Provide gate or ball drain valves at main shutoff valves, low points of piping, bases of vertical risers and at
26 equipment. Pipe to nearest drain.

27 3.06 FLUSHING AND CLEANING OF PIPING SYSTEMS

28 A. Building HVAC Piping Systems:

- 1 1. Clean piping thoroughly. Purge pipe of construction debris and contamination before placing the
2 piping systems in service. Provide whatever temporary connections are required for cleaning,
3 purging and circulating fluids through the piping system.
- 4 2. On completely new piping system installations, the Contractor shall use temporary strainers and
5 temporary pumps that can create fluid velocities up to 10 ft/sec if necessary to flush and clean the
6 piping systems. Do not use Owner's permanent strainers to trap debris during pipe flushing
7 operations. Fit the temporary construction strainers with a line size blow-off valve.
- 8 3. When constructing minor piping modifications or additions verify with Owner if the Owner's pumps
9 and strainers can be used for flushing and chemical cleaning operations. When the flushing and
10 cleaning operations are complete, the Contractor shall insure the strainer baskets and screens
11 installed in the piping systems permanent strainers replaced with clean elements. Keep temporary
12 strainers in service until the equipment has been tested, then replace straining element with a new
13 strainer and clean and deliver the old straining elements to Owner. Fit the Owner's strainers with a
14 line size blow-off valve.
- 15 4. Install bypass piping or hoses at the supply and return piping connections at heat exchangers,
16 chillers, cooling towers, pumps and cooling coils, etc. to prevent debris from being caught or causing
17 damage to equipment which will be connected to the piping system.
- 18 5. Circulate a chemical cleaner in chilled and heating water as well as condenser and generator cooling
19 piping systems to remove mill scale, grease, oil and silt. Circulate GE-Betz Entec 323 detergent
20 with GE-Betz Entec 234 anti-foam compound. Circulate to 48 hours, flush system and replace with
21 clean water. Dispose of chemical solution in accordance with local codes. The chilled and heating
22 water system should then be treated with GE-Betz Entec 338, nitride borate, 350 ppm as nitride with
23 MBP inhibitor. When the chemical cleaning is complete, remove, clean and reinstall all permanent
24 screens. Contractor shall notify Owner so that the re-installation of clean strainer screens may be
25 witnessed.

26 3.07 WELDING

- 27 A. Scope: This article applies to welded chilled and heating water piping fittings and other appurtenances.
 - 28 1. Piping and fittings shall be welded and fabricated in accordance with the latest edition of
29 ASME/ANSI the latest editions of Standards B31.9 for all systems. Machine beveling in shop is
30 preferred. Field beveling may be done by flame cutting to recognized standards.
 - 31 2. Ensure complete penetration of deposited material with base metal.
 - 32 a. Contractor shall provide filler metal suitable for use with base metal. Contractor shall keep
33 inside of fittings free from globules of weld metal.
 - 34 b. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc
35 or gas welding process.
 - 36 c. All pipe shall have the ends beveled 37-1/2 degrees and all joints shall be aligned true before
37 welding.
 - 38 d. Except as specified otherwise, all changes in direction, intersection of lines, reduction in pipe
39 size and the like shall be made with factory-fabricated welding fittings. Mitering of pipe to
40 form elbows, notching of straight runs to form tees, or any similar construction is not
41 permitted.

1 **REFRIGERANT PIPING AND ACCESSORIES**

2
3 **PART 1 - GENERAL**

4
5 1.01 RELATED DOCUMENTS

- 6
7 A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and
8 Division 01 Specification Sections, apply to this Section.
9
10 B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this
11 Section is directly applicable to them.

12 1.01 SCOPE

- 13
14 A. Furnish and install all labor, materials, equipment, tools and services and perform all the operations required
15 in connection with, or associated with the construction of complete refrigerant piping system, as indicated on
16 the Drawings.
17

18 **PART 2 - PRODUCTS**

19
20 2.01 REFRIGERANT PIPING

- 21
22 A. Refrigerant piping shall be fabricated of hard drawn "ACR" tubing that has been cleaned and capped for
23 refrigeration service. Fittings shall be wrought copper and shall be installed with silver solder joints. The
24 end of all pipe and the inside of all fittings shall be carefully cleaned before joining. No acid shall be used in
25 cleaning or as a flux in soldering joints. Bleed nitrogen through all piping while soldering.
26
27 B. Provide replaceable core type liquid line filter dryer, sized for system capacity at 2 psi pressure drop per ARI
28 Standard 710, sight glass-moisture indicator, thermal expansion valve with adjustable superheat externally
29 equalized, refrigerant shut-off, relief and solenoid valves.
30
31 C. All refrigerant lines shall be sized by equipment manufacturer for the field conditions, actual lengths and
32 number of fittings, etc.
33

34
35 **PART 3 - EXECUTION**

36
37 3.01 INSTALLATION

- 38
39 A. Install and insulate all refrigerant piping per unit manufacturer's latest published recommendations. Slope
40 all lines to facilitate oil return to compressor. Provide suction line traps per manufacturer's
41 recommendations.
42
43 B. Refrigerant piping shall be installed as shown. If the compressor manufacturer recommends any
44 modifications, such modifications shall be made at no cost to the Owner.
45
46 C. Test and dehydrate all refrigerant piping as follows:
47
48 1. After completion of the piping system and before charging, test the system with dry nitrogen at 250 psi
49 for 24 hours. Test joints under pressure with soap solution. During the test, isolate expansion valves
50 and other auxiliary devices to prevent damage due to high pressure.
51
52 2. After the initial pressure test has been completed and the system proved tight, introduce a mixture of
53 refrigerant and dry carbon dioxide into the system at 150 psi and test all devices and fittings for leaks
54 using a halide torch.

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3. Following the satisfactory completion of all tests, evacuate the system by means of a vacuum pump connected to the liquid line. After 20 inches of vacuum is obtained, close the suction and discharge valves at the compressor and continue evacuation for 24 hours. Vacuum shall be measured with a mercury column vacuum gauge.

D. After dehydration, introduce the manufacturer's recommended type and quantity of refrigerant into the system through the filter/dryer.

END OF SECTION

1 **HVAC DUCTWORK**

2

3 **PART 1 – GENERAL**

4 1.01 RELATED DOCUMENTS

5 A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and
6 Division 01 Specification Sections, apply to this Section.

7 B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and
8 this Section is directly applicable to them.

9 1.02 SUMMARY

10 A. Perform all Work required to provide and install ductwork, flexible duct, hangers, supports, sleeves,
11 flashings, vent flues, and all necessary accessories as indicated in the Contract Documents. Provide any
12 supplementary items necessary for proper installation

13 1.03 REFERENCE STANDARDS

14 A. The latest published edition of a reference shall be applicable to this Project unless identified by a specified
15 edition date.

16 B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this
17 Project.

18 C. All materials, installation and workmanship shall comply with the applicable requirements and standards
19 addressed within the following references:

20 1. ASHRAE – Handbook of Fundamentals; Duct Design.

21 2. ASHRAE – Handbook of HVAC Systems and Equipment; Duct Construction.

22 3. International Energy Conservation Code – 2015 Edition

23 4. ASTM A 90 – Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.

24 5. ASTM E 96 – Standard Test Methods for Water Vapor Transmission of Materials.

25 6. ASTM A 167 – Stainless and Heat Resisting Chromium-Nickel Steel Plate, Sheet and Strip.

26 7. ASTM A525 – General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip
27 Process.

28 8. ASTM A 527 – Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.

29 9. ASTM B209 – Aluminum and Aluminum Alloy Sheet and Plate.

30 10. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.

31 11. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems.

32 12. NFPA 96 – Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from
33 Commercial Cooling Equipment.

- 1 13. NFPA 45 – Laboratory Ventilating Systems and Hood Requirements.
- 2 14. SMACNA – HVAC Duct Construction Standards (Latest Edition).
- 3 15. SMACNA – Rectangular Industrial Duct Construction Standards (Latest Edition).
- 4 16. SMACNA – Round Industrial Duct Construction Standards (Latest Edition).
- 5 17. SMACNA – HVAC Air Duct Leakage Test Manual (Latest Edition).
- 6 18. UL 181 – Factory-Made Air Ducts and Connectors.
- 7 19. Engineering Design Manual for Air Handling Systems United McGill Corporation (UMC).
- 8 20. Assembly and Installation of Spiral Ducts and Fittings, UMC
- 9 21. Engineering Report No. 132 (Spacing of Duct Hangers), UMC
- 10 22. AWS D1.1 American Welding Society Structural Welding Code.

11 1.04 DEFINITIONS

- 12 1. 2 inch W.G. Pressure Class: Ductwork systems up to 2 inch w.g. positive or negative static pressure
13 with velocities less than or equal to 1500 fpm.
- 14 2. 3 inch W.G. Pressure Class: Ductwork systems over 2 inch w.g. and up to 3 inch w.g. positive or
15 negative static pressure with velocities less than or equal to 2500 fpm.
- 16 3. 4 inch W.G. Pressure Class: Ductwork systems over 3 inch w.g. and up to 4 inch w.g. positive or
17 negative static pressure with velocities less than or equal to 2500 fpm.
- 18 4. 6 inch W.G. Pressure Class: Ductwork systems over 4 inch w.g. and up to 6 inch w.g. positive or
19 negative static pressure with velocities less than or equal to 2500 fpm.
- 20 5. 10 inch W.G. Pressure Class: Ductwork systems over 6 inch w.g. and up to 10 inch w.g. positive or
21 negative static pressure with velocities greater than 2500 fpm.

22 1.05 SUBMITTALS

23 A. Product Data:

- 24 1. Provide the following information for each sheet metal system furnished on the Project.
 - 25 a. System name and type.
 - 26 b. Duct system design pressure.
 - 27 c. Duct material.
 - 28 d. Duct gauge.
 - 29 e. Transverse joint methods.
 - 30 f. Longitudinal seam type.

- 1 g. Sealant type.
- 2 h. SMACNA rectangular reinforcement type.
- 3 i. SMACNA intermediate reinforcement type.
- 4 j. SMACNA transverse reinforcement type.
- 5 B. Record Documents:
- 6 1. Submit Shop Drawings on all items of ductwork, plenums, and casings including construction details
7 and accessories specified herein in accordance with Division 01. Ductwork construction details and
8 materials used for duct sealant, flexible connections, etc., shall be submitted and approved prior to
9 the fabrication of any ductwork.
- 10 2. Draw ductwork Shop Drawings on minimum ¼ inch equal to one foot scale building floor plans and
11 shall indicate duct sizes, material, insulation type, locations of transverse joints, fittings, ductwork,
12 bottom elevation, offsets, ductwork specialties, fire and fire/smoke dampers, and other information
13 required for coordination with other trades. Clearly designate fire and fire/smoke partitions on the
14 Shop Drawings. Detail Drawings for Mechanical Rooms and air handling unit locations shall be
15 submitted at a minimum scale of ¼ inch equal to one foot.
- 16 3. Coordinate with other trades and building construction prior to submitting Shop Drawings for
17 review. Indicate location of all supply, return, exhaust and light fixtures from approved reflected
18 ceiling plans on Shop Drawings.

19 1.06 DELIVERY AND STORAGE

- 20 A. Deliver products to the Project Site and store and protect products under provisions of Division 01 and
21 Section 23 05 00.
- 22 B. Protect materials from rust both before and after installation.

23 1.07 WARRANTY

- 24 A. All ductwork shown on the Drawings, specified or required for the air conditioning and ventilating systems
25 shall be constructed and erected in a first class workmanlike manner.
- 26 B. The Work shall be guaranteed for a period of one (1) year from Project Substantial Completion date against
27 noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the
28 system is in operation, should these defects occur, they shall be corrected as directed by the Owner at
29 Contractor's expense.

30

31 **PART 2 – PRODUCTS**

32 2.01 GENERAL

- 33 A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements,
34 and conform to codes and ordinances of authorities having jurisdiction.

35 2.02 APPLICATION

- 1 A. Ductwork systems shall be constructed in accordance with the following materials as a minimum standard.
2 Refer to Drawings for any deviation from this Table:

AIR SYSTEM	MATERIAL	MINIMUM PRESSURE CLASSIFICATION ⁽¹⁾
Supply and Return Systems:		
Single Zone FCU Supply	Galvanized Steel	2.0" w.g.
Single Zone SHU Supply	Galvanized Steel	4.0" w.g.
Terminal Unit Connection	Metal Flexible Duct	As Specified
Terminal Units to Supply Air Device	Galvanized Steel ⁽²⁾	2.0" w.g.
Return Air Device to Return Distribution	Galvanized Steel ⁽²⁾	-2.0" w.g.
Return Air Distribution	Galvanized Steel	-4.0" w.g.
Return Air Distribution/Vertical Riser	Galvanized Steel	-4.0" w.g.
Exhaust Systems:		
Exhaust Air Device to Exhaust Distribution	Galvanized Steel ⁽²⁾	-2.0" w.g.
Exhaust Air Distribution	Galvanized Steel	-4.0" w.g.

- 3
- 4 B. Notes to Table:
- 5 1. Positive pressure unless noted otherwise in Table.
- 6 2. Air device connections may be made with insulated flexible duct as specified herein.
- 7 3. Applies to exhaust system for general laboratory exhaust, fume hoods, and bio-safety cabinets.
8 Refer to Drawings for construction of additional exhaust systems.

9 2.03 DUCTWORK MATERIAL AND CONSTRUCTION

- 10 A. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating
11 systems shall be of materials as hereinafter specified unless indicated otherwise on Drawings. All air
12 distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable
13 standards of SMACNA where such standards do not conflict with NFPA 90A and where class of
14 construction equals or exceeds that noted herein.
- 15 B. Ductwork shall be constructed of G-90 coated galvanized steel of ASTM A653 and A924 Standards.
- 16 C. Minimum gauge of round, oval or rectangular ductwork shall be 26 gauge per SMACNA Standards.
- 17 D. All duct sizes shown on the Drawings are clear inside dimensions. Allowance shall be made for internal
18 lining, where specified, to provide the required free area.
- 19 E. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched
20 (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with
21 sheet metal caps if the openings are to be left unconnected for any length of time.
- 22 F. Except for specific duct applications specified herein, all sheet metal shall be constructed from prime
23 galvanized steel sheets and/or coils up to 60 inches in width. Each sheet shall be stenciled with
24 manufacturer's name and gauge.
- 25 G. Sheet metal must conform to SMACNA sheet metal tolerances as outlined in SMACNA's "HVAC Duct
26 Construction Standards".

- 1 H. Where ducts are exposed to view (including equipment rooms and where ducts pass through walls, floors or
2 ceilings) furnish and install sheet metal collars around the duct.
- 3 I. Spin-in fittings shall be as specified under Section 23 33 00 – Ductwork Accessories.
- 4 J. Duct Sealing: All ductwork, regardless of system pressure classification, shall be sealed in accordance with
5 Seal Class A, as referenced in SMACNA Standards. All transverse joints, longitudinal seams, and duct
6 wall penetrations shall be sealed.
- 7 1. DO NOT THIN. Do not apply when rain or freezing temperatures will occur within 36 hours. All
8 seams and joints in shop and field fabricated ductwork shall be sealed by Duct sealant which shall be
9 applied per manufacturer’s instructions. Minimum drying time shall be allowed per manufacturer’s
10 instructions. Additional time for drying shall be allowed in climates where temperature and
11 humidity may affect the curing of the sealant. Sealant shall be allowed to completely dry and cure
12 before air is circulated through the ductwork.
- 13 2. Sealant shall be water based latex UL 181B-M sealant with flame spread of 0 and smoke developed
14 of 0. Sealants shall be similar to Hard Cast Versa-Grip 181, Ductmate Pro Seal or Design
15 Polymeric DP 1010.
- 16 3. Sealer shall be rated by the manufacturer and shall be suitable for use at the system pressure
17 classification of applicable ductwork.
- 18 4. Except as noted, oil or solvent-based sealants are specifically prohibited.
- 19 5. For exterior applications, “Uni-Weather” (United McGill Corporation) solvent-based sealant shall be
20 used.
- 21 6. Duct testing; All ducts should be tested in accordance with the requirements of IECC 2015,
22 paragraph R403.3.3 or R403.3.4., except that all ducts shall be tested, regardless of their location
23 within or external to the building envelope.

24 2.04 RECTANGULAR AND ROUND DUCTWORK

- 25 A. Metal gauges listed in SMACNA HVAC Duct Construction Standards, Metal and Flexible Duct, are the
26 minimum gauges which shall be used. Select metal gauge heavy enough to withstand the physical abuse of
27 the installation. In no case shall ductwork be less than 26 gauge per SMACNA Standards. Transverse
28 bead all flat surfaces which are more than 12” wide. Transverse beading shall be on 12” centers and shall
29 be a minimum of 1/8” deep at the center of the bead and 3/8 wide at the base of the bead. **Do not cross-**
30 **break negative pressure ductwork.**
- 31 B. All longitudinal seams for pressures up to 2.0” w.g. rectangular duct shall be selected for the specified
32 material and pressure classification. Seams shall be as referenced in SMACNA Standards.
- 33 C. All longitudinal seams for ductwork pressures in excess of 2.0” w.g. shall be “Pittsburgh Lock” only.
- 34 D. All transverse joints and intermediate reinforcement shall be as shown in SMACNA Tables 1-4 through 1-
35 9, and Figure 1-4 with Drive Slip connections (reinforced or un-reinforced as required) on the short sides
36 and hemmed “S” slip connections (reinforced or un-reinforced as required) on the long sides. “S” and
37 drive connectors are acceptable for use on ducts with pressure classification of +/- 1” w.g. (maximum).
- 38 E. All transverse joints and intermediate reinforcement on rectangular duct shall be as shown in SMACNA
39 Standards. Transverse joints shall be selected consistent with the specified pressure classification, material
40 and other provisions for proper assembly of ductwork.

1 F. Spiral round duct and fittings shall be as manufactured by United McGill Sheet Metal Company or
2 approved equivalent. All fittings shall be factory fabricated, machine formed and welded from galvanized
3 sheet metal.

4 G. Joints in spiral duct and fittings shall be assembled, suspended, sealed and taped per manufacturer's
5 published assembly and installation instructions.

6 H. Contractor may use DUCTMATE, Elgen or Ward Industries coupling systems, as an option, on rectangular
7 ductwork. The DUCTMATE, Elgen or Ward Industries systems shall be installed in strict accordance with
8 manufacturer's recommendations.

9 2.05 CONICAL BELLMOUTH FITTING AND TAPS

10 A. Conical bell mouth fittings shall be made from 26-gauge G-90 coated galvanized steel. Two piece
11 construction with a minimum overall length of 6 inches and factory sealed for high-pressure requirements.
12 Average off loss coefficient for sizes 6, 8 and 10 shall be less than 0.055. Branch taps, including taps to
13 terminal units, may also be 45° entry expanded taps. Such taps shall be constructed and installed in
14 accordance with Fig. 2-6 of the SMACNA Manual.

15 B. Provide each fitting with minimum 24 gauge damper plate with locking quadrant operator and sealed end
16 bearings. Damper blade shall be securely attached to shaft to prevent damper from rotating around shaft.
17 Shaft shall be extended to clear insulation and allow normal operation without damaging the insulation.

18 C. Provide a flange and gasket with adhesive peel-back paper for ease of application. The fittings shall be
19 further secured by sheet metal screws spaced evenly at no more than 4 inches on center with a minimum of
20 four (4) screws per fittings.

21 D. Conical bell mouth fittings shall be Series 3000G as manufactured by Flexmaster U.S.A., Inc. or Buckley
22 Air Products, Inc., "AIR-TITE".

23 2.06 CASINGS AND PLENUMS – 2 INCH W.G. PRESSURE CLASS

24 A. All 2 inch w.g. pressure class casings and plenums for mixed air plenums shall be constructed in
25 accordance with SMACNA Standards. Where plenums are connected to louvers, the Plenum bottom shall
26 be watertight, sloped and sealed to drain water to the outside face of the building through the face of the
27 louver.

28 B. All casings shall enclose the filter and automatic dampers as shown on the Drawings. Casings shall be
29 fabricated of galvanized sheet metal erected with three-foot center maximum standing seams reinforced
30 with ¼-inch bars. The casing shall be stiffened on three-foot centers maximum with angle irons tack
31 welded in place.

32 C. All openings to the casing shall be properly sealed to prevent any air leakage. Access doors shall be
33 installed as indicated on the Drawings and shall be air tight, double skin insulated construction with frames
34 welded in place. Doors shall be rubber gasketed with #390 Ventlok gasketing and equipped with fasteners
35 equal to Ventlok #310 latches and #370 hinges that can be operated from both the inside and the outside.

36 D. Casings shall be anchored by the use of angle irons sealed and bolted to the curb and floor of the apparatus
37 casing. Casings shall be tested and provided tight at a pressure of three inches water column.

38 E. Insulate per Section 23 07 13.

39 2.07 CASINGS AND PLENUMS – 6 INCH W.G. PRESSURE CLASS

- 1 A. Shall enclose filters and automatic dampers at air handling unit systems. Casings shall be constructed of
2 cellular, standing seam panels with 3 inch deep reinforced "hat" sections as manufactured by metal deck
3 manufacturers and as described in SMACNA Standards.
- 4 B. All openings to the casing shall be properly sealed to prevent air leakage. Install access doors for easy
5 access to equipment. Access doors shall be air tight, double skin insulated construction with frames welded
6 in place. Doors shall be rubber gasketed with #390 Ventlok gasketing and equipped with fasteners equal to
7 Ventlok #310 latches and #370 hinges that can be operated from both the inside and the outside. Hinges
8 shall be equivalent to Ventlok #370.
- 9 C. Anchor casing by the use of galvanized angle irons sealed and bolted to the curb and floor of the apparatus
10 casing as indicated in SMACNA Standards.
- 11 D. Provide sufficient access openings to allow access for maintenance of all parts of the apparatus. Access
12 door size shall be as large as feasible for the duty required.
- 13 E. Insulate per Section 23 07 13.
- 14 2.08 ELBOWS RECTANGULAR DUCTS
- 15 A. Construct elbows as follows in order of preference:
- 16 1. Rectangular, single thickness vaned elbows.
- 17 2. Long radius, un-vaned elbows.
- 18 3. Short radius, single thickness vaned elbows.
- 19 B. Long radius elbows shall have a centerline radius of not less than one and one-half (1-1/2) times the duct
20 width. Short radius elbows shall have a centerline radius of not less than one times the duct width.
- 21 C. Contractor shall have the option to substitute short radius vaned elbows, but shall request the substitutions
22 at the time of submittal of Product Data.
- 23 D. Provide turning vanes in all rectangular elbows and offsets.
- 24 E. Job fabricated turning vanes, if used, shall be fabricated of the same gauge and type of material as the duct
25 in which they are installed. Vanes must be fabricated for same angle as duct offset. Submit Shop
26 Drawings on factory fabricated and job fabricated turning vanes.
- 27 F. All turning vanes shall be anchored to the cheeks of the elbow in such a way that the cheeks will not
28 "breathe" at the surfaces where the vanes touch the cheeks. In most cases, this will necessitate the
29 installation of an angle iron support on the outside of the cheek parallel to the line of the turning vane.
- 30 G. In 90-degree turns that are over 12 inches wide in the plane of the turn, provide and install double thickness
31 vanes on integral side rails. For ducts less than 12 inches in width, use single thickness vanes. The
32 installation of the turning vanes shall be as described for single thickness vanes. On other types of turns or
33 elbows, single thickness trailing edge vanes shall be used.
- 34 2.09 FLEXIBLE DUCT
- 35 A. Flexible duct shall be used where flexible duct connections are shown on the Drawings to air distribution
36 devices and terminal units and as scheduled under "Ductwork System Applications".
- 37 B. Acoustical Flexible Duct to Diffusers, Grilles, and Terminal Units.

- 1 1. Maximum length 6'-0" (six feet), installed with no more than 90 degrees of bend. Where longer duct
2 runs or more bends are necessary, provide rigid round ductwork.
- 3 2. Acoustical flexible duct shall be manufactured with an acoustically rated polyethylene fabric or CPE
4 inner film as the core fabric, mechanically locked by corrosion-resistant galvanized steel helix.
- 5 3. Core shall be factory pre-insulated with a total thermal performance of R3.5 or greater. Outer jacket
6 shall be a fire-retardant polyethylene vapor barrier jacket with a perm rating not greater than 0.10 per
7 ASTM E96, Procedure A.
- 8 4. Duct shall be rated for a minimum positive working pressure of 6 inches w.g. and a negative
9 working pressure of 4 inches w.g. minimum.
- 10 5. Temperature range shall be -20°F to 250°F.
- 11 6. Duct must comply with the latest NFPA Bulletin 90A and be listed and labeled by Underwriters
12 Laboratories, Inc. as Class I Air Duct, Standard 181, and meet GSA, FHA and other U.S.
13 Government standards; flame spread less than 25; smoke developed less than 50.
- 14 7. Acoustical flexible duct shall be similar to Peppertree "Commercial EH" Type "HM", Flexmaster
15 Type 1M, Atco Rubber Products "039", or Thermaflex M-KE for construction and acoustical
16 performance standards.
- 17 C. Metal Flexible Duct:
- 18 1. Shall be used for terminal unit connections to sheet metal ductwork and air distribution devices in
19 non-accessible ceiling areas, or where shown on the Drawings.
- 20 2. Maximum length 5'-0" (five feet). Where longer duct runs or direction changes are necessary,
21 provide rigid round ductwork.
- 22 3. Duct shall be constructed of 0.005 inch thick 3003-H14 aluminum alloy in accordance with ASTM
23 B209. Duct shall be spiral wound into a tube and spiral corrugated to provide strength and
24 flexibility.
- 25 4. Core shall be either factory pre-insulated or field insulated per the requirements of Section 23 07 13,
26 with a total thermal performance of R-6 or greater. The duct shall be rated for a minimum positive
27 and negative working pressure of 10 inch w.g.(through 16" diameter).
- 28 5. Temperature range shall be -40°F. to 250°F.
- 29 6. Duct must comply with the latest NFPA Bulletin 90A and be listed and labeled by Underwriters
30 Laboratories, Inc. as Class I Air Duct, Standard 181, and meet GSA, FHA and other U.S.
31 Government standards; flame spread less than 25; smoke developed less than 50.
- 32 7. For health care occupancies, provide Medical Grade metal flexible duct similar to Flexmaster Type
33 MGA-TL-M.

34 PART 3 – EXECUTION

35 3.01 INSTALLATION

- 36 A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards
37 and conform to codes and ordinances of authorities having jurisdiction.

- 1 B. All installation shall be in accordance with manufacturer's published recommendations.
- 2 C. All exhaust ductwork from Airborne Infectious Isolation Rooms shall be marked **“Caution; AIIR**
3 **Exhaust” every 20 feet or change of direction.** Marking shall be by painted stencil or commercially
4 available plastic labels affixed to the duct or insulation surface.
- 5 D. Cleanliness:
- 6 1. Before installing ductwork, wipe ductwork to a visibly clean condition.
- 7 2. During construction, provide temporary closures of metal or taped polyethylene on open ductwork
8 and duct taps to prevent construction dust or contaminants from entering ductwork system. Seal ends
9 of ductwork prior to installation to keep ductwork interior clean. Remove closures only for
10 installation of the next duct section.
- 11 3. For ductwork supplying Clean Rooms, Operating Rooms and/or other Patient Care areas, sanitize
12 ductwork with a biocidal agent EPA approved for HVAC systems immediately prior to installing
13 and sealing ductwork.
- 14 4. During duration of construction, maintain the integrity of all temporary closures until air systems are
15 activated.
- 16 E. Provide openings in ductwork where required to accommodate sensors, controllers, and other devices.
17 Furnish and install access doors at all fire dampers, smoke dampers, and combination fire/smoke dampers.
- 18 F. Provide pitot tube openings where required for testing of systems, complete with metal can with spring
19 device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install
20 insulation material inside a metal ring. Sleeve of pitot tube opening shall be no more than one inch long.
21 Opening shall be one inch wide to accept pitot tube.
- 22 G. Install all ducts tight to structure unless otherwise noted. The Mechanical Contractor shall coordinate with
23 all other trades and the General Contractor prior to the construction or installation of the duct system.
24 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- 25 H. Install duct type smoke detectors furnished under Section 28 30 00. Furnish and install access doors at
26 each sampling tube assembly. Coordinate location of detectors and installation requirements with the
27 Electrical Subcontractor.
- 28 I. Slope underground ducts to plenums or low pump out points at 1:500. Provide access doors for inspection.
- 29 J. Coat buried, metal ductwork without factory jacket with one coat and seams and joints with additional coat
30 of asphalt base protective coating.
- 31 K. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in
32 closed position.
- 33 L. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for cleanout.
34 Use stainless steel for ductwork exposed to view and stainless steel for ducts where concealed.
- 35 M. All visible welds in ductwork between bio-safety cabinets, canopy hoods and fume hoods and the ceiling
36 shall be ground and polished.
- 37 N. Slope duct toward grilles for moisture-laden ducts. Provide drain and trap at elbow of main moisture
38 exhaust duct system.

1 O. Flexible Duct:

- 2 1. The terminal ends of the duct core shall be secured by compression coupling, nylon tie strap or
3 stainless steel worm gear type clamp.
- 4 2. Fittings on terminal units and on sheet metal duct shall have flexible duct core slipped over duct and
5 coupling or clamp tightened, then connection sealed with sealant insulation of flexible duct shall be
6 slipped over connection to point where insulation abuts terminal unit or insulation on duct.
- 7 3. These insulation connections shall be sealed by applying UL 181 A-P/B-FX approved aluminum foil
8 tape with pressure sensitive adhesive to bridge the two surfaces and result in a complete vapor
9 barrier.

10 P. Support flexible ducts as per SMACNA standards to prevent sags, kinks and having 90 degree turns.
11 Maximum distance between supports shall be 5'-0". Minimum width of support shall be 1' and support
12 shall not reduce the inner diameter of the duct when at rest.

13 Q. Hangers and Supports:

- 14 1. All ductwork supports shall be in accordance with Table 4-1 (rectangular duct) and Table 4-2 (round
15 duct) of the SMACNA Standards, with all supports directly anchored to the building structure.
- 16 2. Rectangular duct shall have at least one pair of supports on minimum 8'-0" (eight feet) centers. All
17 horizontal round and flat oval ducts shall have duct hangers spaced 10'-0" (ten feet) maximum.
- 18 3. Lower attachment of hanger to duct shall be in accordance with Table 4-4 of the SMACNA
19 Standards.
- 20 4. Vertical ducts shall be supported where they pass through the floor lines with 1-1/2 inch x 1-1/2 inch
21 x 1/4 inch angles for duct widths up to 60 inches. Above 60 inches in width, the angles must be
22 increased in strength and sized on an individual basis considering space requirements.
- 23 5. Hanger straps on duct widths 60 inches and under shall lap under the duct a minimum of 1 inch and
24 have minimum of one fastening screw on the bottom and two on the sides.
- 25 6. Hanger straps on duct widths over 60 inches shall be bolted to duct reinforcing with 3/8 inch bolts
26 minimum.

27 3.02 DUCTWORK SYSTEM CLEANING

- 28 A. Upon request of the Design Professional at any time prior to project completion, a random inspection of the
29 internal cleanliness of the duct system may be performed.
- 30 B. If the results of the random inspection indicate a "dirty" condition inside the duct system or if the system
31 has been operated without all scheduled filters in place, or if the integrity of temporary closures has been
32 compromised, Contractor shall have ductwork cleaned according to the applicable National Air Duct
33 Cleaners Association (NADCA) Standards, by an independent, third-party Certified Regular Member of the
34 NADCA, and obtain a written report certifying the results of the aforementioned cleaning.
- 35 1. For ductwork supplying Clean Rooms or patient care areas, also sanitize the ductwork interior per
36 NADCA standards with a biocidal agent specifically approved by the EPA for use in HVAC
37 systems.

1 C. Before turning the installation over to the Owner, Contractor shall certify that the air handling systems have
2 only been operated with scheduled filters in place. Otherwise, Contractor shall present evidence that the
3 ductwork was cleaned as required above.

4 3.03 TESTING

5 1. All medium and high pressure duct systems (positive or negative) shall be pressure tested according
6 to SMACNA test procedures (HVAC Air Duct Leakage Test Manual).

7 2. Design pressure for testing ductwork shall be determined from the maximum pressure generated by
8 the fan at the nominal motor horsepower selected.

9 3. Total allowable leakage shall not exceed 1 percent of the total system design airflow rate.

10 4. When partial sections of the duct system are tested, the summation of the leakage for all sections
11 shall not exceed the total allowable leakage.

12 5. Leaks identified during leakage testing shall be repaired by:

13 a. Complete removal of the sealing materials.

14 b. Thorough cleaning of the joint surfaces.

15 c. Installation of multiple layers of sealing materials.

16 6. The entire ductwork system shall be tested, excluding connections upstream of the terminal units
17 (i.e. ductwork shall be capped immediately prior to the terminal units, and tested as described
18 above).

19 7. After testing has proven that ductwork is installed and performs as specified, the terminal units shall
20 be connected to ductwork and connections sealed with extra care. Contractor shall inform the
21 Owner when joints may be visually inspected for voids, splits, or improper sealing of the joints. If
22 any leakage exists in the terminal unit connections/joints after the systems have been put into
23 service, leaks shall be repaired as specified for other leaks.

24 A. All low-pressure duct systems (positive or negative) shall be inspected for visible and audible signs of
25 leakage.

26 1. Leaks identified by inspection shall be repaired by:

27 a. Complete removal of the sealing materials.

28 b. Thorough cleaning of the joint surfaces.

29 c. Installation of multiple layers of sealing materials.

30 2. Discrepancies found during testing and balancing between duct traverses and diffuser/grille readings
31 shall result in re-inspection, repair and retest until discrepancies are eliminated.

32 B. Ductwork leakage testing and/or inspection shall be performed prior to installation of external ductwork
33 insulation.

34 **END OF SECTION**

1 **DUCTWORK ACCESSORIES**

2

3 **PART 1 – GENERAL**

4 1.01 RELATED DOCUMENTS

5 A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and
6 Division 01 Specification Sections, apply to this Section.

7 B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and
8 this Section is directly applicable to them.

9 1.02 SUMMARY

10 A. Perform all Work required to provide and install the following ductwork, accessories indicated in the
11 Contract Documents with supplementary items necessary for proper installation.

12 1. Airflow control dampers and spin-in fittings.

13 2. Fire dampers, smoke dampers, and combination fire and smoke dampers.

14 3. Flexible duct connections.

15 4. Duct access doors.

16 5. Screens.

17 6. Duct test holes.

18 7. Guy wire systems.

19 1.03 REFERENCE STANDARDS

20 A. The latest published edition of a reference shall be applicable to this Project unless identified by a specified
21 edition date.

22 B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this
23 Project.

24 C. All materials, installation and workmanship shall comply with the applicable requirements and standards
25 addressed within the following references:

26 1. AMCA 500D – Laboratory Method of Testing Dampers for Rating.

27 2. AMCA 500L – Laboratory Method of Testing Louvers for Rating.

28 3. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.

29 4. NFPA 101 – Life Safety Code.

30 5. SMACNA – HVAC Duct Construction Standards.

31 6. UL 33 – Heat Responsive links for Fire-Protection Service.

- 1 7. UL 555 – Standard for Fire Dampers.
- 2 8. UL 555C – Standard for Ceiling Dampers.
- 3 9. US 555S – Standard for Smoke Dampers.
- 4 1.04 SUBMITTALS
- 5 A. Product Data:
- 6 1. Provide product data for shop fabricated assemblies including, but not limited to volume control
- 7 dampers, duct access doors, and duct test holes. Provide product data for hardware used.
- 8 B. Record Documents:
- 9 1. Fire Dampers: The damper manufacturer’s literature submitted for approval prior to the installation
- 10 shall include performance data developed from testing in accordance with AMCA 500D standards
- 11 and shall show the pressure drops for all sizes of dampers required at anticipated air flow rates.
- 12 Maximum pressure drop through open fire dampers shall not exceed 0.05-inch water gauge.
- 13 2. Combination Fire/Smoke Dampers: Assign identification numbers for each damper with
- 14 corresponding number noted on Drawings. Provide air quantity, size, free area of damper, pressure
- 15 drop and proposed velocity through each damper. Provide manufacturer’s data of damper and its
- 16 accessories or options.

17 **PART 2 – PRODUCTS**

18 2.01 GENERAL

- 19 A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements,
- 20 and conform to codes and ordinances of authorities having jurisdiction.

21 2.02 MANUFACTURERS

22 A. Dampers:

- 23 1. Greenheck.
- 24 2. Louvers and Dampers, Inc.
- 25 3. Nailor Industries.
- 26 4. Pottorrf
- 27 5. Prefco.
- 28 6. Ruskin.
- 29 7. TAMCO
- 30 8. United Enertech

31 B. Regulators, Locking Quadrants:

- 32 1. Rossi HVAC Hardware

1 2. Young Regulator.

2 2.03 AIRFLOW CONTROL DAMPERS

3 A. Furnish and install dampers where shown on the Drawings and wherever necessary for complete control of
4 airflow, including all supply, return, outside air, and exhaust branches, "division" in main supply, return
5 and exhaust ducts, and each individual air supply outlet. Where access to dampers through permanent
6 suspended ceiling (gypsum board) is necessary, the Contractor shall be responsible for the proper location
7 of the access doors.

8 B. Dampers larger than three (3) square feet in area shall be controlled by a self-locking splitter damper
9 assembly.

10 C. Volume damper blades shall not exceed 48 inches (48") in length or twelve inches (12") in width and shall
11 be of the opposed interlocking type. The blades shall be of not less than No. 16 gauge galvanized steel
12 supported on one-half inch (1/2") diameter rust-proofed axles. Axle bearings shall be the self-lubricating
13 ferrule type.

14 D. Volume dampers and other manual dampers shall be carefully fitted, and shall be manually controlled by
15 damper regulators as follows:

16 1. On exposed or accessible un-insulated ductwork, provide the "Everlock" damper handle by Rossi
17 HVAC Hardware (no substitutions), with a 2" standoff bracket for external insulation. Provide the
18 optional damper position indicator with the damper operator.

19 2. On exposed or accessible externally insulated ductwork the regulator rod shall be 3/8" square
20 aluminum, designed to fit, full length, through a formed square channel in the damper blade,
21 designed for use on duct with insulation thickness specified for duct, and shall have four (4) 3/16
22 inch holes provided to rivet or screw regulator to the duct surface. The flange that covers the raw
23 edge of the insulation shall be high enough so that it slightly compresses the insulation and holds
24 insulation in place. The handle shall be 3/8 inch above the flange, and shall easily turn without
25 roughing up the insulation.

26 3. On concealed ductwork above inaccessible ceilings, the regulator shall be Young 270-301 flush
27 mounted, remote regulator with flexible cable (length as required) with chrome plated exposed cover
28 plates located as directed by the Design Professional.

29 E. Spin-in fittings may be used for duct taps to air devices and shall include dampers on all duct to air devices
30 (diffusers and grilles) even though a volume damper is specified for the air device. Spin-in fittings shall be
31 similar to Flexmaster FLD with "Everlock" damper handle and blade as specified above. Spin-in fittings
32 shall be sealed at the duct tap with sealant as specified herein. Determine location of spin-in fittings after
33 terminal units are hung or after location of light fixtures are confirmed to minimize flexible duct lengths
34 and sharp bends.

35 2.04 FIRE DAMPERS

36 A. Each fire damper shall be constructed and tested in accordance with Underwriters Laboratories Safety
37 Standard 555, latest edition. Dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the
38 construction shown in the Architectural Drawings) protection rating, 160° F or 165° F fusible link, and
39 shall bear a U.L. Label in accordance with Underwriter's Laboratories labeling procedures. Construct fire
40 dampers such that damper frame material and curtain material are galvanized.

41 B. Fire dampers shall be curtain blade type and damper shall be constructed so that the blades are out of the air
42 stream to provide 100 percent free area of duct in which the damper is housed.

- 1 C. Equip fire dampers for vertical or horizontal installation as required by location shown on Drawings.
2 Install fire dampers in wall and floor openings utilizing steel sleeves, angles and other material and
3 practices as required to provide an installation equivalent to that utilized by the manufacturer when the
4 respective dampers were tested by Underwriter's Laboratories. Mounting angles shall be minimum 1-1/2
5 inch by 1-1/2 inch by 14 gauge and bolted, tack welded or screwed to the sleeve at maximum spacing of 12
6 inches and with a minimum of two connections at all sides. Mounting angles shall overlap at least equal to
7 the duct gauge as defined by the appropriate SMACNA Duct Construction Standard, latest edition, and as
8 described in NFPA 90A. The entire assembly, following installation, shall be capable of withstanding 6
9 inch water gauge static pressure.
- 10 D. All fire dampers shall be dynamic rated type.
- 11 E. Completely seal the damper assembly to the building components using manufacturer recommended
12 material(s).
- 13 2.05 COMBINATION FIRE/SMOKE DAMPERS
- 14 A. Provide one damper motor for each 12 square feet of damper area.
- 15 B. Each combination fire/smoke damper shall be 1-1/2 hour fire rated under UL Standard 555, Current
16 Edition, and shall be further classified by Underwriter's Laboratories as a Leakage Rated Damper for use in
17 smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. Damper
18 manufacturer shall have tested and qualified with UL, a complete range of damper sizes covering all
19 dampers required by this Specification. Testing and UL qualifying a single damper size is not acceptable.
20 The leakage rating under UL555S shall be no higher than Leakage Class 1 (4 CFM per square foot at one-
21 inch water gauge pressure and 8 CFM per square foot at 4 inches water gauge pressure). Maximum air
22 pressure drop through each combination fire/smoke damper shall not exceed 0.10 inch water gauge at the
23 design air quantity. (Note that this may require a larger damper than the connected duct size). All ratings
24 shall be dynamic.
- 25 C. Damper frame shall be minimum 20-gauge galvanized steel formed into a structural hat channel shape with
26 tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be
27 integral high surface area non-electrolytic materials construction to incorporate a friction free frame blade
28 lap seal, or molybdenum disulfide impregnated stainless steel or bronze iolite sleeve type turning in an
29 extruded hole in the frame or an extruded frame raceway. Dampers may be either parallel or opposed blade
30 type. Blades shall be constructed with a minimum of 14-gauge equivalent thickness. Blade edge seal
31 material shall be able to withstand 450° F. Jamb seals shall be flexible stainless steel compression type or
32 lap seal type.
- 33 D. In addition to the leakage ratings specified herein, combination fire/smoke dampers and their operators
34 shall be qualified under UL555S to an elevated temperature of 350° F. Electric operators shall be installed
35 by the damper manufacturer at the time of damper fabrication. Damper and operator shall be supplied as a
36 single entity that meets all applicable UL555 and UL555S qualifications for both dampers and operators.
37 Manufacturer shall provide a factory-assembled sleeve. Sleeve shall be minimum 20-gauge for dampers
38 where neither width nor height exceeds 48 inches or 16-gauge where either dimension equals or exceeds 48
39 inches.
- 40 E. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close)
41 under HVAC system operation conditions with pressures at least 4 inches water gauge in the closed
42 position, and 2500 FPM air velocity in the open position.
- 43 F. Primary power for dampers shall be taken from the Equipment Branch of the Essential Electrical System.
44 Provide the required control power transformer to reduce the primary voltage to 24 VAC. Coordinate the
45 location of all powered dampers with the Division 26 contractor prior to installation to assure all devices
46 are provided with the required power.

- 1 G. Each combination fire/smoke damper, except as noted hereinafter, shall be equipped with a UL Classified
2 firestat/releasing device. The firestat/releasing device shall electrically (24 VAC) lock the damper in a
3 closed position when the duct temperatures exceed 165°F and still allow the appropriate authority to
4 operate the damper as may be required for smoke control functions. Damper must be operable while the
5 temperature is above 350°F. Actuator/operator package shall include two damper position indicator
6 switches linked directly to damper blade to provide capability of remotely indicating damper position. One
7 switch shall close when the damper is fully open, and the other switch shall close when the damper is fully
8 closed. The firestat/releasing device and position indicator switches shall be capable of interfacing
9 electrically with the smoke detectors, building fire alarm system, and remote indicating/control stations or
10 building automation system (BAS).
- 11 H. Damper releasing device shall be mounted within the airstream. Device shall be activated and the damper
12 shall close and lock when subjected to duct temperatures in excess of approximately 285°F.
- 13 I. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open
14 supplies and normally closed returns, or as indicated on the Drawings, and shall be furnished and installed
15 by the damper manufacturer as required by the U.L. rating mentioned above. Motors shall be electric to
16 match the type of temperature control system specified elsewhere in this Specification. Furnish all relays,
17 wiring, and other labor and material necessary to completely interconnect the smoke detector system.
- 18 J. Furnish each damper in a square or rectangular configuration. Furnish and install sleeves manufactured by
19 the approved damper manufacturer for each damper. Construct sleeves with square or rectangular to
20 square, rectangular round or oval adapters as required. Dampers shall be installed in the sleeves in
21 accordance with manufacturer's U.L. installation instructions. The entire assembly, following installation,
22 shall operate smoothly and be capable of withstanding 6 inch gauge static pressure.
- 23 K. All combination fire/smoke dampers shall be dynamic type.
- 24 L. Completely seal the damper assembly to the building components using manufacturer recommended
25 material(s).
- 26 2.06 SMOKE DAMPERS
- 27 A. Provide one damper motor for each 12 square feet of damper area.
- 28 B. Each smoke damper shall be dynamic rated type and shall be further classified by Underwriter's
29 Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of
30 UL555S, and bear a UL label attesting to same. Damper manufacturer shall have tested, and qualified with
31 UL, a complete range of damper sizes covering all dampers required in this Specification. Testing and UL
32 qualifying a single damper size is not acceptable. Leakage rating under UL555S shall be no higher than
33 Leakage Class I (4 CFM per square foot at one-inch water gauge pressure and 8 CFM per square foot at 4
34 inches water gauge pressure). Maximum air pressure drop through each smoke damper shall not exceed
35 0.10-inch water gauge at the design air quantity. (Note that this may require a larger damper than the
36 connected duct size). All ratings shall be dynamic.
- 37 C. Damper frame shall be minimum 0.125-inch aluminum formed into a structural hat channel shape with
38 corner braces for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be
39 stainless steel sleeve type turning in an extruded hole in the frame or an extruded frame raceway. Dampers
40 shall be opposed blade type. Blades shall be airfoil shaped double skin construction. Blade edge seal
41 material shall be silicone rubber designed to withstand 450°F. Jamb seals shall be aluminum flexible metal
42 compression type.
- 43 D. In addition to the leakage ratings specified herein, smoke dampers and their operators shall be qualified
44 under UL555S to an elevated temperature of 350°F. Pneumatic operators shall be installed by the damper
45 manufacturer at the time of damper fabrication. Damper and operator shall be supplied as a single entity

1 that meets all applicable UL555 and UL555S qualifications for both dampers and operators. Manufacturer
2 shall provide factory-assembled sleeve. Sleeve shall be minimum 21-gauge for dampers where neither
3 width nor heights exceeds 48 inches or 16-gauge where either dimensions equals or exceeds 48 inches.

4 E. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close)
5 under HVAC system operation conditions, with pressures of at least 4 inches water gauge in the closed
6 position, and 2000 FPM air velocity in the open position.

7 F. The damper must be operable while the temperature is above 350°F. The actuator/operator package shall
8 include two damper position indicator switches linked directly to damper blade to provide capability of
9 remotely indicating damper position. One switch shall close when the damper is fully open, and the other
10 switch shall close when the damper is fully closed. Position indicator switches shall be capable of
11 interfacing directly with the remote smoke detectors, building fire alarm systems, and remote
12 indicating/control stations (BAS).

13 G. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open
14 supplies and normally closed returns, or as indicated on the Drawings, and shall be furnished and installed
15 by the damper manufacturer as required by the UL rating mentioned above. Motors shall be electric to
16 match the type of temperature control system specified elsewhere in this Specification. Furnish all required
17 relays, wiring and other labor and material necessary to completely interconnect the smoke detector system.

18 H. Furnish each damper in a square or rectangular configuration. Furnish and install sleeves manufactured by
19 the approved damper manufacturer for each damper. Construct sleeves with square or rectangular to
20 square, rectangular, round, or oval adapters as required. Install dampers in the sleeves in accordance with
21 manufacturer's UL installation instructions. Entire assembly, following installation, shall operate smoothly
22 and be capable of withstanding 6 inch water gauge static pressure.

23 I. All smoke dampers shall be dynamic type.

24 J. Completely seal the damper assembly to the building components.

25 2.07 FLEXIBLE CONNECTIONS

26 A. Where ducts connect to fans, including roof mounted exhaust fans, or at MRI cryogenic vent connections,
27 flexible connections shall be made using "Flexmaster TL-M" or "Ventglas" fabric that is temperature-
28 resistant, fire-resistant, waterproof, mildew-resistant and practically airtight, weighing approximately thirty
29 ounces (30 oz.) per square yard.

30 B. Material used outdoors shall be resistant to ultra-violet radiation. There shall be a minimum of one-half
31 inch (1/2-inch) slack in the connections, and a minimum of two and one-half inches (2-1/2 inch) distance
32 between the edges of the ducts. This does not apply to air handling units with internal isolation.

33 2.08 ACCESS DOORS

34 A. Furnish and install the ductwork, hinged rectangular, pressure relief, or round "spin-in" access doors to
35 provide access to all fire dampers, mixed air plenums, steam reheat coils (install upstream), automatic
36 dampers, etc.

37 B. Where ductwork is insulated, access doors shall be double skin doors with one inch (1") of insulation on
38 the door.

39 C. Where duct size permits, doors shall be eighteen inches (18") by sixteen inches (16"), or eighteen inches in
40 diameter, and shall be provided with Ventlok No. 260 latches (latches are not required in round doors).

41 D. Latches for rectangular doors smaller than 18 inch x 16 inch shall be Ventlok No. 100 or 140.

- 1 E. Doors for zone heating coils shall be Ventlok, stamped, insulated access doors, minimum 10 inch x 12 inch,
2 complete with latch and two (2) hinges, or twelve inches (12”) in diameter.
- 3 F. Round access doors shall be “Inspector Series” spin-in type door as manufactured by Flexmaster USA.
- 4 G. Doors for personnel access to ductwork shall be nominal twenty-four inches (24”) in diameter. Doors may
5 be fabricated in a local approved sheet metal shop in accordance with SMACNA Standards.
- 6 H. Where access doors are installed above a suspended ceiling, this Contractor shall be responsible for the
7 proper location of ceiling access doors.

8 2.09 GUY WIRE SYSTEM

- 9 A. Provide 1/4-inch diameter American Aircraft Steel Cable (plastic coated) with clip for vertical stack off
10 utility fans on roof, with eyebolts for attachment to anchor systems on the roof (refer to details on the
11 plans).

12 2.10 SCREENS

- 13 A. Furnish and install screens on all duct, fan, etc., openings furnished by this Contractor which lead to, or are
14 located outdoors.
- 15 B. Screens shall be No. 16 gauge, one-half inch (1/2”) mesh in removable galvanized steel frame.
- 16 C. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan
17 inlets and fan outlets to which no ductwork is connected.

18 **PART 3 – EXECUTION**

19 3.01 INSTALLATION

- 20 A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards
21 and conform to codes and ordinances of authorities having jurisdiction.
- 22 B. All installation shall be in accordance with manufacturer’s published recommendations.
- 23 C. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches
24 are taken from larger ducts as required for air balancing.
- 25 D. Provide all dampers furnished by the BAS Provider in strict accordance with manufacturer’s written
26 installation instructions and requirements of these Specifications.
- 27 E. Provide fire dampers, and combination fire and smoke dampers at locations indicated, where ducts and
28 outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves,
29 breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- 30 F. Provide backdraft dampers on exhaust fans or exhaust ducts where indicated. Install dampers so that they
31 will open freely.
- 32 G. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and
33 motorized equipment. Cover connections to medium and high pressure fans with leaded vinyl sheet, held
34 in place with metal straps.

- 1 H. Provide duct access doors for inspection and cleaning before and after duct mounted filters, coils, fans,
2 automatic dampers, at fire dampers, and elsewhere as indicated on Drawings. Provide minimum 8 x 8 inch
3 (200 x 200 mm) size for hand access, 18 x 18 inch (450 450 mm) size for shoulder access, and as indicated.
- 4 I. Provide duct test holes where indicated and where required for testing and balancing purposes.
- 5 1. Furnish and install Ventlok No. 699 instrument test holes in the return air duct and in the discharge
6 duct of each fan unit.
- 7 2. Install test holes in locations as required to measure pressure drops across each item in the system,
8 e.g. outside air louvers, filters, fans, coils, intermediate points in duct runs, etc.
- 9 J. Access doors as specified elsewhere shall be provided for access to all parts of the fire and combination fire
10 and smoke dampers. Doors shall open not less than 90 degrees following installation and shall be insulated
11 type where installed in insulated ducts.
- 12 K. Install each fire and combination fire and smoke damper square and true to the building. The installation
13 shall not place pressure on the damper frame, but shall enclose the damper as required by UL555 and
14 UL555S.
- 15 3.02 GUY WIRE INSTALLATION
- 16 A. Coordinate installation of guy wire anchor supports with roofing contractor.
- 17 B. On existing buildings, coordinate with the general contractor and Owner's representative, to assure that any
18 penetrations of the existing roof are made in a way that will not void the existing roof warranty.
- 19 3.03 TESTING
- 20 A. After each fire damper, smoke damper and combination fire and smoke damper has been installed and
21 sealed in their prescribed openings and prior to installation of ceilings, Contractor shall, as directed by
22 Owner, activate part or all dampers as required to verify "first-time" closure.
- 23 B. Activation of damper shall be accomplished by manually operating the resettable link, disconnecting the
24 linkage at the fire damper fusible link, and manually operating the fire/smoke damper through the
25 pneumatic or electronic controls as appropriate.
- 26 C. Failure of damper to close properly and smoothly on the first attempt will be cause to replace the entire
27 damper assembly.
- 28 D. Coordinate smoke damper system interlock requirements with the fire alarm system.

29

30

END OF SECTION

1 **AIR OUTLETS AND INLETS**

2 **PART 1 – GENERAL**

3 1.01 RELATED DOCUMENTS

4 A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and
5 Division 01 Specification Sections, apply to this Section.

6 B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and
7 this Section is directly applicable to them.

8 1.02 SUMMARY

9 A. Perform all Work required to provide and install diffusers, diffuser boots, registers/grilles, louvers, louver
10 penthouses, roof hoods, and goosenecks indicated by the Contract Documents with supplementary items
11 necessary for proper installation.

12 1.03 REFERENCE STANDARDS

13 A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific
14 edition date.

15 B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this
16 Project.

17 C. All materials, installation and workmanship shall comply with the applicable requirements and standards
18 addressed within the following references:

19 1. AMCA 500 – Test Method for Louvers, Dampers and Shutters.

20 2. ANSI/NFPA 90A – Installation of Air Conditioning and Ventilating Systems.

21 3. ARI 890 – Rating of Air Diffusers and Air Diffuser Assemblies.

22 4. ASHRAE 70 – Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.

23 5. SMACNA 1035 – HVAC Duct Construction Standards – Metal and Flexible.

24 1.04 QUALITY ASSURANCE

25 A. Test and rate performance of air outlets and inlets in accordance with ASHRAE 70.

26 B. Test and rate performance of louvers in accordance with AMCA 500.

27 1.05 SUBMITTALS

28 A. Product Data:

29 1. Submit product data and Shop Drawings, indicating type, size, location, application, noise level,
30 finish, and type of mounting.

31 2. Review requirements of outlets and inlets as to size, finish and type of mounting prior to submitting
32 product data.

33

1 B. Operation and Maintenance Data:

2 1. Submit manufacturer's installation instructions under provisions of Division 01.

3 **PART 2 – PRODUCTS**

4 2.01 GENERAL

5 A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements,
6 and conform to codes and ordinances of authorities having jurisdiction.

7 B. Grilles, registers and diffusers shall be as scheduled on the Drawings. Grilles, registers and diffusers shall
8 be provided with sponge rubber or soft felt gaskets where noted on the Drawings. Grilles, slot diffusers
9 and laminar flow bars shall not be internally insulated. If a manufacturer other than the one scheduled is
10 used, the sizes shown on the Drawings shall be checked for performance, noise level, face velocity, throw
11 pressure drop, etc., before the submittal is made. Selections shall meet the manufacturer's own published
12 data for the above performance criteria. The throw shall be such that the velocity at the end of the throw in
13 the five (5) foot occupancy zone will not exceed 50 fpm nor be less than 25 fpm except where indicated
14 otherwise. Noise levels shall not exceed those published in ASHRAE for the type of space being served
15 (NC level). In the vicinity of lab hoods, terminal velocity at the face of hood shall not exceed 20 fpm.

16 C. Locations of air distribution devices on Drawings are approximate and shall be coordinated with other
17 trades to make symmetrical patterns and shall be influenced by the established general pattern of the
18 lighting fixtures or architectural reflected ceiling plan, but primarily located to maintain proper air
19 distribution. Where called for on Drawings, grilles, registers and diffusers shall be provided with
20 deflecting devices and manual dampers. These grilles, registers and diffusers shall be the standard product
21 of the manufacturer, and subject to review by the Architect.

22 D. Provide a frame compatible with the type of ceiling or wall in which the devices are installed. Refer to
23 Architectural Drawings for exact type of ceiling specified.

24 E. Coordinate color and finish of the devices with the Architect.

25 2.02 MANUFACTURERS

26 A. Grilles, Registers and Diffusers:

27 1. Krueger Manufacturing Company

28 2. Titus Products

29 3. Price Industries

30 4. Nailor Industries

31 5. Tuttle & Bailey

32 B. Louvers:

33 1. American Warming and Ventilating.

34 2. Ruskin

35 3. Greenheck

36 4. Arrow

37 C. Roof Hoods:

1 1. Greenheck

2 2. Cook

3 3. Acme

4 2.03 SQUARE PANEL FACE SUPPLY AND RETURN AIR CEILING DIFFUSER

5 A. Architectural diffuser with a square panel centered within a square housing similar to the Titus OMNI
6 Model. Drawings that depict two-way and three-way throw options are achieved with the use of filler
7 panel (where required) for directional throw diffusers.

8 B. Opposed blade volume dampers shall be provided with the diffuser, if scheduled on the drawings. The
9 volume damper design shall be similar to the Titus AG-75.

10 C. Although the manufacturers show this model being used only as a supply air device, this same diffuser can
11 also be used as a return air device in non-sterile areas. The neck connection shall be the largest available
12 neck size provide by the manufacturer.

13 D. Provide round or square neck connection as scheduled on Drawings.

14 2.04 PERFORATED FACE RETURN/EXHAUST GRILLES

15 A. Perforated face with back pan, removable face, and neck sizes as indicated on Drawings.

16 B. Provide frame type as indicated on Drawings.

17 C. Fabricate completely of 22 gage steel with a baked enamel off-white finish

18 **PART 3 – EXECUTION**

19 3.01 INSTALLATION

20 A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards
21 and conform to codes and ordinances of authorities having jurisdiction.

22 B. All installation shall be in accordance with manufacturer’s published recommendations.

23 C. Check location of air outlets and inlets and make necessary adjustments in position to conform to
24 architectural features, reflected ceiling plans, symmetry and lighting arrangement.

25 D. Install air outlets and inlets to ductwork with airtight connection.

26 E. Provide balancing dampers on duct take-off to diffusers, grilles and registers, regardless of whether
27 dampers are specified as part of the diffuser, grille, or register assembly. The use of extractors or scoops at
28 duct take-off to diffusers, grilles and registers is not allowed.

29 F. Paint interior surfaces and ductwork visible behind perforated air inlets (without diffuser vanes) matte
30 black. Refer to Division 09.

31 G. Provide all specialties and frames for air distribution devices as required for proper installation in ceiling
32 type as indicated on Architectural Drawings. Provide all cutting and patching of T-bars, gypsum board and
33 other ceiling systems as required for installation of air devices.

34 **END OF SECTION**

35

36

June 6, 2019

AIR OUTLETS AND INLETS 23 37 00

4 of 4

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2

1 **COMPUTER ROOM AIR CONDITIONING UNITS**

2 **PART 1 – GENERAL**

3 1.01 RELATED DOCUMENTS

4 A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and
5 Division 01 Specification Sections, apply to this Section.

6 B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and
7 this Section is directly applicable to them.

8 1.02 SUMMARY

9 A. Perform all Work required to provide and install computer room air conditioning units (CRACU), including
10 factory installed variable speed controlled fans, isolation dampers, coils, motors, and any specialty
11 equipment as indicated in the Contract Documents with supplementary items necessary for proper
12 installation.

13 B. This Section includes factory-assembled CRACU's that includes, but is not limited to, the following:

14 1. Casing.

15 2. Refrigerant Compressors and Condensers.

16 3. Direct Drive Fans with Electronic Commutated Motors.

17 4. Aluminum Fin/Copper Tube Coils.

18 5. Front Filter Access Section.

19 6. Control Sensors, Valves, Electrical Power and Electronic Control Panels.

20 7. Additional Plenum Section.

21 8. Acoustic/Thermal Insulation.

22 9. Visual Local and Remote Alarms.

23 10. Accessories.

24 1.03 REFERENCE STANDARDS

25 A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific
26 edition date.

27 B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this
28 Project.

29

- 1 C. All materials, installation and workmanship shall comply with the applicable requirements and standards
2 addressed within the following references:
- 3 1. ASHRAE 52.2 – Air-Cleaning Devices Used in General Ventilation for Removing Particulate
4 Matter. Addendum B Arrestance & Dust Capacity Insertions and Appendix J MERV-A Ratings.
- 5 2. AMCA 211 – Certified Ratings Program
- 6 3. AMCA 300 – Reverberant Room Method for Sound Testing of Fans.
- 7 4. ARI 260 – Sound Rating of Ducted Air Moving and Conditioning Equipment.
- 8 5. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
- 9 6. Electromagnetic Compatibility Standard EN50081-1 Emissions Interference EN610000-6-4
10 Immunity and ENG61000-3-2 Harmonic Current Emissions.
- 11 7. NFPA 70 – National Electrical Code.
- 12 8. NFPA 75 – Protection of Electronic Computer/Data Processing Equipment.
- 13 9. NFPA 90A – Installation of Air Conditioning and Ventilation Systems.
- 14 10. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems.
- 15 11. UL – Underwriters Laboratories.
- 16 12. FS TT-C-490E – Cleaning Method and Pre-Treatment of Ferrous Surfaces for Organic Coatings.
- 17 13. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc.,
18 as suitable for the purpose specified and indicated.
- 19 1.04 QUALITY ASSURANCE
- 20 A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section
21 with minimum three (3) years documented experience.
- 22 B. Installer Qualifications: Company specializing in performing the Work of this Section with minimum three
23 (3) years experience approved by manufacturer.
- 24 1.05 SUBMITTALS
- 25 A. Product Data:
- 26 1. Provide data that indicates physical dimensions, weights, component capabilities, efficiency ratings,
27 fan performance, materials gages and finishes of panels, electrical conduit, and piping size
28 connections.
- 29 2. Provide information concerning the location of maintenance access panels, minimum clearance
30 requirements for proper operation of equipment and components.
- 31 3. Provide data of filter media depth filter performance data in accordance with ASHRAE 52.2 and
32 show the filters are certified per NFPA 90 flame spread and smoke rating standards.
- 33 4. Provide fan curves with specified operating point clearly plotted, as tested and certified per AMCA
34 211 Standards. Ratings to include system effects. Bare fan ratings will not satisfy this requirement,
35 but shall be submitted for comparison purposes. All fan data shall be generated from specified
36 testing. The fan shall compare favorably with the scheduled data listed in the Drawings.

- 1 5. Submit sound power level data for both fan outlet and casing radiation at rated capacity as tested and
2 certified per AMCA 300 and ARI 260 standard for ducted units and DX units with compressors
3 inside the unit casing. All fan data shall be generated from specified testing. The fan shall compare
4 favorably with the scheduled data listed in the construction Drawings. The selected unit will not
5 exceed the scheduled sound power data.
- 6 6. Unit manufacturer shall submit full sound performance data to the Project Sound Consultant for
7 evaluation. Unit shall be finally configured so as not to exceed sound levels as scheduled on
8 Contract Documents.
- 9 7. Provide data on all coils as tested and certified per ARI standards.
- 10 8. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and
11 control wiring, clearly indicating factory-installed and field-installed wiring.
- 12 9. All materials shall have NFPA-90 rating of 25/50 or better.
- 13 10. Manufacturer's Instructions: Provide start-up information and maintenance required prior to start-
14 up.
- 15 B. Record Documents:
- 16 1. Submit under provisions of Division 01.
- 17 2. Shop Drawings: Indicate manufactured products, assemblies and accessories. Indicate water, drain,
18 chilled water, location of valves, rough-in piping and electrical and connection requirements.
- 19 C. Operation and Maintenance Data:
- 20 1. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating
21 instructions, installation instructions, and maintenance and repair data.
- 22 1.06 EXTRA MATERIALS
- 23 A. Provide an additional set of filters for each CRACU.
- 24 1.07 WARRANTY
- 25 A. Provide five-year manufacturer's warranty.
- 26 B. Warranty shall cover entire CRACU including refrigeration compressor(s) and condensing units.
- 27 **PART 2 – PRODUCTS**
- 28 2.01 GENERAL
- 29 A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements,
30 and conform to codes and ordinances of authorities having jurisdiction.
- 31 2.02 MANUFACTURERS
- 32 A. Liebert Corp., Columbus, OH 43229
- 33 B. Compu-Air, Inc., Whittier, CA 90606
- 34 C. Data Air, Inc., Garden Grove, CA
- 35 D. United CoolAir Corp., York, PA (VAV System Floor-by-Floor Packaged Unit, 8 to 71 tons)

- 1 E. Stulz Air Technology Systems, Inc., Frederick, MD 21704
- 2 2.03 MANUFACTURED UNITS
- 3 A. Provide factory assembled pre-piped direct expansion packaged CRACUs with air cooled condenser,
4 consisting of cabinet, fans, filters, humidifier, pre-wired electrical panel and control panels.
- 5 B. Assemble each CRACU for either up or down airflow configuration listed in the Owner's equipment
6 schedule drawing(s).
- 7 2.04 CABINET AND FRAME
- 8 A. Structural Frame: A minimum 16 gage welded tubular or angle steel suitably braced for rigidity, capable of
9 supporting equipment components, piping and a welded angle or tubular steel floor stand with adjustable
10 legs and vibration isolation pads.
- 11 B. Raised floor stand shall be provided to allow for ease of installation of the AC unit onto a raised floor.
12 Floor stand height shall be adjustable and shall ship separately for field installation, and shall meet seismic
13 loads per IBC seismic requirements.
- 14 C. Insulated Panels: Exterior panels shall be furniture grade, constructed from minimum 20 gage sheet steel.
15 The front panels shall be hinged and removable to permit front access to equipment components.
16 Insulation in the panel shall be a high-density thermal and acoustical insulation liner and sealed with self-
17 extinguishing gasket materials conforming to NFPA 90A and 90B.
- 18 D. Finish of Interior and frame supports and stand shall be mill-galvanized or coated with an epoxy finish or
19 an approved equivalent manufacturer's standard finish.
- 20 E. Finish of Exterior Surfaces: Finish shall be furniture grade, painted with a 2-ply epoxy finish to match and
21 provide corrosion protection.
- 22 2.05 EVAPORATOR FANS AND MOTORS
- 23 A. Fans: Direct drive statically and dynamically balanced centrifugal plug type fans.
- 24 B. Motor: Fan motors are electronically commutated variable speed with permanently lubricated bearings.
- 25 2.06 COMPRESSORS
- 26 A. Digital Scrol compressors step less variable capacity control with suction gas cooled motors, vibration
27 isolators, thermal overloads, crank case oil sight glass, suction line strainer, internal motor protection, low
28 refrigerant suction pressure switch, and a manual reset high refrigerant discharge pressure switch.
- 29 B. Provides dual refrigeration circuits for redundancy to permit the compressors to be individually serviceable
30 without dismantling other components or removing unit from service.
- 31 C. The DX refrigerant R-410AS or R-407C.
- 32

- 1 2.07 REFRIGERANT SPECIALTIES AND COOLING COIL
- 2 A. The direct expansion cooling coil of seamless copper tubes expanded into aluminum fins A-frame or
3 vertical flat face configuration.
- 4 B. Two refrigeration circuits, each with hot gas mufflers, expansion valve with external equalizer, liquid line
5 solenoid valve, liquid line filter-drier, refrigerant sight glass with moisture indicator, service shut-off valves
6 and charging valves. Receiver to be sized for liquid refrigerant storage capacity for pump down cycle.
- 7 C. Mount coil assembly in stainless steel drain pan.
- 8 2.08 CONDENSERS
- 9 A. Water Cooled: Shell and tube type to Section 8D of ANSI/ASME code with liquid line service valve and
10 head pressure actuated water regulating valve. Terminate cabinet for easy external connections per Owners
11 Drawings.
- 12 B. Air Cooled: Air cooled refrigerant condenser, consisting of corrosion resistant cabinet, copper tube
13 aluminum fin coils arranged for two circuits, multiple direct drive propeller fans with permanently
14 lubricated ball bearing single or three phase motors with internal overload protection. Refer to Motors
15 Section 20 05 13.
- 16 2.09 FILTERS
- 17 A. Media: Pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid;
18 enclosed in cardboard frame; 4 inch nominal thickness.
- 19 B. Rating: ASHRAE 52.2; MERV 10 efficiency, 430-450 ft/min face velocity, 0.30-4 inch w.g. initial
20 resistance, 1.0 inch w.g. recommended final resistance. Refer to Filter Specification 23 40 00 for approved
21 manufacturer.
- 22 2.10 HUMIDIFIER
- 23 A. Electrode Canister Type Humidifier:
- 24 1. The humidifier shall be of a self-contained steam generating electrode type utilizing a plastic
25 disposable canister with full probes connected to electric power via electrode screw connector. The
26 electrodes shall be constructed from expanded low carbon steel, zinc plated and dynamically formed
27 for precise current control. The humidifier assembly shall include integral fill cup, fill and drain
28 valves and associated piping.
- 29 2. The canister shall be designed to collect the mineral deposits in the water and provide clean particle
30 free steam to the air stream.
- 31 3. Water chemistry requirements must be provided with humidifier submittal data.
- 32 2.11 ELECTRICAL PANEL
- 33 A. The electrical system shall conform to National Electrical Code requirements.
- 34 B. All internal wiring shall be neatly wrapped on run in conduit or cable trays and routed in bundles. Each
35 wire shall end with a service loop and be securely fastened by an approved method. Each wire in the unit
36 shall be numbered for ease of service tracing. All electrically actuated components shall be easily
37 accessible from the front of the unit without reaching over exposed high voltage components or rotating
38 parts.
- 39 C. Service Connections, Wiring and Disconnect Requirements: Conform to Sections 26 05 19 and 26 27 26.

- 1 D. The electric panel located inside the unit casing shall be a NEMA 250, and be a Type 2 UL listed enclosure
2 at least four feet above the floor for service convenience and shall include all the contactors, starters, fuses,
3 circuit breakers, and terminal boards.
- 4 E. The control cabinet shall meet NEMA 250, and be a Type 2 UL listed enclosure, with piano hinged door,
5 grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock,
6 and fusible control circuit step-down transformer.
- 7 F. The control circuit shall be 24 volts AC, wire in accordance with NEC Class II requirements. The low
8 voltage control circuit wiring shall be routed in separate bundles from the higher voltage power wiring.
- 9 G. Disconnect Switch: Manual non-fused disconnect with handle accessible with panel closed and capable of
10 preventing access until switched to "off" position.

11 2.12 ELECTRONIC CONTROL SYSTEM

- 12 A. Included in the system's electrical control circuit shall be a terminal connection for remote stop/start of the
13 air conditioner by remote source.
- 14 B. Solid state with start button, stop button, temporary loss of power indicator, manual reset circuit breakers,
15 temperature control, humidity control and monitor panel.
- 16 C. Monitor Panel: Back lighted with no visible indicator lights until operating function is activated; indicators
17 include cooling, humidification, loss of air flow, change filters, high temperature, low temperature, high
18 humidity, low humidity [high head pressure (each compressor), and low suction pressure (each
19 compressor).
- 20 D. Temperature and Humidity Control Modules: Solid state plug-in with adjustable set point, "push-to-test"
21 calibration checks button, and built-in visual indicators to indicate mode of operation.

22 2.13 MICROPROCESSOR CONTROL SYSTEM

- 23 A. The Microprocessor control system shall continuously monitor operation of process cooling system;
24 continuously digitally display room temperature and room relative humidity; sound alarm on system
25 malfunction and simultaneously display problem
- 26 B. Malfunctions alarmed as follows: Power Loss, Loss of Air Flow, High Room Temperature, Low Room
27 Temperature, High Humidity, Low Humidity, and Cooling, Compressor Overload, Low Refrigerant
28 pressure and High Refrigerant Pressure.
- 29 C. Light Emitting Diodes Display: Control Power On, System On, Humidification, De-humidification taking
30 place, Alarm condition, Compressor No. 1 operating, Compressor No.2 operating and reheat coil on/off
31 status.
- 32 1. Provide push buttons to STOP process cooling system, START process cooling system, SILENCE
33 audible alarm, push-to-test LED indicators, and display room relative humidity. Microprocessor
34 shall have a general alarm dry set of contacts and shall be remotely monitored by the building
35 automation system (BAS). The general alarm shall be fail safe and activate (open contacts) on
36 system malfunction and/or temperature and/or humidity values outside of specified operating range.
- 37 D. Provide all necessary hardware and/or software to provide the following two remote monitoring
38 connections simultaneously:
- 39 1. Remote monitoring utilizing dry contact closure for general alarm for environmental conditions
40 exceed alarm parameters and dry contacts for microprocessor malfunction/trouble. These
41 connections will be monitored by Owner's Building Automation System.

42 PART 3 – EXECUTION

1 3.01 PREPARATION

2 A. Verify that flooring system is ready to receive Work and that opening dimensions are as indicated on Shop
3 Drawings.

4 B. Verify that proper power supply is available.

5 3.02 INSTALLATION

6 A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards
7 and conform to codes and ordinances of authorities having jurisdiction.

8 B. All installation shall be in accordance with manufacturer's published recommendations.

9 C. Contractor shall coordinate installation of computer room air conditioning units with computer room raised
10 floor installer.

11 D. Provide adequate drainage connections for coil condensate and humidifier blow down.

12 E. Provide shut off valves at eater inlet and outlet piping on DX units equipped with water cooled condensers.

13 **END OF SECTION**

14