

PROJECT MANUAL

for

Ben Taub EC Shock Trauma Rooms 1, 2, 3, 4 & 5 Renovations

PBK Project no. 1625 / 1773

for the

Harris Health System

13 October 2017

Issue for Bid

Date: 10/13/2017

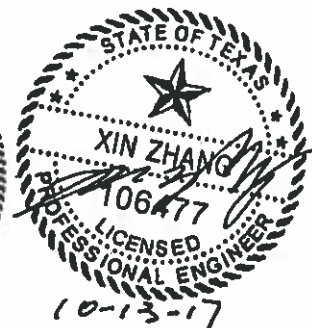
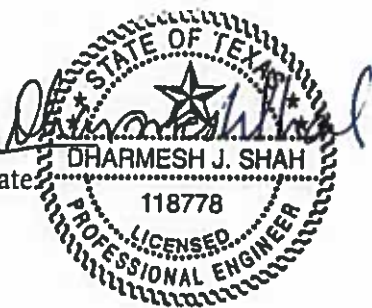
Expires: 12/31/2017

Engineer of Record:

Dharmesh J. Shah State

TEXAS Registration

No. 118778





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Professional Seals:

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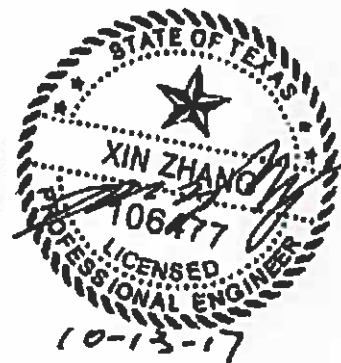
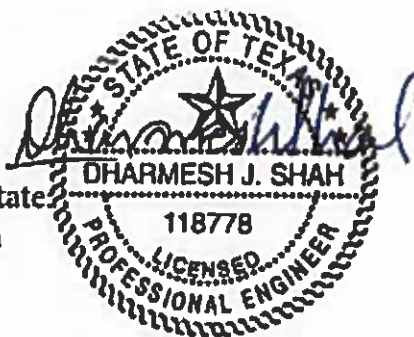
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PBK Architects
Project No. 1625 / 1773

Ben Taub EC Shock Trauma Rooms 1, 2, 3, 4 & 5 Renovations
Harris Health System

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 INFORMATIONAL DOCUMENTS

- A. Informational Documents: The Owner is making certain documents available for the Bidders information. The Owner does not warrant the accuracy of the information contained with these documents. Bidders are encouraged to verify conditions prior to submitting their bid.
 - 1. Informational documents and reports are provided for convenience and are intended as information only. These documents are not a part documents of the Contract Documents.
 - 2. The Owner and Architect have no liability for the use of or interpretation of data from supplementary documents and reports provided for the bidder's information.
 - 3. Copies of informational documents are available upon request.
 - a. Physicist's Report.

1.3 ASBESTOS CONTAINING MATERIALS (ACM) REPORTS

- A. The Asbestos Survey is prepared by the Owner's hazardous materials consultant and is made available upon request.
- B. There is a potential that asbestos or other hazardous containing materials exists where demolition work is scheduled to occur. If hazardous materials are uncovered, immediately stop Work in the area protect persons from harmful exposure, and notify the Owner and Architect without delay.
- C. If the suspect substance is found to be asbestos or other hazardous material, the Owner will arrange for removal or perform abatement under a separate contract. Do not resume Work in the area until abatement is complete and authorization to proceed is received. Work may continue in areas that are not affected by hazardous materials.
- D. Hazardous materials abatement is specifically excluded from the Work of the Contract.

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Not used.

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Not used.

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PART 1 - GENERAL

1.1 DESCRIPTION

- A. Intent of drawings and Specifications is to obtain complete systems, tested, adjusted, and ready for operation.
- B. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 20, 21, 22 and 23 Contract Documents shall have the following meanings:
 - 1. "Provide" or "provided" shall mean "furnish and install".
 - 2. "Furnish" or "furnished" does not include installation.
 - 3. "Install" or "installed" does not include furnishing.
- C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.
- D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.
- E. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.
- F. Where Architectural features govern location of work, refer to architectural drawings.
- G. Contractor may install additional piping, fittings and valves, not shown on drawings, for testing purposes or for convenience of installation. Where such materials are installed, they shall comply with specifications and shall be sized to be compatible with system design. Remove such installed materials when they interfere with design conditions or as directed by Architect.

1.2 RELATED WORK

- A. Continuity of Service:
 - 1. No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before any work is started.
 - 2. When interruption of services is required, Architect, Owner, and other concerned parties shall be notified and shall determine a time.
- B. Demolition:
 - 1. Division 02 - Selective Demolition.
 - 2. Perform demolition as required to accomplish new work.
 - 3. Accomplish work in neat workmanlike manner to minimize interference, annoyance or inconvenience such work might impose on Owner or other Contractors.
 - 4. Unless otherwise noted, remove from premises materials and equipment removed in demolition work.
 - 5. Equipment noted to be removed and turned over to Owner, shall be delivered to Owner at place and time Owner designates.
 - 6. Where materials are to be turned over to Owner or reused and installed by Contractor, it shall be Contractor's responsibility to maintain condition of materials and equipment equal to that existing

before work began. Repair or replace damaged materials or equipment at no additional cost to Owner.

7. Where demolition work interferes with Owner's use of premises, schedule work through Architect, Owner and with other Contractors to minimize inconvenience to Owner. Architect must approve schedule before Contractor begins such Work.

C. Painting:

1. Painting of mechanical equipment will be done under Division 09 unless specified otherwise or unless equipment is to be furnished with factory applied finish coats.
2. Furnish equipment with factory applied prime finish unless otherwise specified.
3. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Architect.
4. Furnish one can of touch up paint for each factory-applied coat of product.

1.3 REQUIREMENTS OF REGULATORY AGENCIES

- A. Rules and regulations of Federal, State and Local Authorities and utility companies, in force at time of execution of Contract shall become part of this specification.

1.4 REFERENCE STANDARDS

- A. Agencies or publications referenced herein refer to the following:

1. AGA American Gas Association
2. AMCA Air Movement and Control Association
3. ANSI American National Standards Institute
4. AHRI Air-Conditioning, Heating and Refrigeration Institute
5. ASHRAE American Society of Heating Refrigerating and Air Conditioning Engineers
6. ASPE American Society of Plumbing Engineers
7. ASSE American Society of Sanitary Engineering
8. AWS American Welding Society
9. AWWA American Water Works Association
10. ASME American Society of Mechanical Engineers
11. ASTM American Society for Testing and Materials
12. CDA Copper Development Association
13. CISPI Cast Iron Soil Pipe Institute
14. FMG FM Global
15. FS Federal Specifications
16. IEEE Institute of Electrical and Electronics Engineers
17. MCA Mechanical Contractors Association
18. MSS Manufacturers Standardization Society
19. NEC National Electrical Code
20. NEMA National Electrical Manufacturers Association
21. NFPA National Fire Protection Association
22. NIST National Institute of Standards & Technology
23. NSF National Sanitation Foundation
24. OSHA Occupational Safety and Health Administration
25. PDI Plumbing and Drainage Institute
26. SMACNA Sheet Metal and Air Conditioning Contractors National Association

- 27. UL Underwriters Laboratories, Inc.
- 28. WQA Water Quality Association

B. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.5 SUBMITTALS

A. Shop Drawings (Product Data):

1. Refer to Division 01 - Submittal Procedures.
2. Note that for satisfying submittal requirements for Divisions 20, 21, 22 or 23, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the expression "Shop Drawings" is generally used throughout Specification.
3. Submit shop drawings for equipment and systems as requested in the respective specification sections. Submittals that are not requested may not be reviewed.
4. Specifically mark general catalog sheets and drawings to indicate specific items submitted and its correlation to specific designation for product in drawings.
5. Specifically indicate proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
6. When manufacturer's reference numbers are different from those specified, provide correct cross-reference numbers for each item. Clearly mark and note submittals accordingly.
7. Submit complete record of required components when fixtures, equipment and items specified include accessories, parts and additional items under one designation.
8. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
9. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
10. Submittals that are not complete, not permanent or not properly checked by Contractor will be returned without review.

B. Certificates and Inspections:

1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Operation and Maintenance Manuals:

1. Refer to Division 01 - Operation and Maintenance Data.
2. Upon completion of Work but before final acceptance of system, submit to Architect for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2" thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.
3. Organize manuals by specification section number and furnish table of contents and tabs for each piece of equipment or system.
4. Fire protection system shall be separately bound.
5. Manuals shall include the following:
 - a. Copies of Shop Drawings
 - b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment, with component exploded views and part numbers. Where manufacturer's data includes several types or models, designate applicable type or model.
 - c. CD ROM's of O&M data with exploded parts lists where available
 - d. Phone numbers and addresses of local parts suppliers and service companies

- e. Internet/WEB page addresses where applicable
 - f. Wiring diagrams
 - g. Startup and shutdown procedures
 - h. Composite electrical diagrams
 - i. Flow diagrams
 - j. Lubrication instructions
 - k. Factory and field test records (Refer to Test and Balancing in Part 3 of this section.)
 - l. Air and water balance reports
 - m. Valve identification charts as specified in Section 20 05 53 - Mechanical System Identification
 - n. Access panel identification charts as specified in Section 20 05 53 - Mechanical System Identification
 - o. Additional information, diagrams or explanations as designated under respective equipment or systems specification sections.
6. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
7. Furnish O&M Manuals and instructions to Owner prior to request for final payment.
- D. Record Documents:
- 1. Refer to General Conditions of Contract, and Division 01 - Project Record Documents. Prepare complete set of record drawings in accordance with Division 01.

1.6 JOB CONDITIONS

A. Building Access:

- 1. Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Electrical Coordination:

- 1. Contractors for Divisions 20, 21, 22 and 23 shall provide the following items as specified under their respective Division(s) (Division 20, 21, 22 and 23):
 - a. Motors
 - b. Electrically powered equipment
 - c. Electrically controlled equipment
 - d. Starters, where specified
 - e. Variable frequency drives, where specified
 - f. Control devices, where specified
 - g. Temperature Control wiring
 - h. Wiring diagrams to Electrical Contractor for apparatus indicating external connection and internal controls.
 - i. Disconnect devices furnished with units (VFDs, chillers, prepackaged control devices, etc.)
 - 1). Devices shall have an interrupting rating not less than that of the upstream overcurrent device as shown on electrical drawings.
 - 2). Equipment electrical connection points shall be labeled with listed electrical short circuit current rating (SCCR). SCCR shall not be less than interrupting rating of upstream overcurrent device as shown on electrical drawings. SCCR shall be marked on equipment control enclosure in accordance with UL508, or other acceptable, accredited third-party testing agency standards.
- 2. Electrical Contractor will provide the following devices required for control of motors or electrical equipment, unless noted otherwise.
 - a. Starters

- b. Disconnect devices
 - c. Control devices:
 - 1). Pushbuttons
 - 2). Pilot lights
 - 3). Contacts
 - d. Conduit, boxes and wiring for power wiring.
 - e. Conduit, boxes and wiring for control wiring, except temperature control wiring.
3. Electrical Contractor will make connections, from power source to starter or variable frequency drive and from starter or variable frequency drive, where specified, to motor for ready to operate.
 4. Where starters or other similar control devices are furnished by this contractor, they shall be installed by this contractor and wired by Electrical Contractor.
 5. Should any change in size, hp rating, voltage, or means of control be made to any motor or other electrical equipment after Contracts are awarded, this contractor shall immediately notify Electrical Contractor of change. Additional costs due to these changes shall be responsibility of this contractor.
- C. Cutting and Patching:
1. Refer to General Conditions of the Contract, and Division 01 - Cutting and Patching.
 2. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
 3. Provide materials required for patching unless otherwise noted.
 4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
- D. Housekeeping and Cleanup:
1. Refer to Division 01 - Closeout Procedures.
 2. As work progresses and/or as directed by Architect, periodically remove waste materials from building and leave area of work broom clean. Upon completion of Work, remove tools, scaffolding, broken and waste materials, etc., from site.
- 1.7 WARRANTY
- A. Refer to Division 01 for general warranty requirements.
 - B. Refer to technical sections for warranty requirement for each system.
 1. Where no warranty requirements are called out, warrant for 1 year after acceptance by Owner equipment, materials, and workmanship to be free from defect.
 - C. Warrant that systems will operate without objectionable noise, vibration and uncontrolled expansion.
 - D. Repair, replace or alter systems or parts of systems found defective at no extra cost to Owner.
 - E. In any case, wherein fulfilling requirements of any warranty, if this contractor disturbs any work warranted under another contract, this contractor shall restore such disturbed work to condition satisfactory to Architect and warranty such restored work to same extent as it was warranted under such other contract.
 - F. Warranty shall include labor, materials, and travel time.

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

- A. Refer to Division 01 - Product Requirements.

PART 3 - EXECUTION

3.1 GENERAL

- A. Verify elevations and dimensions prior to installation of materials.

3.2 DELIVERY, STORAGE, HANDLING, AND PROTECTION

- A. Deliver products to the site under provisions of Division 01.
- B. Store and protect products under provisions of Division 01.
- C. Store in clean, dry space.
- D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with manufacturer's written instructions.
- F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.
- G. Protect openings in equipment until connected to system to prevent entry of foreign materials.

3.3 FLOOR, WALL, ROOF AND CEILING OPENINGS

- A. Coordinate location of openings, chases, furred spaces, etc., with appropriate Contractors. Provide sleeves and inserts that are to be built into structure during progress of construction.
- B. Remove temporary sleeves, if used to form openings, prior to installation of permanent materials. Utilize minimum 24 ga galvanized sheet metal for permanent sleeves unless otherwise noted.
- C. Provide Schedule 40 carbon steel pipe with integral water stop for steel sleeves required in interior floor slabs.
- D. Submit to Structural Engineer for review and approval size and location of core-drilled holes prior to execution.
- E. Submit product data and installation details for penetrations of building structure. Include schedule indicating penetrating materials (metal pipe, plastic pipe, conduit, etc.), sizes of each, opening sizes and sealant products intended for use.
- F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Section 20 05 73 - Mechanical Systems Firestopping.
- G. Provide minimum 1" clearance around penetration openings intended for pipe. Where fire resistant penetrations are required, size openings in accordance with written recommendations of firestopping systems manufacturer.
- H. Openings for underground pipes passing through foundations or under footings shall have minimum clearance of 1-1/2" to concrete. Do not disturb footing bearing soil.

- I. Openings for underground pipe passing through on grade concrete slabs shall have minimum 1/4" clearance to concrete. Seal openings with urethane caulk.
- J. Openings for insulated piping shall be sized based on outside diameter of insulation when it is specified or detailed to be continuous through opening.
- K. Openings for duct penetrations shall be no more than 1/2" larger on all sides than size of duct or duct including duct insulation, if applicable. Where firestopping systems are required at penetrations, size in accordance with recommendations of firestopping systems manufacturer, but opening shall not exceed 1" average clearance on all sides. Openings for ducts with fire dampers shall be in accordance with fire damper installation requirements.
- L. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.
- M. Seal non fire-rated wall openings with urethane caulk.
- N. In lieu of openings as specified herein penetration systems as manufactured by Pro Set may be used, including sleeve couplings and plug.
- O. If total Pro Set system with Water Guard "CR" is used, opening shall not need additional water proofing or riser clamps.
- P. Finish and trim penetrations as shown on details and as specified.
- Q. Provide chrome or nickel plated escutcheons where piping passes through walls, floors or ceilings and is exposed in finished areas. Size escutcheons to fit pipe and pipe covering for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitors' closets, storage rooms, etc., unless suspended ceilings are specified.

3.4 EQUIPMENT ACCESS

- A. Install piping, conduit and accessories to permit access to equipment for maintenance. Relocate piping, equipment or accessories to provide access at no additional cost to Owner.
- B. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment without moving other future or installed equipment or system components.
- C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors for valves, shock stops or other equipment shall provide access for servicing, repairs, and/or maintenance.
- D. Provide necessary coordination and information to the Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes, and rough-in dimensions.

3.5 EQUIPMENT SUPPORTS

- A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.

3.6 SUPPORT PROTECTION

- A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, guard certain equipment to protect personnel from injury.

- B. Provide minimum 1/2" thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment and mechanical supporting devices suspended less than 7 ft. above floors, platforms or catwalks in these areas.
- C. Protect threaded rod or bolts at supporting elements as described above. Trim threaded rod or bolts such that they do not extend beyond supporting element.

3.7 TEST AND BALANCING

- A. Tests for equipment, ductwork and piping systems shall be performed as specified in their respective specification sections in accordance with technical requirements noted.
- B. Provide equipment required for testing, including fittings for additional openings required for test apparatus.
- C. All ductwork and piping inspections and testing shall be successfully completed and approved before application of covering materials.
- D. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or material as necessary and repeat inspection and test until equipment or systems meet test requirements. Make repairs with new materials. Caulking of holes or threaded joints is not allowed.
- E. Contractor is responsible for certifying in writing equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria, test medium and pressure used, duration of test and name and title of person signing test certification document.
- F. Maintain copies of certified test results, including those for any failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.
- G. Balancing of various systems shall be in accordance with associated specification sections in addition to requirements noted herein.

3.8 START-UP

- A. Systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation. This includes "Owner-Furnished, Contractor-Installed" (OFICI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.
- B. Follow manufacturer's pre-start-up check-out, start-up, trouble shooting and adjustment procedures.
- C. Contractor shall provide services of technician/mechanic knowledgeable in start-up and check-out of types of systems and equipment on project.
- D. Provide start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel.
- E. Coordinate start-up with all trades.

3.9 CLEANING

- A. Clean systems after installation is complete.
- B. Clean piping and ductwork both internally and externally to remove dirt, plaster dust or other foreign materials. When external surfaces of piping are rusted, clean and restore surface to original condition.
- C. Clean pipeline strainers to restore them to original condition or replace with new strainer elements.
- D. Clean equipment and plumbing fixtures as recommended by manufacturers.

- E. Replace throwaway or replaceable media air filters used during construction period with new filters or new filter media after construction has been completed and before building is turned over to Owner. Filter replacement shall be as hereinafter specified.
- F. Blow and clean dirt, plaster dust and other foreign matter from coils, terminal devices, diffusers, registers and grilles.
- G. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.
- H. Provide additional cleaning of individual piping systems and apparatus as hereinafter specified.

END OF SECTION 20 00 00

SECTION 20 05 29 - MECHANICAL SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 20 07 00 - Mechanical Systems Insulation
- B. Section 23 31 14 - Ductwork (for additional duct supports requirements)

1.2 DESCRIPTION

- A. Provide all supporting devices as specified and as required for proper support of piping, ductwork, equipment, materials and systems.
- B. Support for all conditions of operation, including variations in installed and operating weight of equipment, piping and ductwork, to prevent excess stress and allow for proper expansion and contraction.
- C. Support of fire protection pipe shall comply with NFPA 13, Installation of Sprinkler Systems, 2003 Edition.

1.3 SUBMITTALS

- A. Shop Drawings for each piping system for all pipe sizes and all applicable equipment including, but not limited to, the following:
 - 1. Manufacturer's name
 - 2. Model numbers
 - 3. Materials of construction and load ratings (lbs.)
 - 4. Schedule of hangers and support devices with pipe support spacing
 - 5. Insulated pipe supports along with application chart or table
 - 6. Insulation protection saddles and weight bearing insulation table
 - 7. Details and calculations for sizing supplementary steel utilized for trapeze or specially designed supports
 - 8. Structural attachments, inserts and concrete anchors. Submit ICC-ES Evaluation Report for each type of anchor.
 - 9. Calculations and drawings for concrete inserts and anchors for each application
 - 10. Drawings showing specific locations of any weld attachments to structure, including weight supported by such attachments
 - 11. Drawings showing specific locations of any suspended loads which exceed 100 lbs. within joist chord panel to be attached to open web steel joist structural members. Include weight supported by such attachments. (Panel is length of chord between two adjacent diagonal web members at point of connection to chord.)
 - 12. All other appropriate data

1.4 DESIGN CRITERIA

- A. Materials and application of pipe hangers and supports shall conform to latest requirements of ANSI/ASME B31 Code for Pressure Piping and MSS Standard Practice SP-58-2009 (Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation), except as supplemented or modified herein.

- B. Support materials shall be steel or stainless steel unless specifically indicated.
- C. Support devices shall be factory fabricated by manufacturers and have published load ratings.
- D. Unless otherwise indicated, design structural support members and support devices, including couplings, rods, trapeze supports and strut systems, with safety factor in accordance with AISC Manual of Steel Construction, but not less than 2.0.
- E. Determine maximum deflection using the following equation.

$$D = \frac{H \text{ or } L}{250}$$

Where D = Max deflection in inches

H = Member height in inches

L = Member length in inches

- F. Unless otherwise indicated, hangers, support devices and hardware shall be steel and shall have factory standard black, primed, galvanized or electroplated finish for indoor application, and hot-dipped galvanized finish for outdoor application and corrosive atmospheres. Coat cut edges, welds or any damaged finish with galvanized paint.
- G. Unless otherwise indicated, steel support devices exposed to ventilation air stream shall be stainless steel or steel with either galvanized finish or paint finish. Paint type shall be approved by Architect/Engineer.
- H. Unless otherwise indicated, continuous insert channels are not allowed.
- I. Punching, drilling, or welding of building structural steel is not allowed unless approved by Structural Engineer.
- J. Coordinate with General Contractor for any proposed weld attachments to building structure. This may result in use of other welding codes or standards, which may apply to "structural work". Execution of this work may be assigned to General Trades responsible for building structural steel. Cost for this work, however, will remain the responsibility of this Contractor.
- K. Top or bottom chords of open web steel joists may be used to support loads, provided total load within panel does not exceed 100 lbs. and load is placed concentric to joist. (Panel is length of chord between two adjacent diagonal web members at point of connection to chord).

PART 2 - PRODUCTS

2.1 STRUCTURAL SUPPORTS

- A. Design and provide all supporting steel, not indicated on structural drawings, that is required for installation of mechanical equipment and materials, including angles, channels, beams, connections, etc. to suspend or floor support equipment.

2.2 HANGER RODS (METALLIC)

- A. Rods shall conform to the latest MSS Standards except as modified herein. Furnish rods complete with adjusting and lock nuts.
- B. Rods shall have electroplated zinc or hot dip galvanized finish.

- C. Unless otherwise indicated, size rods for individual hangers and trapeze support as indicated in the following schedule. Rod size may be reduced one size for double rod hangers. Total weight of equipment, including valves, fittings, pipe, pipe content and insulation, shall not exceed limits indicated.

<u>Max. Pipe Size With Single Rigid Rod</u>	<u>Rod Diameter (inches)</u>	<u>Max Load (lbs.) of Hanger Rod (Not exceeding 650°F Service Temp.)</u>
2"	3/8	730
3"	1/2	1350
5"	5/8	2160
8"	3/4	3230

2.3 BOLTS, NUTS, STUDS AND WASHERS

- A. ASTM A307, electroplated zinc finish

2.4 ROD ATTACHMENTS

- A. Anvil Fig. 290 (MSS Type-17), galvanized finish

2.5 METAL FRAMING SUPPORT SYSTEM (STRUT SYSTEM)

- A. Manufacturers: Unistrut, B-Line Strut Systems, Anvil-Strut, Power-Strut, Erico, Superstrut, Kindorf, Hilti, and Hydra-Zorb
- B. Channels shall have epoxy paint or electroplated zinc finish.
- C. Channels shall not be lighter than 12 ga.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.
- B. Coordinate hanger and support installation to properly group piping of all trades.
- C. Piping and ductwork shall be supported independently from other piping or ductwork.
- D. Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.
- E. Do not support equipment, piping or ductwork from metal roof decking or ceiling grid.
- F. Refer to Section 20 00 00 - General Mechanical Requirements for requirements of personnel injury protection guards for supporting devices.

END OF SECTION 20 05 29

SECTION 20 05 53 – MECHANICAL SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: For identification materials and devices
- B. Valve Schedules: For each piping system
- C. Samples: Of color, lettering style, and graphic representation required for each identification material and device.

PART 2 - PRODUCTS

2.1 IDENTIFYING DEVICES

- A. Stencil Paint:
 - 1. Oil-based, alkyd enamel, black color
- B. Marker System:
 - 1. Manufacturers: Brady USA, Marking Services Inc. (MSI), Kolbi, or Seton
 - 2. Manufacturer's standard, preprinted with color coding, lettering size and length of color field according to ASME A13.1.
 - 3. Use pressure-sensitive type or "snap-on" type.
 - 4. "Strap-on" type may be used for piping over 6" size including insulation.
- C. Valve Tags:
 - 1. Minimum 1-1/2" diameter, 0.032" thick, polished brass or 316 stainless steel.
- D. Laminated Plastic Nameplates:
 - 1. Nameplates shall be approximately 1-1/2" x 4", 1/16" thick, and have 1/2" high lettering. Face of plastic nameplates shall be black with white letters.
 - 2. Fasteners shall be self-tapping, stainless steel screws or contact type with permanent adhesive.

PART 3 - EXECUTION

3.1 GENERAL

- A. After painting and/or covering is completed, identify equipment and piping as indicated. Locate identification as conspicuously as possible except where such would distract from finished area.
- B. Where markers are used in high heat applications or exposed to harsh chemical or acid environments, specifically select marker materials for those applications.
- C. Coordinate, obtain and confirm mechanical systems identification criteria and requirements from Owner.

3.2 PIPING SYSTEM IDENTIFICATION

- A. Install pipe identification on each system.

- B. Place flow directional arrows at each pipe identification location.
- C. Identify all piping (except medical gas) not less than once every 25 ft., not less than once in each room, at each branch, adjacent to each access door or panel, at each valve and where exposed piping passes through walls and floors.
- D. Identify medical gas piping systems identified in Section 22 63 16 in accordance with NFPA 99.
 - 1. Medical gas piping system labels shall be located as follows:
 - a. At intervals of not more than 20 ft.
 - b. At least once in every room
 - c. On both sides of walls or partitions penetrated by piping
 - d. At least once every story transversed by risers
 - 2. Medical gas piping shall be labeled by stenciling or adhesive markers that identify patient medical gas, support gas, or vacuum system and include:
 - a. Gas/Vacuum system name or chemical symbol per NFPA 99 Table 5.1.11
 - b. Gas/Vacuum color code per NFPA 99 Table 5.1.11
 - c. Operating pressure in addition to gas name where positive pressure piping systems operate at pressures other than standard pressures defined by NFPA 99 Table 5.1.11.
 - 3. Medical gas piping shall not be painted.
- E. Identify piping by stenciling. Height of lettering shall be same as pipe diameter up to maximum of 1" in height. When finished color of piping is dark, stenciling shall be on white background.
- F. Identify piping with marker system.
 - 1. For "strap-on" type, ensure marker is fitted snugly to pipe or pipe insulation surface with sufficient straps.

3.3 VALVE IDENTIFICATION

- A. Identify valves with brass tags bearing system identification and valve sequence number in 1/2" black characters. Attach tag to valve body with brass jack chain and "S" hook for brass tag and SS jack chain or SS braided wires with swag sleeves and "S" hook for stainless steel tag. Non-metallic fasteners are not allowed.
- B. Valve numbers shall be prefixed with corresponding piping system identification in 1/4" black letters.
- C. Valve tags are not required at terminal devices unless valves are greater than 10 ft. from device or located in another room not visible from terminal unit.
- D. Furnish typewritten valve schedule indicating valve number, fixtures, equipment or areas served by each numbered valve and incorporate in O&M Manuals.

3.4 DUCT SYSTEM IDENTIFICATION

- A. Install duct identification for each supply, return and exhaust air system.
- B. Identify all ductwork not less than once every 25 ft. and not less than once in each room.
- C. Identify duct system by stenciling exterior of duct or insulation jacket by name as either "Supply Air (AHU-x)", "Return Air (RF-x)", or "Exhaust Air (EF-x)". "-x" shall indicate system number (e.g. AHU-1).
- D. Stencils shall be 2" (min) lettering, shall include direction arrow and shall be on bottom of duct or insulation jacket such that it is visible from floor below.

- E. Do not identify systems exposed in architecturally “finished” spaces.
- F. Hazardous ductwork shall have appropriate warning signs posted to protect personnel from exposure.

3.5 ACCESS PANEL IDENTIFICATION

- A. Identify each service opening or access opening for fire, smoke, and fire/smoke damper with minimum 1/2” high letters indicating type of damper.
- B. Furnish typewritten charts with identification and location of all access panels serving equipment and valves and incorporate in O&M Manuals.

END OF SECTION 20 05 53

SECTION 20 05 73 – MECHANICAL SYSTEMS FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 07 84 00 - Firestopping

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 - General Requirements.

1.3 SCOPE

- A. Work under this Section includes but is not limited to the following:
 1. Penetrations through fire-resistance-rated floor, roof, walls, partitions, and smoke barriers including openings containing pipes, ducts and other penetrating items.
 2. Penetrations through non-fire-resistance-rated floors where vertical service riser penetrates 3 or more floors.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. Firestopping systems shall be UL Classified for the application and correspond to those indicated by reference to designations listed by UL Fire Resistance Directory.
- B. Firestop materials and methods shall conform to requirements of Local Code Authority Having Jurisdiction.

1.5 SUBMITTALS

- A. Manufacturer's specifications and product data for each type of product including composition and limitations, documentation of UL Certification for firestopping systems to be used and manufacturer's installation instructions.
- B. Material safety data sheets provided with product delivered to job-site.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having necessary experience, staff, and training to install manufacturer's products per specified requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product, type and UL Label where applicable.
- B. Store materials to prevent deterioration or damage due to moisture, temperature changes, contaminants or other causes.
- C. Handle in accordance with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

1.8 PROJECT CONDITIONS

- A. Do not install firestopping when ambient or substrate temperatures are outside limits permitted by firestopping manufacturers or when substrates are wet because of rain, frost, condensation or other causes.
- B. Install and cure firestopping per manufacturers' written instructions using natural ventilation or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.
- C. Notify Owner's testing agency at least seven (7) days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. 3M, Hilti, Tremco, Nelson Firestop Products, Specified Technologies, Inc., or RectorSeal Corp.
- B. Pro-set firestop products may be used for specific applications, provided products meet requirements in this Section.
- C. HydroFlame water/firestop sleeves may be used for specific applications provided products meet requirements in this Section.

2.2 MATERIALS

- A. Use only firestop products that have been UL 1479, ASTM E814 Tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance.
- B. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Sealants: 250 g/L
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L
 - 3. Sealant Primers for Porous Substrates: 775 g/L
- C. Where UL classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.

2.3 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean out openings immediately before installing firestopping to comply with manufacturer's written instructions.
- B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

3.3 INSTALLATION

- A. Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during application. After installing fill materials and allowing materials to fully cure, remove forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Avoid multiple penetrations of common fire barrier opening. Seal each penetration in accordance with manufacturer's UL installation details. When multiple penetrations are unavoidable, seal openings with appropriate UL Classified firestopping systems.

3.4 IDENTIFICATION

- A. Identify Through-Penetration Firestop Systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6" of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners or self-adhering type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words: "Warning--Through-Penetration Firestop System—Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing and inspecting agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.5 CLEANING AND PROTECTION

- A. Clean surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as Work progresses.

- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION 20 05 73

SECTION 20 07 00 - MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 20 05 29 - Mechanical Supporting Devices
- B. Section 23 31 14 - Ductwork (Duct Lining)

1.2 DESCRIPTION

- A. Provide insulating materials and accessories as required for mechanical systems as specified below.
- B. Insulating products delivered to construction site shall be labeled with manufacturer's name and description of materials.

1.3 DEFINITIONS

- A. Concealed areas, where indicated in this Section, shall apply to shafts, furred spaces and space above finished ceilings, inaccessible tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.
- B. Unless otherwise indicated, unit of thermal conductivity is Btu·in/(h·ft²·°F).

1.4 SUBMITTALS

- A. Shop Drawings for each piping system for all pipe sizes, each ductwork system, and all equipment including, but not limited to, the following:
 - 1. Manufacturer's name
 - 2. Schedule of insulating materials
 - 3. Insulation material and thickness
 - 4. Jacket
 - 5. Adhesives
 - 6. Fastening methods
 - 7. Fitting materials
 - 8. Intended use of each material
 - 9. Manufacturer's data sheets indicating density, thermal characteristics, temperature ratings
 - 10. Insulation installation details (manufacturer's installation instruction/details, Contractor's installation details, MICA plates where applicable)
 - 11. All other appropriate data

1.5 DELIVERY, STORAGE AND HANDLING

- A. Insulation material shall be delivered to project site in original, unbroken factory packaging labeled with product designation and thickness. Shipment of materials from manufacturer to installation location shall be in weather-tight transportation. Protect insulation materials from moisture and weather during storage and installation. Protect insulation material against long exposure to UV light from sun.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Insulation:

1. Owens Corning, Johns Manville, Manson, Knauf or CertainTeed similar to product indicated except where product of manufacturers not listed above is specifically identified for special type of insulation.

B. Coatings, Mastics, Sealants and Adhesives:

1. Foster, Childers, Vimasco, Miracle or Pittsburgh Corning

2.2 MATERIALS

A. Products used for or related to air conditioning and ventilating systems shall conform to NFPA 90A possessing flame spread index of not over 25 and smoke developed index no higher than 50.

B. Unless otherwise indicated, all products, material itself or on composite basis, shall have flame spread index not more than 25 and smoke developed index not more than 50, when tested in accordance with ASTM E-84 or UL723.

2.3 INSULATION

A. Insulation materials shall be fire retardant, moisture and mildew resistant, vermin proof, and suitable to receive jackets, adhesives and coatings as indicated.

B. Glass fiber insulation shall be of inert inorganic material, non-corrosive to mechanical surfaces.

C. Insulating cement shall be Quick-Cote by PK Insulation MFG Co. or Ryder GP, with dry density of no more than 38 lb./ft³ thermal conductivity of 0.96 at 400°F mean temperature, and service temperature to 1200°F.

D. Filling and finishing cement shall be Super-Stik by PK Insulation MFG Co., or Ryder MW, with dry density of no more than 24 lb./ft³, thermal conductivity of 0.74 at 500°F mean temperature, and service temperature to 1900°F.

E. Type F Insulation (Flexible Glass Fiber):

1. Minimum density of 0.75 lb./ft³ with thermal conductivity of not more than 0.29 at 75°F mean temperature, and suitable for temperatures to 250°F. Owens Corning "All Service Duct Wrap", Johns Manville Microlite EQ Type 75.

2.4 JACKETS

A. Jacket puncture resistances shall be based on ASTM D-781 test methods. Vapor barrier permeance ratings shall be based on ASTM E-96 Procedure A.

B. Type D-2 Jacket:

1. Glass fiber reinforced foil Kraft laminate with permeance not exceeding 0.02 perm and beach puncture resistance 25 units minimum. Owens Corning "FRK", Johns Manville "FSK".

2.5 ADHESIVES, MASTIC, COATINGS, SEALANTS, AND REINFORCING MATERIALS

A. Products shall be compatible with surfaces and materials on which they are applied, and shall be suitable for use at operating temperatures of systems to which they are applied.

B. Products shall be fire retardant, moisture resistant and mildew resistant and vermin proof.

- C. Vapor Barrier Mastic: Below ambient insulation. Water vapor permeance shall be less than 0.08 perms at 45 mils dry film thickness per ASTM F1249.
 - 1. Foster 30-65 Vapor Fas
 - 2. Childers CP-34
 - 3. Vimasco 749
- D. Lagging Adhesive/Coatings: Indoors applications used in conjunction with canvas/glass cloth.
 - 1. Foster 30-36
 - 2. Childers CP-50 AMV1
 - 3. Vimasco 713
- E. Glass fiber fabric reinforcing shall be 10 x 10 mesh similar to Childers Chil Glas #10 or Foster Mast A Fab.
- F. Wire mesh reinforcing shall be 22 ga, 1" galvanized.
- G. Insulation cement shall be ANSI/ASTM C195, hydraulic setting mineral wool.
- H. Finishing cement shall be ASTM C449.

2.6 METAL BANDS AND WIRES

- A. Aluminum bands shall be 0.5" x 0.020" up to 48" diameter and 0.75" x 0.020" over 48" diameter.
- B. Stainless steel bands shall be 0.5" x 0.015" or 0.75" x 0.015".
- C. Stainless steel wires shall be 16 ga.

2.7 INSULATION FASTENERS

- A. Insulation fasteners shall be cup head weld pins, galvanized low carbon steel, minimum 12 ga (0.105") pins.
- B. Washer edge shall be beveled.
- C. Fasteners shall be stainless steel for stainless steel ductwork application.
- D. Insulation fasteners using adhesive are not allowed.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Provide insulation and jackets as indicated in the following schedule. The schedule applies to both exposed and concealed applications unless noted otherwise:

<u>Service</u>	<u>Ductwork/Equipment System</u>		
	<u>Jacket Type</u>	<u>Insulation Type</u>	<u>Insulation Thickness</u>
Supply Ducts Concealed	D-2	F	2"

Return Ducts

D-2

F

2"

3.2 INSTALLATION - GENERAL

- A. All insulation installation methods shall be performed in accordance with the latest edition of National Commercial and Industrial Insulation Standards published by MICA (Midwest Insulation Contractors Association) and manufacturer's installation instructions, except as modified in this Section of specifications.
- B. Install products with good workmanship, with smooth and even surfaces. Use full-length factory-furnished material where possible. Do not use scrap pieces.
- C. Apply insulation only on clean, dry surfaces, after all rust and scale have been removed and testing of systems has been completed. Do not insulate any section of system that must be pressure tested until after it has been successfully tested. Any removal and reinstallation to correct system defects prior to end of guarantee period shall be accomplished at no expense to Owner.
- D. Install insulating materials with necessary joints and terminations, to permit easy access and removal of equipment sections where inspection, service or repair is required, and to allow for expansion.
- E. Where possible longitudinal joints in jackets shall face toward wall or ceiling.
- F. Apply insulation to each pipe or duct individually. Common insulation applied to adjacent pipes or ducts will not be accepted.
- G. Unless otherwise indicated, pipe and duct insulation shall be continuous through walls and floors.
- H. Where multiple layers of insulation are used, stagger and secure each layer with metal bands.
- I. Where penetrations occur through fire-rated walls, partitions, or floors, provide fire seal as specified in Section 20 00 00 - General Mechanical Requirements and Section 20 05 73 - Mechanical Systems Firestopping.
- J. Insulate the following systems for complete vapor barrier protection:
 - 1. All insulated ductwork
 - 2. All equipment with surface temperature below 65°F

3.3 DUCTWORK AND COMPONENTS

- A. Apply duct insulation evenly over duct surface. Unless otherwise indicated, insulation and jacket shall run continuously between duct and duct supports. Maintain insulation thickness specified over duct reinforcing members.
- B. For support points of rectangular or oval ducts supported by trapeze hangers, place weight-supporting insulation at bottom of duct over trapeze. Weight supporting insulation inserts shall be minimum 6" long with same thickness as insulation specified and shall be Type G, H or P insulation. Size inserts based on compression strength and weight being supported.
- C. For support points of round ducts smaller than 16" diameter, weight-supporting insulation is not required for either rigid or flexible glass fiber insulation.
- D. For support points of round ducts 16" diameter and larger, place weight-supporting insulation between duct and strap or trapeze. Weight-supporting insulation shall be minimum 6" long with same thickness as insulation specified and shall be Type G, H or P insulation. Size inserts based on compression strength and weight being supported.

- E. Flexible glass fiber insulation may be installed outside of support for round ducts 24" diameter or smaller, provided that vapor barrier integrity is maintained at rod penetration.
- F. Secure flexible glass fiber insulation (Type F) to underside of horizontal rectangular or oval ductwork 24" in width or greater and on vertical sides of horizontal and vertical ductwork with weld pin not over 18" on center and within 3" of butt joint or edge.
- G. Fastening insulation anchors to ductwork with adhesives is not allowed. Where weld pin fasteners are used, install them without damage to interior galvanized surface. Where weld pin fasteners cannot be used, use other type of fasteners such as metal bands.
- H. Where insulation is required for ductwork, provide insulation over entire ductwork system, including system components such as filters, mixing air chambers, sound attenuators, air measuring stations, reheat coils, etc. For fire dampers, smoke dampers and combination F/S dampers in ductwork requiring insulation, install insulation and jacket to wall and apply vapor barrier sealant to prevent condensation.
- I. Provide insulation over supply air diffusers, grilles and unlined boots after termination point of flexible ducts or rigid duct insulation to prevent from sweating.
- J. Where vapor barrier jackets are specified, pins and staples if used shall be jacketed over with matching material using 4" tape. Where staples are used for systems requiring vapor barrier, cover lap and staples with finish coat of vapor barrier mastic. Vaporseal insulation seams, punctures, and tears with two 4" wide coats of vapor barrier mastic.
- K. Insulation without factory jacket shall be cut and mitered to suit surface. Build up voids, seams and joints with insulating cement, cover with glass fabric as specified herein and finish to smooth surface.
- L. For other than factory-applied vapor barrier jackets, apply 2 coats of vapor barrier mastic with glass fiber reinforcing fabric, after application of insulating cement. For surfaces not requiring vapor barrier jackets, apply 2 coats of weatherproof breather mastic with glass fiber reinforcing fabric after application of insulation cement. Apply coating in accordance with manufacturer's recommended procedure.
- M. D-2 jackets:
 - 1. Butt together joints and seams firmly and cover with 3" wide FSK tape. Cover FSK tape with 4" minimum width vapor barrier mastic in 2 coats.

END OF SECTION 20 07 00

SECTION 23 05 95 - AIR SYSTEMS TEST ADJUST BALANCE

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 23 33 14 - Ductwork Specialties

1.2 DESCRIPTION

- A. This Contractor shall be responsible for providing complete testing, adjusting and balancing (TAB) work for air systems, such as air handling units, return fans, exhaust fans, air terminal devices, diffusers, grilles and other air moving processes included in this project.
- B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports, as specified herein.
- C. Scope of work includes TAB of new work specified herein and includes all equipment, distribution systems, and terminal units connected.
- D. All existing air systems within scope of demolition/renovation areas shall be rebalanced as necessary to provide new air flows as indicated on drawings. This shall include measurements of existing system air flows prior to demolition and confirmation that air flows to all spaces served by systems being modified are equal to air flows that existed prior to work being started.
- E. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC), National Environmental Balancing Bureau (NEBB), or Testing, Adjusting and Balancing Bureau (TABB). Procedures shall be in accordance with the latest edition of AABC, NEBB or TABB Standards, ASHRAE - 2011 HVAC Application Chapter 38, and as detailed herein.
- F. Mechanical Contractors who are members of AABC or NEBB and who have qualified personnel available to perform work may submit Quality Assurance Submittal for approval. Mechanical Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor who meets these requirements. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor to submit for approval.
- G. Upon direction of Architect/Engineer or TAB subcontractor, Mechanical Contractor shall provide at no additional cost to Owner, any additional work and/or devices necessary to properly balance system, including fan sheaves, motor sheaves and/or drive belts.
- H. TAB work shall not proceed until assigned personnel have been approved by Architect/Engineer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be completed before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Architect/Engineer.

1.3 SUBMITTALS

- A. General:
 - 1. Make submittals in accordance with project submittal procedure. Submit minimum of 5 copies of submittals unless more directed (3 for O&M Manuals, 1 for A/E, 1 for Contractor).
 - 2. Reports shall be assembled using 3-ring hard cover binder with Project Name and location on cover and side panel. All information sheets shall be 8-1/2" x 11" white bond paper. Use preprinted forms of NEBB, AABC or TABB wherever possible. Provide sortable electronic version as well as hard copy. Provide numbered tabs for each system. Assemble report in the following order:

- a. Transmittal letter
 - b. Cover sheet with Project title, location, submittal date, and name and addresses of Owner, Mechanical Contractor, TAB subcontractor, Architect, and Engineer
 - c. Index of numbered tabs listing major systems
 - d. Data organized by system in the following order:
 - 1). Equipment data and measurement summary
 - 2). Equipment measurement data
 - 3). Branch main measurement data
 - 4). Terminal device measurement data arranged by room or zone
- B. Quality Assurance Submittal:
1. Within 30 days of signing contract, Contractor shall submit the following information:
 - a. Firm resume
 - 1). AABC or NEBB active membership certificate
 - 2). Names of 3 recent relevant completed projects along with project address, Owner's contact person, supervising design professional
 - b. Supervisor resume
 - c. Balance technician(s) resume
 2. Architect/Engineer and/or Owner reserves the right to contact previous project representatives and to reject persons whom Architect/Engineer and/or Owner feel are not qualified for this project due to lack of relevant experience or problems on previous projects.
- C. Planning Report:
1. Submit Planning Report as detailed in Part 3 of this Section to demonstrate to Architect/Engineer and Owner that proper procedures are being followed. Planning Report shall be submitted after Quality Assurance submittal and 30 days before any fieldwork starts.
- D. Initial Test Report:
1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to Architect/Engineer and Contractor incomplete work or problem areas to be resolved before final balance is completed.

1.4 REFERENCE STANDARDS

- A. Refer to the latest publications of NEBB, AABC, TABB, ASHRAE, and Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) publications for establishing required procedures.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

- A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB, AABC or TABB Standards and instrument manufacturer's specifications.
- B. Instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by A/E upon request. Calibration and maintenance of instruments to be in accordance with requirements of NEBB, AABC or TABB Standards.

2.2 INSTRUMENT TEST HOLE PLUGS

- A. Center-pull plugs similar to Alliance Plastics CP Series. Plug material shall be Grade 1 virgin polyethylene.

PART 3 - EXECUTION

3.1 GENERAL

- A. TAB work shall be done in separate phases as outlined herein. TAB schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.
- B. Unless otherwise specified, maximum acceptable offset tolerance is plus or minus 10% of the design flow rates as indicated on drawings and/or as scheduled.
- C. For spaces where supply airflow rates and exhaust airflow rates are used to maintain pressure relationships, such as nuclear medicine rooms, maximum acceptable supply air offset shall be 0 to +10% of design flow rate. Associated exhaust air (or return air) flow rate shall be balanced to provide indicated airflow differential between supply air and exhaust air (or return air) after supply air system has been balanced.
- D. For Airborne Infectious Isolation (All) rooms, isolation rooms, Protective Environment (PE) rooms, and other negative and positive pressure rooms provided with pressure differential monitoring devices, TAB contractor shall initially balance rooms to supply air and return/exhaust air offsets indicated on drawings. Space pressure monitors shall be set to alarm as indicated below:

Space Description	Alarm Setpoint (in. w.c.)	Minimum Initial Pressure Differential (in. w.c.)
Negative Pressure Rooms	-0.01	-0.015

- 1. TAB contractor shall confirm and coordinate balance schedule with completion of all partition wall penetrations and door seals prior to completion of balance work.
- 2. During initial balancing to the indicated supply and return/exhaust air offsets, TAB contractor shall record pressure differential as observed at space pressure monitor in TAB reports. Minimum initial pressure differential shall be as indicated in the above table.
- 3. If initial offsets do not meet specified minimum pressure differential, TAB contractor shall incrementally increase (50 CFM) exhaust air flow offset from negative pressure rooms until minimum pressure differential is achieved and record final offset and pressure differential in TAB report.

3.2 PLANNING PHASE

- A. Procedure:
 - 1. Obtain the latest Contract Documents including addenda, applicable construction bulletins and change orders. Obtain shop drawings and performance curves from Mechanical Contractor for fans, flow measuring devices, and all terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.
- B. Planning Report:
 - 1. Planning Report shall contain the following minimum requirements.
 - a. Samples: Provide copies of all forms to be used.
 - b. General narratives: Furnish written narratives of all procedures used. Include separate narratives for each fan and air handling system. Identify flow-measuring devices to be used at

- each fan, air terminal device, and air outlet. Narrative shall include statement that every air outlet shall be measured and adjusted. Provide different narratives for constant and variable flow systems. Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances.
- c. Air system narratives: Provide narratives for each air system which shall include procedures for measuring static pressures at each component of air handling system to generate a static pressure profile. Measurements shall be made to measure performance of system in all operating modes including economizer mode using 100% outside air where applicable. Differentiate between constant and variable flow systems.
 - d. Non-standard air system narratives: Include narratives on how to measure and adjust for different air densities for systems with static pressures greater than 8" WG or temperatures greater than 140°F.
 - e. Air terminal narratives: Narratives shall describe procedures for measuring flows and adjusting controls to meet specified minimum and maximum flow rates based on actual field installed conditions.
 - f. Branch duct and air outlet measurements: Indicate on preprinted forms all measurements to be taken in field. Include branch duct or air outlet identification, system, space served, location, and design flow rates (include zone and system summaries). Indicate duct or air outlet neck size, make, model number, and design velocities.
2. Pre-balance Checklist - to include, but not limited to:
- a. Check for completeness of work
 - b. System cleaning if required
 - c. Check fire, smoke and balancing damper positions
 - d. Place system into normal operation without economizers.
 - e. Install test openings where required.
 - f. Indicate type of test holes to be used and installation procedure.
 - g. Note condition of filters.
 - h. Provide temporary blankoffs to simulate design pressure drops of filters.
 - i. Chisel holes and duct tape are not allowed.
 - j. Wet cooling coils
 - k. Fan wheels, blades, bearings, alignment, starters, vibration isolators, and rotation
 - l. Drive belt tension and alignment
 - m. Setting of automatic dampers to proper position including shutoff and bypass dampers
 - n. For hoods and ovens indicate temperature and humidity. Correct for density changes.
 - o. Set up of controls and control devices
3. Measuring Instrument List - list what measuring instruments will be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:
- a. Manufacturer name and model number
 - b. Measurement range
 - c. Pressure/temperature limits
 - d. Date put into service
 - e. Date of last calibration
 - f. Include certificate from calibration firm
4. Architect/Engineer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument, which has not been recalibrated within past year.

3.3 SET-UP PHASE

- A. Procedure:
 - 1. Perform prebalance checkout as per Planning Phase narrative.
- B. Initial Test:
 - 1. Measure fan data and flows in "as found" condition after initial damper settings are made.
- C. Initial Test Report:
 - 1. Submit report to Architect/Engineer and Mechanical Contractor indicating all measurements made and make notes of all items, which are not complete or are not within design tolerance.

3.4 FINAL BALANCE PHASE

- A. Procedure:
 - 1. Perform all procedures as per Planning Phase narrative. Correct all deficiencies and redo procedures as required before submitting Final Report.
- B. Final Report:
 - 1. Submit report to Architect/Engineer and Mechanical Contractor indicating all data and measurements as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.
- C. Final Report Adjustments:
 - 1. Architect/Engineer reserves the right to check any measurement made and to reject any portion of work not within required tolerance of design flow. TAB Contractor shall resubmit all or portions of Final Report as directed by Architect/Engineer.

END OF SECTION 23 05 95

SECTION 23 31 14 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 20 05 29 - Mechanical Supporting Devices
- B. Section 20 07 00 - Mechanical Systems Insulation
- C. Section 23 05 95 - Air Systems Test Adjust Balance
- D. Section 23 33 14 - Ductwork Specialties

1.2 SUBMITTALS

- A. For each duct system, submit schedule utilizing reinforcement tables from SMACNA HVAC Duct Construction Standards Metal and Flexible where applicable. Each duct system schedule shall include, but not be limited to, the following:
 - 1. Name of Contractor/manufacturer fabricating each duct system
 - 2. Material and gauge
 - 3. Pressure class
 - 4. Transverse joint type and length and reinforcement rigidity class with designated joint T number or proprietary duct connection if utilized for each system
 - 5. Certified test results of proprietary joint products, if used, tested in accordance with SMACNA procedures
 - 6. Intermediate reinforcement spacing and rigidity class with metal angle dimensions and gauge
 - 7. Type of longitudinal seam
 - 8. Fitting construction details
 - 9. Support methods including spacing, upper attachments, and lower attachments
 - 10. Sealant and gasket
 - 11. Sealing class
- B. Duct leakage testing methods, apparatus and apparatus certification signifying meter is in conformance with ASME Requirements for testing meters.
- C. Duct liner including data on thermal conductivity, air friction correction factor, and temperature and velocity limitation.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Protect duct and fittings from damage due to normal handling during shipment and storage. Protection shall be applied to ends of duct to prevent dirt and moisture from entering ducts and fittings.

1.4 DESCRIPTION

- A. Furnish and erect ductwork free of objectionable vibration, chatter, and pulsations. Verify dimensions at site, making field measurements and drawings necessary for fabrication and erection.
- B. Duct sizes indicated are net inside dimensions.

- C. Where size for a duct segment is not indicated, the duct segment size shall be equal to the largest duct segment to which it is connected. Transition to smaller size shall occur on side of fitting where smaller size is indicated.

1.5 DESIGN CRITERIA

- A. All products shall conform to NFPA 90A, and shall possess flame spread rating of not over 25 and smoke developed rating no higher than 50.
- B. Unless otherwise indicated, construct all ductwork of galvanized sheet metal for pressure class not less than 2" WG for positive pressure ductwork and not less than -2" WG for negative pressure ductwork.
- C. Ductwork shall comply with Local, State and Federal requirements.
- D. Unless otherwise indicated, pressure class for VAV system supply ductwork between supply fan discharge and air terminal device inlet shall be equal to static pressure at fan discharge but not less than 4" WG; pressure class for ductwork on suction side of air handling unit and suction side of return fan shall be equal to static pressure at inlet of return fan but not less than -2" WG.
- E. Unless otherwise indicated, pressure class for constant air volume system ductwork shall be equal to external static pressure (fan entrance or discharge pressure minus associated unit internal component pressure drop), but not less than ± 2 " WG.
- F. Duct transverse joints and reinforcement material, including angle ring flanges and stiffeners, shall be of same material as duct.
- G. Except as modified in this Section of specifications or on drawings, use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications:
 - 1. HVAC Duct Construction Standards Metal and Flexible, 3rd Edition, 2005, for rectangular and round ductwork up to positive 10" WG and negative 10" WG and flat oval ductwork up to positive 10" WG.
 - a. Tie rods shall be 1/2" or 3/4", galvanized steel EMT/conduits with bolt assembly consisting of rubber washer and friction anchored threaded insert similar to Ductmate Easyrod or PPI Condu-Lock.
 - b. Internal tie rods are not allowed for welded ductwork and special exhaust systems, such as fume hood exhaust, BSC exhaust, animal room exhaust, BSL-3 exhaust, cagewash exhaust, shower room exhaust, kitchen hood exhaust, dishwasher exhaust, etc.

PART 2 - PRODUCTS

2.1 GALVANIZED STEEL SHEET

- A. Lock Former Quality (LFQ), cold rolled, open hearth soft steel sheet capable of double seaming without fracture, ASTM A924/A924M or ASTM A653/A653M. Galvanized coating shall be G90.
- B. Use G90 Galvaneal or Zincgrip where painting is specified.

2.2 FLEXIBLE DUCT

- A. Manufacturers: Thermaflex, or Flexmaster
- B. Factory fabricated, UL listed under UL-181 as Class 1 duct, meeting requirements of NFPA 90A with flame spread of 25 or less and smoke developed rating of 50 or under.
- C. Flexible duct shall have minimum ratings as follows:
 - 1. Operating Temperature: -20°F to 250°F
 - 2. Internal Working Pressure: Positive: 6" WG

Negative: 1" WG

- 3. Burst Pressure: 2-1/2 times working pressure
- 4. Velocity: 5000 fpm
- D. Unless otherwise indicated, duct shall be nonmetallic insulated type composed of polyester film, polyethylene film, nylon film, CPE film, or coated woven fiberglass liner bonded permanently to corrosion resistant coated steel wire helix without adhesive.
- E. Insulation shall be flexible fiberglass insulation with minimum R-value of 6 at mean temperature of 75°F. Vapor barrier jacket shall be aluminum foil reinforced, polyethylene, or metalized polyester film with minimum perm rating of 0.05 permper ASTM.
- F. Insulation material shall not be exposed to air stream.
- G. Lined flexible duct shall have the following minimum acoustical performance in accordance with ARI Standard 885. Dynamic Insertion Loss in each octave band of 5 ft. or 10 ft. straight duct shall not be less than the following:

<u>Duct Diameter (in)</u>	<u>Dynamic Insertion Loss (dB)</u>					
	<u>Octave Band Center Frequency (Hz)</u>					
	<u>(Based on 5 ft. length)</u>					
	<u>125</u>	<u>250</u>	<u>500</u>	<u>1000</u>	<u>2000</u>	<u>4000</u>
6"	6	9	18	22	24	15
8"	6	10	18	20	21	12
10"	5	11	18	18	18	9

2.3 DUCT SEALANTS AND GASKETS

- A. Sealant:
 - 1. Flexible, water based, adhesive sealant compounded specifically for sealing joints and seams in ductwork. Hardcast, McGill AirSeal, Ductmate PROseal, Mon-Eco Industries, Childers, DP1010 or H.B. Fuller/Foster.
 - 2. Sealants shall be UL 723 listed, conform to ASTM E84, and meet NFPA 90A and 90B.
 - 3. Sealants shall comply with requirements for LEED IEQ 4.1.
 - 4. Select sealants as recommended by manufacturer for specific application.
 - 5. Submit sealant manufacturer's data sheets including performance data, pressure ratings, surface burning characteristics data, VOC compliance with LEED IEQ 4.1, detailed installation instructions.
 - 6. Duct tapes are not allowed.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install ductwork parallel to building walls and ceilings and at such heights not to obstruct any portion of ceiling, window, doorway, stairway, or passageway. Install ductwork to allow adequate access and service space for equipment. Refer to drawings and/or manufacturer's recommendations. Install vertical ductwork plumb. Where interferences develop in field, offset or reroute ductwork as required to clear such interferences. In all cases, consult drawings for exact location of duct spaces, ceiling heights, door and window openings or other architectural details before installing ductwork.

- B. Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Check plans showing work of other trades and consult with Engineer in event of interference. Transform, divide, or offset ducts as required, in such a manner as to maintain same cross-sectional area of duct as indicated on drawings. Where it is necessary to install pipes or similar obstructions through ducts, consult with Engineer and obtain written approval from Engineer and Owner. If approved, provide streamlined encasement or collar designed in accordance with SMACNA Standards and seal to prevent air leakage.
- C. Ductwork shall be free of kinks and dents.
- D. Fabricate and install duct, fittings, joints, seams, reinforcement, supports, sealing, liner, etc., in sizes indicated on drawings and in accordance with manufacturer's published data and SMACNA Standards except as modified in this section of specifications or on drawings.
- E. Provide transitions where different size or different shape ductwork segments are connected. Use concentric transitions unless otherwise shown. Unless otherwise indicated, make diverging transitions with maximum angle of 15° per side (30° total diverging) and converging transitions with maximum angle of 25° per side (50° total converging).
- F. Provide transitions at ductwork system components and connections to equipment. Refer to Specification Section 23 37 13 – Diffusers, Registers, and Grilles, for additional information regarding diffuser/register/grille connections.
- G. Refer to ductwork symbols list on drawings for additional and dimensional requirements for fittings.
- H. Seal duct seams and joints to meet SMACNA Class A as minimum for all ductwork including low-pressure ductwork.
- I. Construct ductwork so that interior surfaces are smooth. Internal duct hangers and internal bracing are not allowed. Refer to Part 1, Design Criteria for internal tie rods.
- J. Support coils, filters, air terminals, dampers, sound attenuator devices or other devices installed in duct systems with angles or channels, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets, nuts, bolts and washers.
- K. Air terminal devices may be supported by strap hangers if air terminal manufacturer approves. Strap hangers are not allowed for fan powered devices, double wall type and Titus Steri-Loc type devices.
- L. Where 2 different metal ducts meet, install joint in such a manner that metal ducts do not contact each other by using proper gasket seal or compound.
- M. Do not install ductwork over electrical panelboards, switchgear, switchboards or motor control centers.
- N. When original galvanized finish is altered or damaged, apply field galvanizing paint as follows:
 - 1. Prepare surface with use of power sanders or wire brushes to remove rust, paint, etc.
 - 2. Apply cold galvanizing material equal to ZRC Products, Inc.

3.2 ELBOWS

- A. Rectangular Duct:
 - 1. Unless specific type is indicated, use radius elbows with minimum centerline radius to width or diameter ratio of 1.5. Where 1.5 radius elbows do not fit, use the following elbows.
 - a. Supply Air Ductwork:
 - 1). 1.0 radius elbows
 - 2). Square throat elbows with turning vanes where 1.0 radius elbows do not fit
 - b. Return or Exhaust Air Ductwork:

- 1). 1.0 radius elbows with full splitter vanes (SMACNA Type RE3) as follows:
 - a). One vane for duct width 24" to 48"
 - b). Two vanes for duct width 49" to 72"
 - c). Three vanes for duct width 73" and larger
 - d). Fabricate vanes in accordance with SMACNA HVAC Duct Construction Standard, Chart 4-1 (p 4.11) and Figure 4-9 (p 4.13).
- 2). 45° throat with radius heel elbows with full splitter vanes as follows where 1.0 radius elbows do not fit:
 - a). One vane for duct width 12" to 24"
 - b). Two vanes for duct width 25" to 36"
 - c). Three vanes for duct width 36" and larger
 - d). Fabricate vanes in accordance with SMACNA HVAC Duct Construction Standards, Chart 4-1 and Figure 4-9.
- 3). Square throat - radius heel elbows or square throat elbows with turning vanes are not allowed unless specifically indicated.

B. Round and Oval Duct:

1. Unless specific type is indicated, use radius elbows with centerline radius to diameter ratio of 1.5 regardless of duct velocity. Where 1.5 radius elbows do not fit, use 1.0 radius elbows.

3.3 LONGITUDINAL SEAM

A. Rectangular Duct:

1. Unless otherwise indicated, use Pittsburgh lock seam.
2. Seal longitudinal seams with approved sealant or pre-sealed with encapsulated mastic.
3. Button punch snap lock construction (SMACNA L-2) may be used for ductwork that is both 2" WG (+ or -) and lower, and 36" and smaller in width or height. For ductwork over 24" in width or height, add screw 4" from each end.
4. Button punch snap lock construction is not allowed for ductwork in chases and areas above inaccessible ceiling.
5. Button punch snap lock construction is not allowed on aluminum ductwork.

B. Round and Oval Duct:

1. Unless otherwise indicated, longitudinal seams shall be in accordance with SMACNA HVAC Duct Construction Standards with the following exceptions.
 - a. SMACNA seam types RL-3, 6A, 6B, 7 and 8 shown in Figure 3-2 are not allowed.

3.4 TRANSVERSE JOINT

A. Rectangular Duct:

1. Transverse joints shall be in accordance with SMACNA HVAC Duct Construction Standards.
2. Ductmate 25/35 connection systems with corner clips or optional nuts and bolts may be used. Incorporate use of all Ductmate accessories to ensure integrity of transverse connection. Install joints in strict accordance with the latest edition of Ductmate 25/35 Assembly and Installation Instruction Manual and Duct Construction Standards. Nexus or WDCI will be acceptable.
3. Lockformers TDC or Engles TDF may be used in accordance with T-25 flanges of SMACNA HVAC Duct Construction Standards Metal and Flexible, 2005, provided that corner pieces with bolts are used. If TDF/TDC flanges are damaged, replace the damaged joint(s) by straightening and reinforcing with minimum 1-1/2" x 1-1/2" x 1/4" angle at each side of transverse joint.

3.5 DUCT SUPPORTS

- A. Unless otherwise indicated, use straps or Z bar hangers with 3/8" rods to support rectangular ducts 60" wide and smaller and trapeze hangers with rods or angles to support rectangular ducts over 60" wide.
 - 1. Use trapeze hangers to support externally insulated ductwork with weight bearing inserts. Refer to Section 20 07 00 – Mechanical Systems Insulation and details.
- B. For round ducts 24" diameter or smaller, use single hanger.
 - 1. Cable Suspension System may be used up to 16" diameter at spaces higher than 8 ft. above floor or platform.
 - 2. Round Duct Strap Bracket by Ductmate Industries may be used up to 24" diameter.
- C. Refer to Section 20 07 00 - Mechanical Systems Insulation for ductwork insulation, weight bearing inserts and insulation protection shield requirements.
- D. Support flexible duct at manufacturer's recommended intervals but at least every 5 ft. Maximum sag shall be 0.5" per ft. between supports. Hanger or saddle material in contact with flexible duct shall be minimum 0.5" wide.
- E. The following upper attachments, upper attachment devices, lower hanger attachments, hanger devices, and/or hanger attachments are not allowed except where specifically indicated:
 - 1. Hook or loop
 - 2. Nailed pin fasteners
 - 3. Expansion nails without washers
 - 4. Powder actuated fasteners (forced entry anchors). Forced entry anchors may be used for upper attachments of flexible ductwork supports.
 - 5. Beam or "C" clamps without retaining clips or friction clamps (provide retaining clips for "C" clamps)
 - 6. Friction clamps for ductwork over 12"
 - 7. Non-factory manufactured upper attachments for metal pan deck including wire coil and double circle (Items 16 and 17 of Fig 5-4 of SMACNA HVAC Duct Construction Standards 2005)
 - 8. Wire hanger
 - 9. Trapeze hangers supported by wires or straps
 - 10. Rods, straps or welded studs directly attached to metal deck
 - 11. Drilled hole with attachment to structural steel
 - 12. Lag screw expansion anchor
 - 13. Rivets
 - 14. Non-metallic hangers or straps
- F. Supporting devices shall be standard products of manufacturers having published load ratings.
- G. Refer to Section 20 05 29 - Mechanical Supporting Devices for additional support requirements including attachments to structures.
- H. Unless Architectural Documents indicate the required framing, provide angle iron framing around roof opening where duct penetrates through roof decking, to maintain roof decking structural integrity in accordance with roof decking manufacturer's recommendations. This is not required for concrete decking. For concrete decking, consult with the project structural engineer for location and size of opening prior to execution of Work.

3.6 PROTECTION OF DUCTWORK

- A. Protect ductwork during construction against entry of foreign matter and construction dirt.

- B. Keep ductwork capped when work is complete for the day or when duct is not being worked on or added to. Use of polyvinyl (VISQUEEN) with duct tape wrap is an adequate measure as long as it is secure with no openings or tears in product.
- C. If ductwork is not protected, remove dirt and foreign matter from the duct system and obtain inspection and approval from Engineer upon completion of cleaning before operating fans.
- D. Provide MERV 8 construction filters at each return air ductwork opening during construction.

3.7 CLEANING OF EXISTING DUCTWORK

- A. Source Removal Cleaning Methods: HVAC system shall be cleaned using Source Removal mechanical methods designed to extract containments from within HVAC system and safely remove contaminants from facility. It shall be contractor's responsibility to select Source Removal methods that will render HVAC system visibly clean and capable of passing cleaning verification methods (See applicable NADCA Standards @ www.nadca.com) and other specified test in accordance with all general requirements. No cleaning method, or combination of methods, shall be used which could potentially damage components of HVAC system or negatively alter integrity of system.
 - 1. Methods used shall incorporate use of vacuum collection devices that are operated continuously during cleaning. Vacuum device shall be connected to downstream end of section being cleaned through predetermined opening. Vacuum collection device shall be sufficient power to render areas being cleaned under negative pressure, such that containment of debris and protection of indoor environment are assured.
 - 2. Vacuum devices exhausting air inside building shall be equipped with HEPA Filters, including handheld vacuums.
 - 3. Vacuum devices exhausting air outside building shall exhaust in a manner that will not allow containments to re-enter facility. Release of debris outdoors shall not violate any outdoor Environmental Standards, Codes or Regulations.
 - 4. Methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods will include those which will not potentially damage integrity of ductwork, nor damage porous surface materials such as liners inside ductwork or system components. The bid does not include repair of damaged acoustical insulation. If acoustical insulation is damaged, foreman shall inform appropriate personnel. A meeting will be held at that time to discuss options for repair or replacement of acoustical insulation.
 - 5. Provide access doors required for duct cleaning.

3.8 LOW PRESSURE DUCT CONSTRUCTION (PRESSURE CLASS 2" WG AND UNDER)

- A. Use welds, rivets or nuts, and bolts for fabricating ductwork. Fully threaded sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if screw does not extend more than 1/2" into duct. Sheet metal "TEK" screws 3/4" in length may be used as fasteners in conjunction with factory made transverse joints.
- B. Unless otherwise indicated, construct branch take-off fittings as follows:
 - 1. For branch take-offs including branch ducts serving more than one diffuser or grille, use 45° entry fittings. For supply air ducts, expanded or conical taps may be used.
 - 2. For take-offs serving single diffuser, register or grille, use straight spin-in collars with manual balancing dampers.
- C. Splitter dampers and/or extractors are not allowed.

3.9 FLEXIBLE DUCT

- A. Install flexible ducts in accordance with manufacturer's installation instructions and SMACNA Standards, except as modified in this Section of Specifications.
- B. In supply air systems without air terminal devices, flexible ducts may be used for final connections to diffusers, grilles, and registers. Flexible ducts shall be of minimum length required to make connections, but shall not be greater than 6 ft. in length, unless noted otherwise.
- C. Centerline radius of bends shall not be less than one duct diameters. FlexFlow Elbow supports by Thermaflex or similar products shall be used at diffuser/grille connection to assure full radius elbow.
- D. Support flexible ductwork with min 1-1/2" wide saddle at a maximum of 5 ft. on center and at elbow, with no portion lying on ceiling supporting system.
- E. Individual sections of flexible ductwork shall be of one-piece construction. Splicing of short sections is not allowed.
- F. Connect flexible duct liner to collars with draw bands. If collars have beads, position draw bands behind beads.
- G. Pull insulation and vapor barrier jacket over liner connection and secure with draw band. For terminations at externally insulated ductwork, fittings, grilles, diffusers, etc., secure flexible duct jacket to ductwork insulation jacket with compatible vapor barrier tape.
- H. Flexible ducts are not allowed above non-accessible ceilings.
- I. Flexible ducts are not allowed to pass through any partition, wall, floor or ceiling.

END OF SECTION 23 31 14

SECTION 23 33 14 - DUCTWORK SPECIALTIES

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 23 05 95 - Air Systems Test Adjust Balance

1.2 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Capacities
 - 3. Temperature/pressure ratings
 - 4. Materials of construction
 - 5. Dimensions
 - 6. Manufacturer's installation instructions and/or detailed drawings
 - 7. All other appropriate data

1.3 DESIGN CRITERIA

- A. Products and materials shall conform to NFPA Section 90A, possessing flame spread rating of not over 25 and smoke developed rating no higher than 50.
- B. Ductwork specialties exposed to air stream, such as dampers, turning vanes and access doors, shall be of same material as duct or unit at where the specialties are mounted, unless otherwise noted.
- C. Unless otherwise noted, ductwork specialties shall be designed and constructed for pressure class of ductwork in which they are installed.

PART 2 - PRODUCTS

2.1 MANUAL BALANCING DAMPERS

- A. Manufacturers: Ruskin, Greenheck, Vent Products, Pottorff or Air Balance, constructed in accordance with SMACNA HVAC Duct Construction Standards, except as modified below.
- B. Rectangular Dampers:
 - 1. For low pressure ductwork, for damper blade height up to 12", use single blade type with minimum 22 ga galvanized steel blade with minimum 3/8" rod for blade width up to 18", and with minimum 18 ga galvanized steel blade with minimum 1/2" continuous rod for blade width from 19" to 48". For damper blade height more than 12", use multiple blade type with minimum 16 ga galvanized steel channel frames, opposed blade linkage operation, with blades minimum 16 ga and 6" to 8" maximum blade width, minimum 1/2" continuous rod and 1/2" x 1/2" galvanized steel angle blade stops. Bearings shall be nylon or molded synthetic. Construct dampers over 48" in width or height in multiple sections with mullions.
- C. Single Blade Round Dampers:
 - 1. For low pressure ductwork, damper shall have blade 24 ga, but no less than two gauges more than duct gauge. Rod shall be minimum 3/8" diameter or square continuous. Bearings shall be nylon or molded synthetic.

- D. Provide damper operators with locking devices and damper position indicators. Sheet metal screws are not allowed in construction or installation of dampers. Use rivets or tack welds.
- E. Dampers shall be properly stiffened and fabricated to prevent vibration, flutter or other noise.
- F. Extend damper shafts through duct insulation or use elevated regulators for externally insulated ducts to accommodate specified insulation thickness.

2.2 TURNING VANES

- A. Construct turning vanes in accordance with SMACNA HVAC Duct Construction Standards.
- B. Square Throat Elbow Turning Vanes (Vane Runner Length up to 18" and Vane Length up to 36"):
 - 1. Use single thickness vanes having 2" radius and 1-1/2" spacing, 24 ga minimum. Construct vanes in accordance with SMACNA HVAC Duct Construction Standards.
- C. Square Throat Elbow Turning Vanes (Vane Runner Length over 18" or Vane Length over 36"):
 - 1. Use double thickness vanes having 4.5" radius and 3.25" spacing, 24 ga minimum.
- D. Radius Elbow Splitter Vanes:
 - 1. Splitter vanes for radius elbows shall be extended entire length of fitting and constructed in accordance with SMACNA HVAC Duct Construction Standards.

2.3 ACCESS DOORS

- A. Access doors shall be rectangular, minimum 22 ga frame and minimum 24 ga door, fit air tight with neoprene gasket and shall be suitable for duct pressure class. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners are not acceptable.
- B. Low Pressure Ducts (Pressure Class 2" and Under):
 - 1. Doors shall be hinged type with sash lock for exposed application and non-hinged type with cam latches for concealed application.
 - 2. Access doors constructed in accordance with SMACNA HVAC Duct Construction Standard (Figure 7-2) or similar to Ruskin Model ADC or ADH will be acceptable.
 - 3. Sandwich style access doors made by Ductmate, Ward Industries, Greenheck, or Flexmaster are acceptable, provided that they meet insulation requirements.

PART 3 - EXECUTION

3.1 MANUAL BALANCING DAMPERS

- A. Install manual balancing dampers in supply, return and exhaust branch ducts, as shown on drawings and as required to regulate airflow to meet air balance requirements.
- B. Install manual balancing damper in branch duct to each diffuser and grille. Install dampers as close as possible to take-offs.
- C. Install balancing dampers so as not to flutter or vibrate and as far as possible upstream from the air outlet.

3.2 TURNING VANES

- A. Install turning vanes as shown on drawings and for rectangular square throat elbows unless otherwise indicated. Install turning vanes in accordance with SMACNA Standards and/or manufacturer's recommendations.
- B. Turning vanes are not required in transfer air ducts.
- C. Install turning vanes so that they are tangent to airflow direction.

3.3 ACCESS DOORS

- A. Install access doors where specified, indicated on drawings, and in locations where maintenance, service, cleaning or inspection is required, including automatic dampers, fire dampers, smoke dampers, smoke detectors, fan bearings, heating and cooling coils, reheat coils, humidifiers, filters, bird/insect screens, valves and control devices within duct or casing, at outside air intake duct and at inlet side of turning vanes in return ductwork.
- B. Locate access doors for greatest ease of access.
- C. Size and quantity of duct access doors shall be sufficient to perform intended service, but not less than the following:

<u>Rectangular Duct Size</u>	<u>Minimum Access Door Quantity and Size</u>
14" and smaller	(1) 8" x 8"
12" to 15" and smaller	(1) 12" x 10"
16" to 21"	(1) 18" x 14"
22" to 27"	(1) 18" x 18"
28" to 47"	(1) 24" x 24"
48" to 96"	(2) 24" x 24"

<u>Round Duct Size</u>	<u>Minimum Access Door Size</u>
10" and smaller	8" x 4"
15" and smaller	12" x 8"
29" and smaller	16" x 12"
30" and over	24" x 18"

- D. Increase duct size to accommodate access door size indicated above where required.

END OF SECTION – 23 33 14

SECTION 23 37 13 – DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the Documents
 - 3. Capacities/ratings
 - 4. Materials of construction
 - 5. Sound ratings
 - 6. Dimensions
 - 7. Finish
 - 8. Color selection charts where applicable
 - 9. Manufacturer's installation instructions
 - 10. All other appropriate data

1.2 DESIGN CRITERIA

- A. Performance data shall be based on tests conducted in accordance with ASHRAE Standard 70-2006.
- B. Screw holes on surface shall be counter sunk to accept recessed type screws.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Titus, Price, Nailor, or Krueger
- B. Acceptable manufacturers for specialty products are listed under each item.

2.2 CEILING DIFFUSERS

- A. Diffusers shall be aluminum or steel as scheduled, unless otherwise indicated, and furnished with frame type appropriate to installation. Furnish diffusers with equalizing grids where it is not possible to maintain minimum 2 times duct diameter straight duct into diffuser. Equalizing grids shall consist of individually adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.
- B. Diffuser models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless noted otherwise, diffusers shall have baked enamel or powder coat finish with color selected by Architect.
- C. Perforated face ceiling diffusers shall have minimum 51% free face area and pattern controllers accessible through removable or hinged faceplate. Unless otherwise indicated, pattern controllers shall be curved vane type mounted in neck of diffuser. Unless otherwise indicated, furnish diffusers with round neck inlets with minimum 1" depth.

2.3 REGISTERS AND GRILLES

- A. Registers and grilles shall be aluminum or steel as scheduled unless otherwise indicated, and furnished with frame type appropriate to installation.

- B. Supply registers and grilles shall be double deflection type blades to provide for air deflection adjustment in all directions.
- C. Return and exhaust registers and grilles shall have fixed blade core.
- D. Registers shall be furnished complete with opposed blade volume control dampers, operable from face.
- E. Register and grille models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless noted otherwise, registers and grilles shall have baked enamel finish with color selected by Architect.

2.4 OPERATING ROOM CEILING DIFFUSERS

- A. Diffusers shall be unidirectional flow (laminar flow) type and constructed of
- B. Diffusers shall have integral internal baffle for even distribution air over entire perforated diffuser face.
- C. Diffusers shall have integral volume dampers accessible and adjustable through diffuser face.
- D. Diffusers shall be similar to Titus Model TLF.

2.5 HEPA CEILING DIFFUSERS

- A. Units shall be Flanders Pureflo CH-22, Envirco DCM, Price LFDC or Camfil RFM.
- B. Housing shall be anodized aluminum continuously welded or sealed airtight and include offset knife edge for interface with gel seal filter to eliminate bypass leakage. Knife edge shall be integral part of housing frame to minimize potential leak paths. Fasteners and hardware shall be 304 stainless steel.
- C. Casings shall be factory sealed and tested for leaks.
- D. Damper shall be integral, heavy duty butterfly assembly with air diffusion disk for even airflow across entire filter face. Furnish damper with remote operator accessible from room side of filter.
- E. HEPA Filters shall be 4" deep, listed or classified under UL 900 Test Standard, Class 1, and accessible from room side.
- F. UL 900 is standard. UL 586 is required for Nuclear Grade HEPA Filters. Provide static pressure port.
- G. Provide aluminum foil-backed external casing insulation.
- H. Filters shall be individually tested and certified to be 99.97% minimum efficient with handling 0.3-micron particles in accordance with DOP test method. DOP efficiency, along with filter serial number and manufacturer, to be marked on filter.
- I. Unless otherwise scheduled, all units shall be 24" x 48" with surface mount or T-bar mount as scheduled.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install grilles, registers and diffusers as shown on drawings and according to manufacturer's instructions.
- B. Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar sizes.

- C. Seal connections between ductwork drops and diffusers/registers/grilles air tight.
- D. Support independently diffusers and grilles designed for T-bar mounting that exceed weight limit of ceiling suspension system in which they are to be installed.
- E. Blank off unused portion of linear diffusers and grilles.
- F. Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.
- G. Protect diffusers, registers and grilles from construction dirt. Clean or replace those soiled or stained prior to turnover to Client.

END OF SECTION 23 73 13

SECTION 23 41 14 - FILTERS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the Documents
 - 3. Capacities/ratings; cfm, area, face velocity
 - 4. Efficiencies and initial/final pressure drop
 - 5. Materials of construction
 - 6. Dimensions
 - 7. Filter gauges data
 - 8. Manufacturer's installation instructions
 - 9. All other appropriate data

1.2 DELIVERY, STORAGE AND HANDLING

- A. Ship filters in original package to prevent damage or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer's recommendations. Provide protective coverings during construction.

1.3 DESIGN CRITERIA

- A. Filters shall have UL 900 Listing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. American Air Filter, Camfil/Farr, Flanders Precisionaire, Glasfloss, Airguard or Filtration Group unless otherwise noted under individual filter.

2.2 HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTERS

- A. Filters shall be high capacity type. Clean filter pressure drop shall not exceed 1.35" WG based on 500 fpm face velocity.
- B. Filter size, capacity, and static pressure drop shall be as scheduled.
- C. Filters shall be individually tested and certified shall be 99.97% minimum efficient with handling 0.3-micron particles in accordance with DOP test method. DOP efficiency along with filter serial number and name of manufacturer shall be marked on filter.
- D. Each filter element shall consist of glass fiber media, fire retardant epoxy or self-extinguishing neoprene rubber sealer and neoprene gasket all contained in suitable protected steel frame. Each filter element shall be constructed by self-supporting pleating continuous sheet of formed, corrugated medium. Mount filters in side access housing or holding frames specified elsewhere in this section.
- E. Filters shall be listed or classified under UL 586 test standard.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install filters as shown on drawings and according to manufacturer's instructions.
- B. Provide supports as required and necessary clearance for changing filters.
- C. Provide structural supports, outside casing and blank-off materials for all field assembled filter banks, and filter banks where housings are not furnished by filter manufacturer.

END OF SECTION 23 41 14