

## SECTION 15815 – SHEET METAL WORK AND ACCESSORIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 WORK INCLUDED

- A. Furnish and install a complete system of air distribution, including accessories, to all areas indicated on the contractor drawings.
- B. Create, coordinate and submit ¼" scale Coordination Drawing in accordance with Section 15050.
- C. Provide all ductwork, fittings and accessories to make a complete and operational system in all respects.

#### 1.3 RELATED SECTIONS

- A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

#### 1.4 REFERENCES

- A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.
- B. Material standards shall be as specified or detailed hereinafter and as follows:
  - 1. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
  - 2. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Carbon, Cold Rolled, Commercial Quality.
  - 3. ASTM A 1011/A 1011M – Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.
  - 4. ASTM A 653/A 653M – Standard Specification for Steel Sheets, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.

5. ASTM A 666 – Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
6. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
7. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
8. ASTM C 443 – Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
9. ASTM C 443M – Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric).
10. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
11. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems.
12. NFPA 96 – Installation of Equipment for the Removal of Smoke and Grease-laden Vapors from Commercial Cooking Equipment.
13. SMACNA (LEAK) – HVAC Air Duct Leakage Test Manual.
14. SMACNA (DCS) – HVAC Duct Construction Standards – Metal and Flexible.
15. UL 181 – Factory-Made Air Ducts and Connectors.

## 1.5 SUBMITTALS

- A. See Section 15050 and General Conditions for Additional Requirements.
- B. Product Data: Provide data for duct materials, duct connectors and all accessories. Include sound attenuator test data in accordance with ASTM E477.
- C. The Sheet Metal Contractor shall submit duct fabrication standards and methods of installation, in compliance with SMACNA and these specifications, for review and approval by the Architect, clearly indicating the combination of metal gauges and reinforcement intended for use for each pressure classification. Duct fabrication shall not be allowed until a satisfactory review of this Standard has been performed and fabrication drawings have been reviewed and coordinated. **MERELY SUBMITTING COPIES OF THE SMACNA PRESSURE CLASS TABLES DOES NOT COMPLY WITH THIS REQUIREMENT.**
- D. Provide scaled ductwork fabrication drawings. Fabrication drawings shall be double line and as a minimum include elevations, dimensions, sizes, all offsets rises and drops, air distribution devices.
- E. Provide scaled ductwork coordination drawings for all floors and systems in accordance with Section 15050, Submittals.
- F. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA– HVAC Air Duct Leakage Test Manual.
- G. Manufacturer’s Installation Instructions: Indicate special procedures for glass fiber ducts.
- H. Manufacturer’s Certificate: Certify that installation of glass fiber ductwork meet or exceed recommended fabrication and installation requirements.

- I. Project Record Documents: Record actual locations of ducts, duct fittings and all accessories. Record changes in fitting location and type. Show additional fittings used.

## 1.6 QUALITY ASSURANCE

- A. All ducts and fittings shall be manufactured by a sheet metal fabrication company whose primary business experience is the manufacture of commercial and industrial quality ducts and fittings. Sheet Metal Contractor shall have adequate experience of building ductwork of the types required for this project as well as successful experience with projects of similar scope. Bids from sheet metal shops which do not meet the specified requirements shall not be acceptable.
- B. **No Ductmate, Ward, Nixon or similar factory made slip-on connections will be permitted.**

## 1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not install duct sealants when temperature are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

## 1.8 DELIVERY, STORAGE AND HANDLING

- A. Cleanliness
  - 1. The intent of this Section is to ensure the Owner that the ductwork is manufactured, shipped, stored, field connected and started-up while maintaining a high degree of cleanliness. Ductwork interior shall be fully cleaned prior to start-up by the Contractor. Ductwork open ends shall be shrink wrapped with a minimum of 10 mil plastic to protect the sections during shipping and while in storage.

## PART 2 - PRODUCTS

### 2.1 SHEET METAL WORK

- A. General
  - 1. Acceptable Manufacturers (Provided they are in compliance with these specifications)
    - a. Sheet Metal

- 1) All ducts and fittings shall be manufactured by a sheet metal fabrication company whose primary business experience is the manufacture of commercial and industrial quality ducts and fittings. Sheet Metal Contractor shall have adequate experience of building ductwork of the types required for this project as well as successful experience with projects of similar scope. Bids from sheet metal shops which do not meet the specified requirements shall not be acceptable.

b. Sheet Metal Accessories

- 1) Access Doors
  - a) Ruskin
  - b) Air Balance
  - c) Buckley Associates
  - d) Ductmate
- 2) Flexible Connectors
  - a) Ventlock
  - b) Elgen Manufacturing
  - c) Duro Dyne
  - d) Ventglass
- 3) Flexible Ductwork
  - a) Clevepak Corp.
  - b) Flexible Technologies
  - c) Unaflex Rubber Corp.
  - d) Flexmaster
- 4) Fire Dampers
  - a) Ruskin
  - b) Prefco
  - c) Air Balance
  - d) Greenheck Fan Corp.
  - e) Nailor Industries
  - f) NCA Manufacturing Inc.
- 5) Fire/Smoke Dampers
  - a) Ruskin
  - b) Prefco
  - c) Air Balance
  - d) Greenheck Fan Corp.
  - e) Nailor Industries

- 6) Smoke Dampers
  - a) Ruskin
  - b) Prefco
  - c) Air Balance
  - d) Greenheck Fan Corp.
  - e) Nailor Industries
  
- 7) Automatic Dampers Airfoil
  - a) Ruskin
  - b) Greenheck Fan Corp.
  - c) Nailor Industries
  - d) T.A. Morrison & Co. Inc. (TAMCO)
  - e) NCA Manufacturing Inc.
  
- 8) Balancing Dampers (OBD)
  - a) Ruskin
  - b) Young Regulator
  - c) Prefco
  - d) Greenheck Fan Corp.
  - e) Nailor Industries
  - f) NCA Manufacturing Inc.
  
- 9) Small Balancing Damper less than 48x12
  - a) Ruskin
  - b) Young Regulator
  - c) Ventlock
  - d) Duro Dyne
  
- 2. Unless otherwise noted, all supply, return and exhaust air ductwork of all types shall be constructed of galvanized sheet metal based on the "Pressure Class" indicated in the "Minimum SMACNA Construction Standards" table found hereinafter.
- 3. The drawings are diagrammatic and indicate the arrangements of the principal apparatus, ductwork and piping and shall be followed as closely as possible. Because of the scale of the drawings, it is not possible to show all offsets, rises, drops, rises, fittings, accessories, etc. The Contractor shall carefully investigate the structure, finish conditions, and the work of other trades affecting the work and arrange ductwork, piping, equipment, accessories, etc. accordingly. Provide the best possible arrangement so as to provide the maximum headroom and access to apparatus while providing the minimum resistance to airflow. This work and any extra fittings and offsets required shall be included in the project without extra charge.

4. In addition to sheet metal ductwork provided under this Contract furnish and/or install accessories and devices furnished by others, including but not limited to smoke detectors. Provide and install miscellaneous sheet metal work including safing, mixing baffles, and blank off panels at unused louver areas.
5. All duct systems specified to be installed under this Contract, shall conform to the drawings, specifications, Standards, details and recommendations of the latest Edition of SMACNA "HVAC Duct Construction Standards - Metal and Flexible"; and "Round and Industrial Duct Construction Standards" (hereinafter referred to as Duct Manual). Where the requirements under this Section exceed the requirements of the Duct Manual, the specification shall govern. Wherever the word "should" appears, replace with the word "shall".
6. The Sheet Metal Contractor shall submit duct fabrication standards and methods of installation, in compliance with SMACNA and these specifications, for review and approval by the Architect, clearly indicating the combination of metal gauges and reinforcement intended for use for each pressure classification. Duct fabrication shall not be allowed until a satisfactory review of this Standard has been performed. MERELY SUBMITTING COPIES OF THE SMACNA PRESSURE CLASS TABLES DOES NOT COMPLY WITH THIS REQUIREMENT.
7. All galvanized steel sheet metal shall conform to ASTM A653/A653M (G-90) having not less than 1.25 oz. of zinc on each side of each square foot of sheet. All other duct materials shall be as hereinafter specified as applicable to this Contract.
8. The Sheet Metal Contractor shall install all duct mounted smoke detectors.
9. The Sheet Metal Contractor shall furnish and install all plenums with automatic or manual dampers attached to louvers.
10. The Sheet Metal Contractor shall fabricate and install all canopy hoods, flexible "elephant trunk" exhaust outlets as detailed or noted in the Construction Documents.
11. The Sheet Metal Contractor shall furnish and install exhaust ductwork from emergency generator outlet to exhaust louver including transitions, drains, access doors, flexible connections and baffles to isolate intake from exhaust.
12. There will be no supply and/or return air system ductwork internally lined unless otherwise noted.
13. The Sheet Metal Contractor shall clean and provide temporary caps on all ductwork during installation to prevent dust, dirt and debris from entering ducts during construction, including during shipping, handling and storage in the field.
14. All shop applied fabrication labels shall be applied to the exterior of the ducts. The Sheet Metal Contractor shall remove any material applied to the inside of the ducts before installation.
15. All inline fans shall have companion flanges intake and discharge for removal for servicing.
16. Seal all joints to VAV/VCV/SAV/EV in the field, including reheat coils and sound attenuators.

## 2.2 DUCT CONSTRUCTION

### A. Duct Construction Schedule

Minimum SMACNA Construction Standards						
Ductwork Location	Pressure Class Inches W.G.	Seal Class	Leakage Class	Material	Sound Lining	Table Notes
Supply from Air Handling units to vertical shafts, within vertical shafts and 4'-0" beyond the shafts on each floor	±6	A	4	G-90	No	
Supply on-floors from 4 ft. beyond shafts to terminal units	±4	A	4	G-90	No	
Supply from terminal boxes to outlets	±2	A	4	G-90	No	
Return from Air Handling units to vertical shafts, within vertical shafts and 4'-0" beyond the shafts on each floor	-6	A	4	G-90	No	
Return on-floor from 4 ft. beyond shafts to terminal units	-4	A	4	G-90	No	
Return from outlets to terminal boxes	-2	A	4	G-90	No	2
Return to Air Handling units constant volume systems	-4	A	4	G-90	No	
Supply from Air Handling units constant volume systems	±4	A	4	G-90	No	
Shower exhausts, MRI room emergency exhaust	-3	A	4	Aluminum	No	5
Exhaust from a radioactive process, decay storage, cyclotron exhaust	±6	A Welded	0.5	316 S.S.	No	5
Autoclave exhaust	-4	A	1.5	316 S/S	No	3, 5
Glass washer, cartwasher, dishwasher, sterilizer	-3	A Welded	4	304 S/S	No	3, 5
Toilet exhaust	-3	A	4	G-90	No	2
Soiled docks exhaust, autopsy, isolation room exhaust, anesthesia, general lab exhaust, general central sterile exhaust, med gas storage room, convenience pantry exhaust	-3	A	4	G-90	No	2, 5
General exhaust	-3	A	4	G-90	No	2
Within 30'-0" of each side of exhaust fan (suction & discharge)	±3	A	4	G-90	Yes	2
Kitchen exhaust	-6 Industrial Class 3	A Welded	0.5	Black Steel	No	3, 5

Minimum SMACNA Construction Standards						
Ductwork Location	Pressure Class Inches W.G.	Seal Class	Leakage Class	Material	Sound Lining	Table Notes
Kitchen exhaust exposed	-6 Industrial Class 3	A Welded	0.5	304 S.S.	No	3, 5
Boiler breeching	-4 Industrial Class 3	A Welded	0.5	Black Steel	No	3
Hood exhaust, bench slots, biohazard exhaust, alcohol storage, pathology, grossing room exhaust	-6	A Welded	0.5	304 S.S.	No	5
Dust collection (carpentry shop)	-6 Industrial Class 2	A	1	G-90	No	
Outside air & relief air ductwork	±4	A	4	Same as Ducts	As In- dictated	2
Outside air, relief & exhaust plenums	±4	A	4	Modular Double Wall Panels	Perforated Inner Metal Panel	4
Other	±3	A	4	G-90	No	2
Table Notes						
1 Not Used.						
2 Ductwork in the following locations shall be constructed of aluminum or stainless steel and continuously welded (Joints & Seams) and pitched back to the outlets. · Within 20'-0" of a shower area exhaust. · Within 20'-0" downstream and 5'-0" upstream of a duct humidifier. · Within 20'-0" of a sterilizer area exhaust. · Within 15'-0" of an outside air intake. · Within 20'-0" of a cartwasher exhaust. · Within 20'-0" of a locker room and within room (exhaust). · Within 20'-0" of a locker room and within room (supply).						
3 Pitch horizontal duct back to hood equipment where exhaust originates.						
4 Plenums shall be constructed of 4" thick double-wall, insulated modular plenum panels.						
5 Sound lining shall not be provided at exhaust fans serving wet exhausts, isolation exhaust, radioactive exhaust, Kitchen hood exhaust or biohazard exhaust.						

## 2.3 ADDITIONAL CONSTRUCTION REQUIREMENTS

### A. Minimum Requirements

1. The minimum gauge for any steel duct over 2" or under -2" pressure class shall be 24 gauge except when specified heavier.
2. The minimum gauge for black steel kitchen exhaust ductwork shall be 16 gauge.
3. The minimum gauge for stainless steel kitchen exhaust ductwork shall be 18 gauge.
4. The minimum thickness of any aluminum duct shall be 0.040".



5. The minimum gauge for 304 stainless steel ductwork shall be 22 gauge except when specified heavier.
  6. The minimum gauge for 316 stainless steel ductwork shall be 16 gauge.
  7. The minimum diameter of any tie rod shall be 1/2".
  8. The maximum tie rod spacing shall be 42" unless specifically engineered in accordance with the SMACNA Industrial Rectangular Duct Standard.
  9. When tie rods intersect, they shall be welded to each other.
  10. No ductwork shall be constructed to less than  $\pm 2$ " w.g. This means nothing is constructed to a standard between  $-2$ " w.g. and  $+2$ " w.g.
  11. **Duct dimensions indicated are clear inside dimensions. The sheet metal dimensions shall be increased to accommodate internal liner where liner is required.**
- B. All joints and seams in all ductwork and casings shall be sealed to SMACNA Seal Class "A". In finished areas, sealing compound shall be neatly applied to exposed ductwork and bands shall be provided over, to cover the sealant.
1. Some SMACNA constructions may not be suitable for the leakage classes specified even though they may meet the pressure class and should not be used.
  2. Seal class A Welded means all welded (i.e. transverse joints, longitudinal seams, spiral seams, fire dampers, volume dampers or any accessories) and in addition it means continuously welded.
  3. All sealants, adhesives and coatings shall be of approved kinds and qualities for each point of application, complying with recommendations for the use and storage.
  4. The method of installation and materials for sealing the ductwork shall be submitted by the Sheet Metal Contractor for review and approval by the Architect, as part of the ductwork construction standards and installation submittal.
- C. All longitudinal seams in all ductwork in excess of  $+2$ " w.g. or less than  $-2$ " w.g pressure class shall be made with formed Pittsburgh locks.
- D. Grooved seam/flat lock/pipe lock joining methods is restricted to 2" W.G. pressure class only.
- E. Button punch-snap lock seams are not to be used.
- F. Concealed stainless steel ductwork shall have an ASTM mill rolled No. 1 or No. 2 D finish. Exposed stainless steel ductwork shall have an ASTM mill rolled No. 2 B finish, or higher grade as required by the Architect, with all welds ground smooth and final brushed with stainless steel wire brushes. All welds on exposed stainless steel ductwork shall be free of stain, burn-through, or discoloration to the satisfaction of the Architect.
- G. Tie rods shall not be used in any plenum or large duct requiring internal access or use as an access pathway.
- H. All ductwork required to be removable shall be companion flanged SMACNA Type T-22 for ductwork constructed to SMACNA Metal Duct Standard and companion flanged in accordance with Industrial Standards for ductwork required to be constructed to Industrial Standards.

I. Elbows

1. All dust collection ductwork elbows shall be a centerline radius equal to (2) duct widths or diameters. No reduction shall be allowed.
2. Radius elbows shall be used wherever possible. Where it is impossible or impractical to install a 1.5 times width to centerline radius of elbow (full radius elbow) lesser radii configurations shall be used, each with "radius-proportional" splitter vanes permanently installed within. No radius shall be less than 1.0 times the width. Provide square elbows in rectangular ducts with double thickness vanes with a minimum radius of 4 1/2". Square elbows may only be used when radius elbows will not fit and where specifically approved by the Architect prior to fabrication and/or as required by coordination shop drawings. All offsets shall be of the radius type.

J. Auxiliary drain pans.

1. Provide 1 1/2" deep auxiliary drain pans under any units with cooling coils located above hung ceilings.
2. Pans shall be 6" larger than equipment in all directions.
3. This includes but not limited to all fan coil units.
4. Drains shall be piped to floor drains or utility sinks.

K. Ducts Exposed to Weather

1. For all ducts exposed to weather, after all ducts and joints are sealed and tested as specified herein, apply all over and around the same areas of possible leakage (joints), an approved sealer system, so that ductwork outside the building shall be installed in a manner to result in less than 0.5 leakage class.
2. Exposed ductwork shall be insulated and weather-protected by the Insulation Contractor after the installation is completed and tested.

L. Provide baffles and/or diffusion plates as required in all air handling units, to ensure proper air mixing, coil velocities and air distribution across filters or coils as determined in the field by the Architect, at no additional cost to the Owner.

M. It is the intent of this specification to provide a duct system with minimum resistance to airflow. All take-offs shall be throated and transitions made as gradually as possible. "Bullhead" or sharp take-offs shall not be acceptable.

N. In addition to SMACNA requirements, ductwork in return systems without boxes, ductwork in supply systems without boxes, ductwork in exhaust systems without boxes, ductwork in any Constant Volume System and/or ductwork downstream of VAV Boxes shall be provided with:

1. Volume dampers in all branch takeoffs and in all main branches and ducts of all ductwork systems (supply, return and exhaust) for properly regulating and balancing airflow to all terminal outlets, for all duct sizes, whether shown on the drawings or not.  
**The above requirement is mandatory.**

- O. All rectangular dampers shall be opposed blade and each shall be controlled by an approved galvanized locking quadrant indicating the damper position, as detailed on the drawings.
1. Volume dampers installed into ductwork that is specified to be externally insulated shall have extended activator/handle rods with extension bracket such that adjustment of the damper handle will not disturb the insulation.
- P. Submit the sheet metal shop drawings to the Balancing Contractor of the project for his review and placement of dampers with the final balancing procedures and requirements in mind.
1. Coordinate the location and areas with the Balancing Contractor, and fabricate the ductwork system accordingly.
  2. Provide any and all balancing dampers required by the balancing contractor at no additional cost.
- Q. In addition to SMACNA requirements, all round ductwork, if used in lieu of rectangular supply and/or return/exhaust systems shall conform to SMACNA.
1. The use of flat oval ductwork shall be acceptable only with prior written approval of the Architect. **Note:** Flat oval shall not be used under negative pressure.
  2. Round duct shall be manufactured of spiral lock seam. Ductwork up to 12"Ø and 2" w.g. pressure class can be manufactured with longitudinal lock seams.
  3. All tees shall be conical.
  4. All laterals shall be straight.
  5. All taps through 10" diameter in size shall have a machine drawn entrance and all fittings shall have longitudinal seams, continuous-welded. Both sides of all welds shall be primed with zinc chromate.
  6. All tap entrances shall be free of weld build-up.
  7. Elbows in diameters 3" through 10" shall be 2-section stamped or pleated elbows. Larger elbows shall be gored construction. Elbows shall be fabricated to a centerline radius of 1.5 times the diameter. All gored elbows shall be fabricated according to the following schedule:
- | <u>Elbows</u> | <u># of Gores</u> |
|---------------|-------------------|
| Up to 35°     | 2                 |
| 36° to 71°    | 3                 |
| Over 71°      | 5                 |
8. All field joints in diameters through 48" shall be made with a 2" long slip-fit or sleeve coupling provided assembly is not hindered. Ductwork over 48", and for all sizes where disassembly and removal is required, shall be joined with Vanstone or shop fabricated flanges.
  9. All flanges and taps into spiral ducts shall be factory or shop fabricated and installed as hereinbefore specified. Shipment of loose flanges or taps for field installation shall be avoided.
  10. All access doors for round duct shall be furnished by the access door manufacturer. Round duct access doors shall be of low leakage sandwich type suitable for systems up to 8" pressure, positive or negative. Round duct access doors shall be insulated and shall be equivalent to Ruskin model ARDD.

11. Unless specifically noted otherwise or required by special constraints, all elbows on ductwork changing direction from vertical to horizontal shall be 1.5 times radius.

## 2.4 SPECIAL EXHAUST SYSTEMS

- A. Canopy hoods shall be fabricated of 18 gauge welded 304 stainless steel with No. 2B finish. Canopy hoods shall have all welds ground and polished with stainless steel wire brushes. Welds shall be free of stains, burns or discoloration. Transition to the duct connection shall be a maximum angle of 45°. Duct work shall extend down to mounting height of hood.

## 2.5 QUIET-FLOW MODULAR PLENUM PANELS

- A. Panel wall shall be mounted on a level concrete curb.
- B. Panels shall be 4" thick with interior and exterior solid panel sheets of 18 gauge galvanized steel.
- C. Insulating sound retarding fill shall be incombustible, inert, mildew resistant and verminproof. Insulation shall completely fill inside panel dimension. No voids will be tolerated.
- D. Internal panel reinforcement shall be minimum 18 gauge galvanized steel and spaced so that span does not exceed 2'-0". Perimeter and internal reinforcement end panel sheets shall be welded and riveted to form a rugged metal sheathed acoustical panel. Spot welds shall not exceed 3" on centers.
- E. Door panels shall be constructed of solid 18 gauge galvanized metal sides. Doors shall be supplied 2'-0" wide by 5'-0" high. The doors shall be 4 inch thick of the overlapping seal type. Each door shall be supplied with single continuous air/acoustic seals around the sill, jambs and head. Doors shall have (2) hinges and (2) latches with an inside release handle. Each door shall be assembled with hinge hardware attached and adjusted, and latches to be installed in field. Door latches are to be the wedge lever type with inside handle. Hinges shall be heavy duty and designed for door size and weight. Doors shall be installed to open against the air pressure.
  1. All plenums shall include access doors.
- F. Roof channels, aprons and corner joiners shall be made of 16 gauge galvanized steel formed to prevent a direct path for sound and/or air leakage. Floor channels shall be made of 18 gauge galvanized steel. Panel joiners shall be made of 20 gauge galvanized steel and shall be roll formed to be greater in strength than standard 16 gauge shall be provided. All panel accessories shall be furnished in standard lengths to be field cut to required dimensions. Floor channels shall be pre-punched with 9/32" holes spaced 24" on centers for attachment by 1/4" round head screws with expansion type inserts. All panel joiners and connectors requiring felted surfaces shall have the felt field applied.

- G. Openings for fan and duct connections, where required, shall be provided by the plenum manufacturer. Pipe and conduit penetrations shall be located and cut in the field and sealed in accordance with the manufacturer's instructions.
- H. The plenum structure shall be self-supporting.
- I. Metal surfaces shall be galvanized.
- J. The minimum allowable transmission loss (TL) of the panel, including all components, when tested in accordance with ASTM E90-61T shall be as follows:

<u>Octave Band Center Frequency (Hz)</u>	<u>Transmission Loss</u>	<u>Octave Band Center Frequency (Hz)</u>	<u>Transmission Loss</u>
63	26	1000	51
125	23	2000	59
250	30	4000	58
500	42	8000	58

- K. Panels shall have a maximum heat transfer factor of 0.07 btu/hour/sq.ft./°F temperature difference of standard air.
- L. Plenum installation shall be capable of withstanding a positive or negative internal static air pressure of ±4" w.g.
- M. Plenum design shall meet the combustion requirements established by ASTM E-84. The panels shall not exceed the following limits:
  - 1. Flamespread Classification: 15
  - 2. Smoke Developed: 0
  - 3. Fuel Contributed: 0
- N. Plenum manufacturer shall warrant that when plenums are installed in a workmanlike manner in strict accordance with these specification and manufacturer's instructions, plenums shall meet the acoustical, thermal and air pressure performance specified.

## 2.6 ACCESS DOORS

- A. Provide access doors and frames in all supply, exhaust and return ductwork as required, to permit access to:
  - 1. Both sides of automatic dampers
  - 2. In-box heating coils
  - 3. Fire dampers, smoke dampers
  - 4. Both sides of in-duct coils
  - 5. All plenums
  - 6. In-duct humidifiers

- a. Provide sight doors
  - 7. Other similar equipment
  - 8. Fan Bearings enclosed in ducts.
  - 9. Duct smoke Detectors
    - a. Provide sight doors
  - 10. For cleaning and inspection purposes
  - 11. Where indicated on the drawings
- B. Door construction
- 1. Door size
    - a. Ductwork
      - 1) Minimum 20" x 16"
      - 2) In ducts smaller than 16" they shall be 20" x 2" less than duct width except:
        - a) Terminal Box heating coil door may be 12" x 6"
    - b. Plenums
      - 1) Shall be 20" x 56"
        - a) 18" x 45" door may be used only when 20" x 56" will not fit.
      - 2) Larger door shall be provided if required for equipment removal. Coordinate with equipment.
  - 2. Doors shall match material type and gauge of the duct system in which they are installed.
  - 3. Minimum gauge shall be 22.
  - 4. Provide a neoprene gasketed around their entire perimeter.
  - 5. Where sight doors are required, a wire reinforced safety glass shall be utilized.
  - 6. Insulated or lined ductwork shall have insulated door
  - 7. Insulated plenums shall have insulated door
  - 8. Insulated doors shall be double wall.
  - 9. Insulation between the metal panels shall be of the same thickness as the duct or panel adjacent to the access doors.
  - 10. All access doors shall be hung on heavy hinges and shall be secured in the closed position by means of cast zinc clinching type cam latches
  - 11. Hinged doors shall be similar to Greenheck model HAD-10.
  - 12. Where space conditions preclude hinges, a minimum of (2) cams shall be utilized in low pressure ductwork and a minimum of (4) heavy window type latches shall be utilized in ductwork over 2" pressure class. In all cases where hinged doors are not utilized, a safety retainer chain shall be provided.
  - 13. Cammed doors shall be equivalent to Greenheck model CAD-10.

14. All fire damper access doors in all positive pressure supply ductwork of +3" w.g. or greater construction:
  - a. Shall be of the pressure relief (negative pressure) spring loaded type. Design shall incorporate self-closing spring latch or be complete with secure retainer chain and "D" handle.
  - b. These doors shall be mounted downstream (after shutoff) of fire dampers, fire/smoke dampers or smoke dampers or similar automatic shutting devices.
  - c. These doors shall be of the automatic reset type and similar to Ruskin model ADHP-3.
  
15. Kitchen exhaust.
  - a. Access/cleanout doors in kitchen exhaust ductwork shall be bolted, gasketed, smoke and grease tight.
  - b. Fabrication shall conform to NFPA 96, International Mechanical code and local code in all respects.
  - c. The door shall be hinged or chained to the ductwork.

## 2.7 FLEXIBLE CONNECTIONS (AHUS, EMERGENCY GENERATORS, FANS)

- A. Provide flexible connections of 4" minimum fabric width
  1. Between ductwork and the inlets and outlets of all fans **except**:
    - a. Hazardous exhausts
    - b. Lab exhaust fans located indoors.
  2. Equipment equipped with fans
  3. All ductwork that crosses building expansion joints
- B. The connections shall be placed as close to the equipment as practical except at fan suction connections and the clear gap at rest shall be not less than 3". At fan suction connections, locate flexible duct connection at least 3 duct diameters away from fan inlet connection.
- C. There shall be no tension of the fabric under static or dynamic loads
- D. All fabric for flexible duct connections to equipment shall be a minimum of 22 oz. glass fabric, double coated with Hypalon, fire retardant, waterproof, airtight, and approved by UL, similar to Ventfabrics or Ventglass.
- E. Exterior flexible connection shall be insulated type similar to Duro Dyne.
- F. Flexible connections shall be fabricated from approved flameproofed fabric conforming to NFPA 90A. Asbestos shall not be acceptable.

- G. Flexible connections shall be installed further upstream from fan powered equipment (in the main duct size) to prevent obstruction of the fan inlet due to suction of the fabric into the airstream.
- H. Ductwork shall be increased in size where the flexible connections are located to prevent fully drawn in connections from blocking any duct area. Submit detail for review.

## 2.8 BLANK OFF PANELS FOR UNUSED LOUVER AREAS

- A. Provide minimum 20 gauge sheet metal blank off panels for all unused louver areas:
  - 1. All louver areas not enjoined or connected to an active plenum.
- B. Exterior/visible face of blank off panel shall be cleaned and painted flat black, prior to installation.
- C. Panels shall be screwed to louver frames and caulked to provide a weathertight seal.
- D. Provide insulation of blank off panels. See specification Section 15081 - Ductwork insulation.

## 2.9 FLEXIBLE DUCTWORK

- A. General
  - 1. Flexible duct runs must not exceed 5'-0" in length. Flexible duct shall not exceed a maximum of 1/2" sag per linear foot when installed horizontally.
  - 2. Flexible ductwork shall be supported at a maximum spacing of 2'-6", and as detailed on the drawings. Ductwork must not be compressed. Duct elbows must not exceed 45°.
- B. Flexible Duct (Rigid)
  - 1. Flexible duct shall be similar to Flexmaster Triple Lock Buck Duct Flexible Air Duct. Flexible duct (insulated) shall be UL 181, Class 0 listed air duct and constructed in accordance with NFPA 90A and 90B. It shall have a smoke/flame spread rating of 50/25.
  - 2. Triple Lock Buck Duct shall be made from a tape of dead soft aluminum sheet, spiral wound into a tube and spiral corrugated to provide strength and stability. The joint shall consist of a triple lock that is mechanically performed without the use of adhesives to make a durable airtight seam. A double lock is not acceptable.
  - 3. Insulated flex shall have a gray fire retardant polyethylene outer jacket with an 8 oz. density, 1 1/2" thick fiberglass insulation blanket, factory wrapped.
  - 4. The flexible duct shall be supported as required.
  - 5. Flexible ductwork shall be rated at 12" positive pressure. Duct from 3" to 16" shall have a negative pressure 12" and duct from 18" to 20" shall have a negative pressure of 8".
  - 6. All flexible duct shall be individually cartoned and labeled for delivery to the job site for maximum protection.
  - 7. Provide:



- a. Where indicated in construction greater than +2" or less than -2",
- b. Upstream of supply boxes
- c. Downstream or upstream of exhaust boxes when allowed.

C. Flexible Duct (Fabric)

1. Flexible duct shall be similar to Flexmaster Type 2. Flexible duct (insulated) shall be UL 181, Class 1 listed air duct and constructed in accordance with NFPA 90A and 90B. It shall have a smoke/flame spread rating of 50/25.
2. Duct fabric shall be of a heavy duty coated fiberglass cloth fabric. The fabric material shall be mechanically locked to the outside helix. (Use of adhesives to lock fabric in place is unacceptable.) The helix is constructed of a corrosive resistant galvanized steel, formed and mechanically locked to the duct fabric on the outside to prevent tearing of the flexible duct.
3. Insulated flex shall have a gray fire retardant polyethylene outer jacket with an 8 oz. density, 1 1/2" thick fiberglass insulation blanket, factory wrapped.
4. The flexible duct shall be supported as required to prevent sagging. Flexible duct with excessive sagging will not be approved.
5. Flexible ductwork shall be rated at 12" positive pressure and 10" negative pressure. Negative pressure for 14"R and 16"R shall be 5" and negative pressure for 18"R shall be 1".
6. All flexible ducts shall be individually cartoned and labeled for delivery to the job site for maximum protection.
7. Provide:
  - a. Where indicated in ±2" duct construction except exhaust.
  - b. Downstream of supply boxes

2.10 DAMPERS

A. General

1. The minimum damper requirements shall be as indicated in the following table:

<b>Damper Construction Table</b>						
<b>Type</b>	<b>Approach Velocity (FPM)</b>	<b>Pressure Rating</b>	<b>Instantaneous Pressure Rating</b>	<b>UL555S Leakage Class</b>	<b>Blade Type</b>	<b>Listing</b>
Fire dampers in ducts greater than +2" w.g. or less than -2" w.g. (FD)	2000	4" w.g.	10" w.g.	N/A	OBD 3V	UL555 Dynamic
Other fire dampers (FD)	2,000	4" w.g.	8" w.g.	N/A	Curtain or OBD	UL555 Dynamic
Fire smoke dampers in ducts greater than +2" w.g. or less than -2" w.g. and at all shafts (FSD)	3,000	4" w.g.	14" w.g.	I	Air Foil	UL555, UL555S Dynamic

Damper Construction Table						
Type	Approach Velocity (FPM)	Pressure Rating	Instantaneous Pressure Rating	UL555S Leakage Class	Blade Type	Listing
Other fire smoke dampers (FSD or HFD)	2,000	4" w.g.	8" w.g.	I	OBD 3V	UL555, UL555S Dynamic
Smoke dampers (SD)	3,000	4" w.g.	14" w.g.	I	Air Foil	UL555S Dynamic
Isolation dampers (at units)	4,500	8" w.g.	20" w.g.	I	Air Foil	
Automatic dampers (AD)	4,500	6" w.g.	14" w.g.	I	Air Foil	N/A
Balancing dampers in ducts wider than 48" and/or deeper than 12" (VD or as specified)	2,500	4" w.g.	N/A	N/A	OBD	N/A
Balancing damper in ducts less than 48" by 12" (VD or as specified)	2,500	2"	N/A	N/A	OBD	N/A
Smoke control damper (SCD)	3,000	4"	8"		OBD	UL555S Dynamic

2. Dampers in stainless steel ducts shall be stainless steel.

**B. Automatic Dampers**

1. The Contractor shall furnish and install dampers, except those specified to be supplied by equipment manufacturers. All dampers shall be of low leakage design qualified to UL 555S Leakage Class I (maximum leakage of 4 cfm/sq.ft. at 1" w.g. and 8 cfm/sq.ft. at 4" w.g.). Dampers shall be sized so the frame is outside of the air stream. The Contractor shall review all documents, including the ATC scope work and matrix to identify all damper requirements.
2. Automatic dampers shall be multiple opposed blade. All blank off plates and conversions necessary to install smaller or larger than duct size damper shall be the responsibility of the Contractor. Prior to shop drawings and fabrication, the Contractor must coordinate the largest damper size with the actuator selection by the ATC Contractor.
3. All damper frames shall be constructed of a minimum of 13 gauge galvanized sheet metal and shall have flanges for duct mounting. All multiple damper sections must have jackshafts.
4. Damper blades shall not exceed 6" in width. All blades shall be of corrugated type construction, fabricated from (2) sheets of minimum 22 gauge galvanized sheet steel, spot welded together.
5. All damper bearings shall be made of nylon. Bushings that turn in bearings shall be oil impregnated sintered metal.
6. Replaceable butyl rubber seals shall be provided with the damper. Seals shall be installed along the top, bottom and sides of the frame and along each blade edge. Seals shall provide a tight closing, low leakage damper.

C. Fire Dampers, Ceiling Radiation Dampers, Smoke Dampers, and Combination Smoke/Fire Dampers

1. Fire dampers, smoke dampers and combination smoke/fire dampers shall be provided as shown on the drawings and wherever Architectural drawings indicate fire and/or smoke rated partitions. Devices shall be of the appropriate service for the partition class into which they are installed. Exact requirements and type of partition shall be coordinated with the Architect.
2. All dampers shall meet the requirements of NFPA 90A and further shall be tested, rated and labeled in accordance with UL 555 (6<sup>th</sup> Edition), UL555S (4<sup>th</sup> Edition) and UL555C (1<sup>st</sup> Edition).
3. All dampers shall be tested, rated and labeled as "Dynamic Rated" for closure against airflow in the following configuration:
  - a. Vertical mount (horizontal airflow):
    - Ducted and unducted.
  - b. Horizontal mount (airflow up):
    - Ducted and unducted.
  - c. Horizontal mount (airflow down):
    - Ducted and unducted.

**Note:** Static rated dampers shall not be allowed.

4. Each damper shall be rated to close against maximum design airflow at its installed location, with 400 fpm and .5 in wg. safety factors and against 4" w.g. maximum pressure across the closed damper.
5. All dampers of all ratings and types shall be of the nominal 100% face area type, with blade package and all frame components out of the airstream. These dampers shall include the required oversize enclosures which shall be sealed by the damper manufacturer for the appropriate duct pressure class into which they are installed. All such dampers shall have appropriate rectangular, flat oval or round duct collars to facilitate connection of mating ductwork. The Contractor shall be responsible for any additional sealing of duct collars and connections required to maintain the duct seal class requirements but shall not jeopardize the UL breakaway connection when utilized.
6. The Contractor shall indicate the location and rating of all dampers on his shop drawings and shall provide access doors at each location of sufficient size and type to permit access to the damper components. A list of fire dampers shall be provided for review. The Contractor shall be solely responsible to coordinate all locations of duct access doors and dampers of all types.
7. Contractor shall include damper manufacturer's installation instructions as part of the damper submittal. These instructions shall describe the applicable requirements for damper sleeve thickness; retaining angles; sealing; duct-to-sleeve connections; preparation of wall, floor or ceiling openings; and all other requirements to provide an installation equivalent to that tested by the damper manufacturer during the UL 555, UL555S and UL555C qualification procedures. Contractor shall detail any proposed installations that deviate from these manufacturer's instructions and explain the needed deviations. All fire, smoke and ceiling radiation damper installations shall comply with

the manufacturer's installation instructions. Any submitted deviations must be acceptable to the appropriate authority having jurisdiction.

8. Fire Dampers

- a. Fire dampers shall be provided as shown on the drawings and wherever Architectural drawings indicate fire-rated partitions to the following schedule:

<b>Partition Assembly Fire Rating</b>	<b>Penetration Type</b>	<b>Damper Rating</b>
1 Hour	Ducted and Sprinklered	No damper; duct sleeved and packed only
1 Hour	Ducted and Non- Sprinklered	1.5 Hour
1 Hour	Open (Transfer)	1.5 Hour
1.5 to 2 Hours	Ducted or Open	1.5 Hour
3 Hour	Ducted *	3.0 Hour
4 Hour	Ducted *	3.0 Hour
*No open transfer will be permitted through these partitions.		

- b. Fire damper sleeves shall be manufactured with a metal sleeve of appropriate length and thickness for the required damper installation as shown in the table below:

<u>Maximum Duct I.D.</u>	<u>Sleeve Gauge (U.S.)</u>
Up to 84"	20 gauge
85" & Up	18 gauge

- c. Fusible link temperature rating for all fire dampers shall be 212°F or 50°F above the highest system temperature, whichever is greater.  
d. Dampers in stainless steel ducts shall be stainless steel.  
e. Dampers located in welded systems shall be rigidly connected with welded connections (not breakaway).

9. Smoke Dampers and Combination Fire/Smoke Dampers

- a. Smoke dampers and combination fire/smoke dampers shall be provided as shown on the drawings and wherever architectural drawings indicate smoke/fire rated partitions. Combination fire/smoke dampers shall be dynamically rated for 1.5 or 3 hours as determined by the Architect.  
b. Smoke dampers and combination fire/smoke dampers and actuators shall meet the requirements of NFPA 92A and NFPA 92B and further shall be tested, rated and labeled as a "Leakage Rated Damper for Use in Smoke Control Systems" in accordance with the 4th edition of UL 555S. All smoke dampers shall be of low leakage design qualified to UL 555S Leakage Class I (maximum leakage of 4 cfm/sq.ft. at 1" w.g. and 8 cfm/sq.ft. at 4" w.g.) and shall have a UL 555S elevated temperature rating of 350°F.

- 1) Each smoke damper/actuator combination shall be UL 555S rated to operate at maximum design airflow at its installed location with 400 fpm and .5 in wg. safety factors.
- c. Each smoke damper and combination fire/smoke damper shall be supplied with an appropriate damper actuator installed by the damper manufacturer at the time of damper fabrication. Combination fire/smoke dampers shall be manufactured with a metal sleeve of appropriate length and thickness for the required damper installation, and the damper actuator shall be installed on the sleeve exterior. Smoke dampers may be installed in ductwork up to 24" from wall with no openings between the wall and the smoke damper.
- 1) Damper actuators shall be electric type for 120 volt operation.
  - 2) Power wiring, including interlocking to smoke detectors and fire alarm system, and panels to affect the sequence of operation shall be by the Electrical Contractor.
  - 3) Dampers shall be fail closed as follows:
    - a) Power to Damper: Open
    - b) No Power to Damper: Closed
- d. Damper frame shall be galvanized steel formed into a structural hat channel shape with reinforced corners. The smoke and combination fire/smoke damper blades shall be airfoil type with Class 1 leakage rating. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Blade edge seals shall be silicone rubber designed to withstand 450°F (232°C) and jamb seals shall be stainless steel flexible metal compression type.
- e. Each damper shall be equipped with a remote open or closed position indication switch. The switch shall be over the shaft type using two independent rotary cams and adjustable switch points indicating open and closed positions. Switch can be factory or field applied to manufacturer's damper.
- 1) These switches shall be furnished by the damper manufacturer and wired by the Electrical Contractor, in a location approved by the Architect.
  - 2) Spare contacts shall be provided for additional remote (fire panel) operation.
- f. Each combination fire/smoke damper shall also be equipped with a temperature limited re-openable feature equivalent to Greenheck model TOR providing the following operational sequence:
- 1) Temperature at damper fusible device reaches 165°F or 50°F above highest system temperature, whichever is greatest, and primary heat sensing device closes damper. Remote or local override command panel can then re-open damper.
  - 2) If temperature at damper fusible device reaches 250°F, secondary heat sensing device will close the damper. Override and re-opening above this secondary temperature is not permitted. Both primary and secondary heat

responsive devices shall incorporate a manual reset feature allowing restoration of normal operation after fire emergency has been cleared.

- g. If utilizing system operation for smoke control purposes during the early phase of a fire emergency, each combination fire/smoke damper shall be equipped with a 286°F primary fusible device and 350°F minimum rated damper actuator. .
- h. Dampers in stainless steel ducts shall be stainless steel.
- i. Dampers located in welded systems shall be rigidly connected with welded connections (not breakaway).

Device	Furnished By	Installed By	Actuator By	Actuator Type	End Switches	Control Air	Control Wires	Power	UL Assembly
Automatic Damper (AD)	ATC	HVAC	ATC	Electric	ATC	ATC	N/A	ATC	No
Automatic Damper (AD) (When noted to be electric)	ATC	HVAC	ATC	Electric	ATC	N/A	ATC	ATC	No
Fire Smoke Damper (FSD)	HVAC	HVAC	Damper Manufacturer	Electric	ATC	N/A	ATC	Div 16	Yes
Smoke Damper (SD)	HVAC	HVAC	Damper Manufacturer	Electric	Damper Manufacturer	N/A	ATC	Div 16	Yes
Smoke Isolation Damper (SD)	HVAC	HVAC	Damper Manufacturer	Electric	Damper Manufacturer	N/A	ATC	Div 16	Yes
Fire Damper (FD)	HVAC	HVAC	N/A	N/A	N/A	N/A	N/A	N/A	Yes
Smoke Control Damper (SCD)	HVAC	HVAC	Damper Manufacturer	Electric	N/A	N/A	ATC	Div 16	Yes

- 10. Smoke Control Dampers shall be the same as specified for smoke dampers only without end switches and alarm.

**PART 3 - EXECUTION**

**3.1 SHEET METAL INSTALLATION**

- A. All ductwork shall be installed to true alignment, generally parallel or perpendicular to adjacent building walls, floors and ceilings, so as to present a neat and workmanlike appearance. All fabricated, stored and installed ductwork shall be protected with removable caps, plastic or other means to prevent dirt, water and debris from entering duct system. The Sheet Metal Contractor shall be responsible for maintaining a clean duct system and shall clean and/or replace any ductwork identified by the Owner or Architect as being deficient or dirty. The Sheet Metal Contractor shall be responsible for all costs associated with the temporary protection cleaning and/or replacement of ductwork. All fabrication labels shall be applied to the exterior of the duct. The Sheet Metal Contractor shall be responsible for the removal of all internal labels if such labels were incorrectly applied.
- B. Care shall be paid to the exact locations of all sheet metal work with respect to equipment, ducts, conduits, piping, slabs, beams, columns, ceiling suspension systems, lighting fixtures and electrical, plumbing and fire protection systems in the building. Close coordination and

cooperation shall be exercised with other Trades in locating the piping and equipment in the best interests of the Owner. The drawings and specifications covering other work to be done in the building shall be carefully studied and arrangements shall be made to avoid conflict.

- C. The drawings shall be followed where they are definite and provided such procedures do not cause objectionable conditions for equipment provided installed under this Contract. The drawings are intended to indicate the sizes of ductwork and if certain sizes are omitted or unclear, obtain additional information before proceeding.
- D. Locate and size all openings for ductwork in the building construction. Provide all sleeves as hereinbefore specified.
- E. Provide access doors in ductwork at the following locations:
  - 1. Both sides of all coils
  - 2. Fire dampers
  - 3. Smoke dampers
  - 4. Fire/Smoke dampers
  - 5. Both sides of automatic dampers
  - 6. Humidifiers
  - 7. Both sides of filters
  - 8. At a maximum of 20'-0" and at every change in direction in kitchen exhaust system and/or as required by code.
  - 9. At all exhaust and intake plenums, doors shall allow full body access in all plenums over 4'-0" tall.
  - 10. Otherwise indicated or specified
- F. Provide labels with a minimum of 1" high red letters on white background. Each access door shall be labeled as follows (or worded as required by Code):
  - 1. Fire Damper
  - 2. Fire/Smoke Damper
  - 3. Smoke Damper
  - 4. Kitchen Exhaust Cleanout - Keep Access Clear
  - 5. Automatic Damper
  - 6. Humidifier
  - 7. Filter Access
  - 8. Coil Access
- G. The installation of special items of equipment in the duct systems, including automatic dampers, thermostats, thermometers, duct airflow measuring devices and other related controls, shall be done by this Contractor under the direct supervision of the manufacturer of such controls.
- H. All elbows, tees and branch takeoffs in round ductwork shall be made of the same materials as the ductwork.
- I. Duct connections to equipment shall be in no case smaller than the equipment openings.

- J. All openings for pitot tube traverses shall be fitted with neat removable plugs or caps. As a minimum, such openings shall be provided at every fan inlet and at such other points as may be required for airflow measuring and balancing. Coordinate the location of plugs and caps with the Balancing Contractor.
- K. All internally lined duct sections and joints shall be closely inspected by the contractor before and after each piece is erected. Loose edges, open joints, damaged areas and other defects shall be sealed securely so as to insulate all metal surfaces and so as to endure without falling in the presence of moving air. All liner applications shall comply with SMACNA "Duct Liner Application Standard".
- L. Provide other miscellaneous sheet metal work shown on the drawings including blanking off portions of louvers not required for the specific usage and diffusion plates or mixing air scoops to allow for air mixing where job conditions require the provision of same. All above work shall be provided as part of this Contract at no extra cost to the Owner.
- M. Where applicable and as approved by the Architect, all exposed ductwork shall be installed in a workmanlike manner to result in a neat appearance with no visible penetrations, screws, or other sheet metal imperfections.
- N. Install all UL classified devices in accordance with their UL approved installation sheets.
- O. Counterflashing of duct penetrations through roof shall be provided under this Contract.
- P. Branch takeoffs, tees and vanes, except otherwise specified, shall conform to Figures and Plates of the applicable SMACNA Duct Manuals, as detailed on the HVAC Contract Drawings.
- Q. Where manual balancing dampers are installed above inaccessible ceilings without access panels, the HVAC Contractor shall provide a remote operator similar to the Bowden Cable Control System as manufactured by Young Regulator Co., Cleveland, Ohio.
  - 1. The damper controller and cable (maximum 30 ft.) shall be concealed above the ceiling. Cable shall consist of Bowden cable .054" stainless steel control wire encapsulated in 1/16" flexible galvanized spiral wire sheath. Control kit shall consist of 2-5/8" diameter die cast aluminum housing with 3" diameter zinc plated cover, suitable for painting, and 14 gauge steel rack and pinion gear drive converting rotary motion to push-pull motion. Control shaft shall be D-style flatted 1/4" diameter with 265 degree rotation providing graduations for positive locking and control, and 1 1/2" linear travel capability. Control kit shall be designed to be imbedded in the ceiling flush with the finished surface. Control kit shall be manually operated using Young Regulator Model 030-12 wrench. Control kit shall be Young Regulator Model 270-301 or approved equal.

### 3.2 DUCT HANGERS AND SUPPORTS

- A. Provide suitable angle iron/strap hangers and supports inside the mechanical shafts, mechanical rooms and in ceilings of the buildings, and on the roof(s) as shown on the



drawings (Architectural/HVAC). This work shall be performed as required by job conditions and as instructed by the Architect in the field to support all air distribution ductwork and devices in both horizontal and vertical planes.

- B. When hanging and supporting the ductwork, the following shall be complied with:
1. Except as otherwise noted, ductwork up to 42" in greatest dimension shall be hung by using sheet metal bands secured as a minimum at (2) locations to the vertical sides of the ductwork and at (1) location under the duct. All support systems shall be compatible with the building structure and roofing system as approved by the Architect.
  2. Where ductwork major axis dimension is larger than 42", ductwork shall be hung by using rods of not less than 3/8" soft steel secured to angle iron trapeze support frame around ductwork with threaded nuts for securement and adjustment. All rods used on ductwork exposed in finished spaces shall be plain smooth rods threaded only at the ends.
  3. Ductwork shall be securely attached to the building construction. The hanger design and spacing shall be governed by the major duct dimension and shall be in accordance with SMACNA Duct Manual, except as modified hereinbefore. Vertical ductwork shall be supported at each floor level in an approved manner using angles or channels attached to the ducts. The installation, when complete and under operating conditions, shall be free from chatter or vibration. If necessary to achieve this, additional supports and/or bracing shall be furnished without extra cost to the Owner. Supports and bars and similar items shall be primed and painted structural steel. Touch up with aluminum paint any surfaces where galvanizing is destroyed on indoor ductwork, zinc primer on exposed ductwork with a final coat of aluminum paint. Provide vibration isolation hangers where specified under Vibration Isolation Section of these specifications.
  4. The Sheet Metal Contractor shall provide all supplemental steel required to support the ductwork in shafts, mechanical rooms or on the floor where structural steel is not properly positioned. Beam clamps shall be double sided.
  5. The maximum hanger spacing shall be 10'-0" on centers and additionally on each side of an elbow or change-in-direction fitting.
  6. In addition to the above, provide supports on each side of any duct mounted device, fans, coils, flow measuring stations, framed dampers, etc., to permit removal of the device without disconnecting adjacent duct sections.
  7. Provide angle sway bracing to the structure wherever lateral loads would be imposed on the ductwork, including but not limited to:
    - a. Elbows downstream of fan discharges.
    - b. Ductwork exposed to the weather subject to wind loads.
  8. Ductwork mounted on the roof or otherwise exposed to the elements shall be supported with frames constructed of steel angles and channels regardless of duct size.
    - a. Coordinate all roof supports with General Contractor.
    - b. Provide diagonal cross bracing between supports as required to sustain maximum area wind loads as dictated by the Architect.

9. The Sheet Metal Contractor shall provide expansion compensators, anchors and guides on all high temperature ductwork (breeching, high temperature supply/exhaust) as required.

### 3.3 SHEETMETAL TESTING

#### A. General

1. All ductwork that is required to be tested shall be tested on regular intervals as the job proceeds and shall be completed prior to enclosure in shafts, above ceilings or behind walls.
2. The Sheet Metal Contractor shall keep an up-to-date log of the ductwork tested for review by the Architect. The Sheet Metal Contractor shall notify all other Contractors when the testing is completed and accepted to permit enclosure of ducts.
3. The Sheet Metal Contractor shall furnish and install all blank off plates, blind flanges, safing, etc., necessary to isolate each section of duct being tested for leakage.
4. The Sheet Metal Contractor shall submit for review all proposed testing procedures, sample report, and equipment to the Engineer prior to proceeding. Additionally, the Sheet Metal Contractor shall notify the Engineer when testing is to occur so that the test can be witnessed at the Engineer's option.
5. All test equipment shall be calibrated per ANSI Standards prior to testing. Certified test reports shall be submitted to the Architect prior to commencement of the testing.
6. Testing Procedure
  - a. The testing procedure shall be in accordance with SMACNA "HVAC Air Duct Leakage Test Manual".
  - b. The test pressure shall be the specified construction pressure of the duct system.
7. Scope of Testing
  - a. All ductwork (regardless of pressure class) that will be in inaccessible areas including, but not limited to, all ducts within shafts, above hard ceilings, and those that will be made inaccessible by the work of other Trades. (This shall include  $\pm 2$ " w.g. construction.)
  - b. All ductwork constructed to greater than +2" w.g. or less than -2" w.g.
  - c. All other sheet metal in duct systems constructed to  $\pm 2$ " w.g. shall be tested under normal fan pressure and shall not leak sufficiently to cause audible leaks or blowing detectable by hand. **If, in the opinion of the Architect, the ductwork does not appear to be constructed and/or sealed to the approved shop standards, the Architect may request any or all of this ductwork to be tested at the specified construction pressure.**
  - d. Allowable Leakage
    - 1) The total allowable leakage shall be less than specified leakage class with no audible leaks.

- 2) If no leakage class is listed elsewhere, the system shall meet leakage Class 4.

### 3.4 DUCT CLEANING

- A. Clean dust and debris from interior and exterior of all ducts using wet rags and vacuums.
- B. Cover open ends of ductwork when installation does not proceed for more than one day. This requirement shall apply to each individual run of duct, such that no duct section shall remain open or unconnected for more than 8 hours.
- C. For all supply and return ductwork serving AHU-1 or AHU-2, the following mandatory cleanliness requirements shall be in addition to the previously specified protection requirements and shall include:
  1. Upon fabrication, each duct section shall be cleaned with alcohol wipes and made oil-free.
  2. Following cleaning, each duct section shall be shrink wrapped for shipment.
  3. On-site storage of ductwork, prior to installation, shall be in an enclosed, clean, dry space dedicated to storage of ductwork.
  4. **Prior to installing ductwork on-site, the Contractor shall wipe down the interior of all duct sections with a 5% bleach solution. Wipe duct surface dry with a clean cloth.**
  5. Upon installation, the protection requirements as specified in Para. 3.4B shall apply.

END OF SECTION