PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg. Metal ducts include the following:
   1. Rectangular ducts and fittings.
   2. Single-wall, round, and formed fittings.

B. This Section also includes Duct Cleaning Requirements for both new and existing ductwork as well as repair of damaged duct liner.

C. Related Sections include the following:
   1. Division 23 Section "Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 QUALITY ASSURANCE

A. NFPA Compliance:
   1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
   2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; G90 coating for Holding Building; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

E. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

F. Joint and Seam Tape: 2 inches wide; glass-fiber-reinforced fabric.
G. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

H. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

2.2 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
   1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
   2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
   3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

2.3 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
   1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
   2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
   1. Manufacturers:
      a) Ductmate Industries, Inc.
      b) Nexus Inc.
      c) Ward Industries, Inc.
C. Formed-On Flanges: Construct according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
   1. Manufacturers:
      a) Ductmate Industries, Inc.
      b) Lockformer.
   2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
   3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.4 ROUND DUCT AND FITTING FABRICATION

A. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible."

B. Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible"

C. Duct Joints:
   1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
   2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
   3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
   4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

D. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

E. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

F. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
   1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
   2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
      a) Ducts 3 to 36 Inches in Diameter: 0.034 inch.
      b) Ducts 37 to 50 Inches in Diameter: 0.040 inch.
      c) Ducts 52 to 60 Inches in Diameter: 0.052 inch.
      d) Ducts 62 to 84 Inches in Diameter: 0.064 inch.
   3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
a) Ducts 3 to 26 Inches in Diameter: 0.034 inch.
b) Ducts 27 to 50 Inches in Diameter: 0.040 inch.
c) Ducts 52 to 60 Inches in Diameter: 0.052 inch.
d) Ducts 62 to 84 Inches in Diameter: 0.064 inch.

4. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.

5. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

6. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

7. Round Elbows Larger Than 14 Inches in Diameter: Fabricate gored elbows unless space restrictions require mitered elbows.

8. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040-inch-thick with 2-piece welded construction.

9. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.

10. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

2.5 INSULATION REPAIR COATING

A. Coating as manufactured by Vac Systems Industries “Tough Coat”, Fosters “40/20” or Fiberlock IAQ8000

B. Anti-microbial agent that is a mixture of water, decabromodiphenyl oxide, antimony trioxide and ammonia.


PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
   1. Supply Ducts before Air Terminal Units: 2-inch wg.
   2. Supply Ducts after Air Terminal Units: 1-inch wg.
   4. Exhaust Ducts (Negative Pressure): 1-inch wg

3.2 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install ducts with fewest possible joints.
C. Where new unlined ductwork is connected to existing lined ductwork, install sheet metal enclosure over edge of existing duct liner and install transition fitting at the connection point between new work and existing work.

D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

I. Coordinate layout with suspended ceiling, fire dampers, lighting layouts, and similar finished work.

J. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

K. Electrical Equipment Spaces: Route ducts to provide necessary clearances around electrical panels

L. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

M. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Refer to SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

N. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

3.3 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

1. For pressure classes lower than 2-inch wg, seal transverse joints.

B. Seal ducts before external insulation is applied.

3.4 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. Install concrete inserts before placing concrete.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors.

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
   1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
   3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg.
   4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.7 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

B. Use service openings, as required, for physical and mechanical entry and for inspection.
   1. Create other openings to comply with duct standards.
   2. Disconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.

E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

F. Cleanliness Verification:
1. Visually inspect metal ducts for contaminants.
2. Where contaminants are discovered, re-clean and re-inspect ducts.

3.8 CLEANING EXISTING SYSTEMS (ALTERNATE BID)

A. All existing duct systems are to be cleaned.

B. Use service openings, as required, for physical and mechanical entry and for inspection.
   1. Use existing service openings where possible.
   2. Create other openings to comply with duct standards.
   3. Disconnect flexible ducts as needed for cleaning and inspection.
   4. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
   5. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.

D. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or larger) particles.
   2. When venting vacuuming system to the outside, use filtration to contain debris removed from HVAC system, and locate exhaust down wind and away from air intakes and other points of entry into building.

E. Clean the following metal duct systems by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers
and dehumidifiers, filters and filter sections, and condensate collectors and drains.

5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
7. Dedicated exhaust and ventilation components and makeup air systems.

F. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide operative drainage system for wash-down procedures.
7. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.

G. Cleanliness Verification:
1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
2. Visually inspect metal ducts for contaminants.
3. Where contaminants are discovered, re-clean and re-inspect ducts.

H. Gravimetric Analysis: At discretion and expense of Owner, sections of metal duct system, chosen randomly by Owner, may be tested for cleanliness according to NADCA vacuum test gravimetric analysis.
1. If analysis determines that levels of debris are equal to or lower than suitable levels, system shall have passed cleanliness verification.
2. If analysis determines that levels of debris exceed suitable levels, system cleanliness verification will have failed and metal duct system shall be re-cleaned and re-verified.

I. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

3.9 INSULATION REPAIR AND ENCAPSULATION

A. After cleaning of systems with interior liner, provide video and photographic evidence of damaged liner. Prepare report and submit to Owner and Engineer.

B. Upon approval from owner, coat and repair damaged liner by applying an even coat application with at least 5 mil thick dry coating.
C. Provide both video and photographic documentation of cleaned and repaired system.