PART 1 - GENERAL

These standards apply to the installation of supply, return, outdoor and exhaust air ductwork, accessories and terminal units.

1.01 DESIGN CRITERIA

A. Drawings and Specifications:

1. Indicate unit dimensions, weight loading, required clearances, electrical characteristics and connection requirements on drawings.
2. Include equipment schedules: Identification tag, capacities, balancing requirements, sound power levels, electrical requirements, weights, etc.
3. Provide multiple drawing sections to indicate elevations and spatial requirements.
4. Indicate service access (filters, coils, fans, terminal boxes, electrical equipment, etc.) requirements on plans.
5. Ductwork shall be constructed in accordance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association) “HVAC Duct Construction Standards.”
6. Flexible duct shall be limited to supply diffuser runouts 4 feet maximum length and to total combined bend of maximum of 60 degrees, and provided in accordance with SMACNA.
7. Leakage Test: All ductwork shall be leakage tested for each pressure class (2”. Perform tests according to SMACNA "HVAC Air Duct Leakage Test Manual."
8. 30% Pre Filters, 22” 10 pocket Bag and “POS Approved Gas Phase Filters shall be installed in new air handlers as specified herein before initial startup and at all times during construction, balancing Commissioning and operation.
9. Field labeling of all equipment per schedule, including all terminal units, shall be installed. Refer to General Provisions “Mechanical Equipment Identification Systems.
10. Small labels or other unobtrusive identification tapes specified for suspended ceiling grids (T-bar) below components (e.g., static pressure sensors, VAV

terminals, balancing dampers). Match the nomenclature with the mechanical construction drawings.

11. Design:
    Ductwork: Size air distribution system to match future capacity provided at the air-handling unit. Ducts shall be 3 to 1 maximum duct aspect ratio.
12. Terminal Boxes:
    a. Size shall be limited to up to 1400 cfm each where possible, but no larger than 2,300 cfm. Two or three smaller units may be controlled from a single temperature sensor.
    b. Terminal units must be installed with control panels and hot water supply and return coil connections and valves on the same side. Confirm orientation during design and include left / right orientation in schedule. Reroute HWS & HWR piping as required.

DUCTWORK SIZING GUIDELINE

Pressure Class Range, in WG	Seal Class	Maximum velocity, feet per minute	Maximum pressure drop, in WG per 100 lf
-2 to 2 (downstream of terminal units only)	B	1000-1200	0.08
Over 2 to 4: Constant Volume (Main duct in shaft)	B	1,500	0.08
Over 2 to 4: Variable Volume (Main Duct in Shaft, Upstream of Terminal unit)	B	2,000 - 2,500	0.2
Over 2 to 4: Variable Volume (Main Branch Duct, Upstream of Terminal unit)	B	1,500 - 2,000	0.2
Over 4 to 6: Variable Volume (Main Duct in Shaft, Upstream of Terminal unit)	A	2,000 - 2,500	0.2
Over 4 to 6: Variable Volume (Main Branch Duct, Upstream of Terminal unit)	A	1,500 - 2,000	0.2

Pressure Class Range, in WG	Seal Class	Maximum velocity, feet per minute	Maximum pressure drop, in WG per 100 lf

1. Acoustical Criteria: In general, follow ASHRAE criteria unless project identifies a more stringent requirement.
2. Terminal units shall serve no more than two adjacent zones with identical load profiles.
3. New terminal units shall be installed. Units not to be reused or relocated without direct approval from F&I on a case by case basis.
4. Provide separate volume damper for each air inlet and outlet. Locate volume dampers as far as possible from GRD's.
5. Public Toilet Rooms shall have a minimum of 20 air changes exhaust capacity. Single Toilet Rooms shall have a minimum of 15 air changes exhaust capacity.
6. Transfer air shall be sized for total assembly pressure drop of 0.03 in WG.
7. Controls: Direct Digital Controls shall be utilized.
8. Vibration Isolation and Seismic Restraints: Provide spring isolation with seismic restraints. Secure unit, components and accessories in accordance with Uniform Building Code and SMACNA "Seismic Restraint Manual."
9. Smoke/Fire Dampers: Provide per Uniform Building Code, and SMACNA "Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems," and according to manufacturer's UL-approved written instructions. Install actuators outside the ductwork for easy access.
10. Provide access doors on both sides of all dampers and at equipment for cleaning (coils, filters, etc.)
11. Do Not Use the Following:
    a. Duct board.
    b. Fiberglass ductwork.
    c. Underground ductwork.
    d. Flexible duct for duct mains
    e. Flexible duct for negative pressure systems

f. Electric heating.
g. VAV induction units or dual duct units.
h. Duct tape.
i. Adjustable elbows.
j. Turning Vanes in negatively pressurized ducts.
k. Hard 90 degree rectangular elbows. Use radius elbows.
l. Fire dampers without monitoring of DDC
m. Flat duct taps on supply systems.
n. Face dampers

PART 2 - PRODUCTS

2.01 SHEET METAL MATERIALS

A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.

B. Stainless Steel: ASTM A 480/A 480M, Type 316, sheet form with No. 4 finish for surfaces of ducts exposed to view; and Type 304, sheet form with No. 1 finish for concealed ducts.

C. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form with standard, one-side bright finish for ducts exposed to view and with mill finish for concealed ducts.

D. –2 in WG to 2 in WG Pressure Class Ductwork: Standards: Comply with most stringent requirements and recommendations of Uniform Mechanical Code and SMACNA (Sheet Metal and Air Conditioning Contractors National Association) "HVAC Duct Construction Standards" for fabrication, construction and sealant of duct, fittings, and accessories.

E. Over 2 in to 6 in WG Pressure Class Ductwork: Standards: Comply with most stringent requirements and recommendations of Uniform Mechanical Code and SMACNA "HVAC Duct Construction Standards" for fabrication, construction and sealant of duct, fittings and accessories.

F. Flexible Duct:

1. Manufacturers: Owens-Corning, Thermaflex, Wiremold, Flexaust, or approved equal.
2. UL listed, complete with aluminum flexible interior liner, 1" insulation and exterior vapor barrier. Rated for 10" min w.g. positive pressure. Secure with UL 181 approved clamps. Use of non-metallic clamps is not allowed on ducts with more than 2"wg. Use of non-metallic clamps allowed if: insulation and jacket are pulled back 2" from end of core, apply mastic labeled UL 181B-M to 2" wide uniformly spread around the end of the collar or over the ends of a 4" min length of beaded metal sleeve, slide at least 2" of core over the fitting or sleeve end and past the bead, secure core to collar with a clamp (metallic or non-metallic) applied past the bead. Secure core to sleeve with two clamps (metallic) applied past the beads.
3. Flex duct to be used only for supply air diffuser runouts, maximum length of 4 feet and 60 degrees in total combined bend angle.

G. Flexible Connector:
1. Manufacturers: Durodyne, Ventfabrics, Elgen, or approved equal.
2. UL listed, flameproof, waterproof, air tight, heat resistant to 250º F, neoprene coated fabric, 32 ounce per yard min.
3. 24ga GI, Al or SS sheet metal min.
4. Use duct flex connector for all terminal boxes, fans and air handlers.

H. Medium Velocity Damper:
1. Required on all systems 6" w.g. pressure class or higher. Locate upstream of terminal units and on all major branches to floors, shafts, and areas, in order to isolate the HVAC system for future remodels or shut-downs. Discuss with F&I on locations and show in contract drawings.
    2. Round: 10" w.g. pressure class damper, 10 gauge min steel damper, neoprene 250 deg F blade seal, bearings located on both sides and bolted to frame, flanged with bolt hole for connections to duct, Manual steel lever, with multiple pre-set locking positions. Ruskin CDR82, Price, NCA Manufacturing, Nailor, or approved equal.
3. Rectangular: 10" w.g. pressure class damper. Blades shall be double skin airfoil design, minimum 16 gage galvanized steel. Bearings shall be stainless steel sleeve pressed into frame. Axles shall be minimum ½" diameter plated rood. Dampers shall be equipped with blade and jamb seals for low leakage

applications. Blade seals shall be mechanically attached to blade. Adhesive type seals are not acceptable. Ruskin CD80AF1, NCA Manufacturing, Price, Nailor or approved equal.

I. Duct Liner:

1. Manufacturers: Certain-Teed, Owens-Corning, Johns-Manville, Knauf, or approved equal.
2. Indoor Ductwork: Fiberglass, 1" thickness and 1.5 lbs. density, in accordance with requirements of NFPA Standards 90-A and 90-B and UL 723.
3. Outdoor Ductwork: Fiberglass, 1-1/2" thickness and 3.0 lbs. density, vinyl coated, in accordance with requirements of NFPA Standard 90-A and UL 723.

J. Combination Smoke/Fire Dampers, Smoke Dampers:

All SFD's are controlled and monitored through the DDC system.

Dual end switch proof shall be installed.

1. Airfoil blades, UL label for use in dynamic systems.
2. Combination Smoke/Fire Dampers: UL 555, UL 555S.
3. Fire Dampers: UL 555.
4. Smoke Dampers: UL 555S.
5. Actuators: UL 555, UL 555S.(Install actuators outside the ductwork for easy access.)

K. VAV and CV Control Units (UL Listed):

1. Manufacturers: Titus, Price, Enviro-Tec, Nailor, or approved equal.
2. Single inlet, 0 to 100 percent primary air, 25 to 50 percent primary air at minimum design cooling, but capable of full primary shut-off.
3. U.L Plenum rated enclosure.
4. ARI rated, hot water coil. Coils shall be 2 rows minimum.

L. Fan Powered VAV Units (UL Listed):

Note: use of Fan powered units is **discouraged** – evaluated on a case by case basis and requires specific AV/F&I approval.

1. Manufacturers: Titus, Nailor, Price, or approved equal.
2. Single inlet, fan in parallel or series arrangement with filtered plenum re-circulation. 0 to 100 percent primary air, 25 to 50 percent primary air at minimum design cooling, but capable of full primary shut-off.

3. U.L. Plenum rated enclosure.
4. Solid State Fan speed control switch, fan overload protection and fan disconnect switch.
5. ARI rated, hot water coil. Coils shall be 2 rows minimum.

M. Grilles, Registers and Diffusers:

1. Manufacturers: Titus, Price, Nailor, Krueger, or approved equal.
2. Ceiling mounted units to mate with ceiling system. Performance tests in accordance with ADC Standard 1062 R2, Test Code. Base design units in general to be Titus MCD for ceiling supply diffusers, Titus 350RL for wall grilles, Titus 50R for ceiling returns, and Titus Flow-Bar for linear diffusers.
3. Airport Terminal and other large quantity sidewall diffusers to be Trox DUK, Price JNA, or approved equal.

N. Filters:

1. Minimum Efficiency Reporting Value (MERV) shall be in accordance with ASHRAE Standard 52.2.
2. Filter Media: UL 900 listed, Class I.
3. Medium Efficiency Pleated Pre-Filters: All medium efficiency pre-filters shall be 'pleated' type and shall contain 100% synthetic media with an ASHRAE 52.2 rating of MERV 8-A or greater and an ASHRAE 52.1 average dust spot efficiency of 30%. Filter media shall be hydrophobic. Pleated pre-filter shall be a 'high capacity' model with 18.6 square feet of media per 24x24x2 filter, with an initial resistance of .25"DP at 500 fpm. The media pack shall be enclosed in a heavy duty, moisture resistant, die cut frame with face grids up and downstream. Die cut framing shall have a consistent internal coating of adhesive for complete bonding to media pack, providing integrity to the media pack and eliminating air bypass. Manufacturer must provide a written, 6-month guarantee for pre-filters under normal conditions
4. High Efficiency Bag Type Final Filters: All high efficiency final filters shall contain 100% synthetic media with an ASHRAE 52.2 rating of MERV 14-A. 52.1 initial dust spot efficiency of 80% or greater. Filters shall be a 'bag type' design, 24x24x22 10 pocket, with 77 square feet net media area. Initial

resistance at 500 fpm of .25"DP or less. Media shall be hydrophobic. Media pockets shall be 'ultrasonically welded' to prevent blowout and eliminate the leakage and bypass of 'stitched' media construction. Manufacturer must provide a written, 12-month guarantee for final filters with or without the use of a pre-filter

5. Gas Phase Filters: Filter manufacturers meeting POS approved qualifications and gas phase filter test protocol.
   a. FGI Part No. 2710 (Old Part No. 2710, Now) 3651..
   b. Flanders Vapor Clean Part No. VC-1501-16-01-2424-GD.
   c. Airguard Vari Klean-Formaldehyde Part No. 15505UKP-05-F.
   d. Initial pressure drop shall be less than 0.45 inches static pressure at 500 feet per minute face velocity. Filter shall be 24"X24"X12" deep and fitted with a frame that is compatible (without rework) with the SeaTac International Airport filter rack (based on ESI Vapor Sorb 1501).
   e. Filter Differential Pressure Gage/ Switch: Differential pressure gage/switch with shutoff cocks on each side of differential pressure gage/switch. Provide a differential pressure gage/switch across each filter assembly.

O. Filter Differential Pressure Gage/Switch: Differential pressure gage/switch with shutoff cocks on each side of differential pressure gage/switch. Provide a differential pressure gage/switch across each filter assembly.

P. Louvers (Stationary):
   1. Manufacturers: Ruskin model EME420MD, Cesco, Arrow United, Construction Specialties.
   2. AMCA Certified 99%+ effective ratio wind driven rain performance at 29 and 50 MPH, extruded aluminum with bird screen Minimum 4" frame. Nominal free area 45 to 55 percent. Maximum pressure drop at 0.18-inch WG. Schedule and indicate on architectural drawings.

Q. Backdraft Dampers:
   1. Manufacturers: Ruskin, Prefco, American Warming.
   2. Airfoil blades, UL label for use in dynamic systems.
   3. Frame: 2 inches x minimum 0.090 inch 6063-T5 extruded aluminum channel with front flange and rear flange and mitered corners.

4. Continuous Hinged Side Access Doors: 18 gauge door with Ventlok No. 310 catch and airtight gaskets.
5. Blades: Single-piece, overlap frame, Parallel action, Horizontal 0.025 inch formed aluminum. Bearings: Corrosion-resistant, long-life, synthetic, formed as single piece with axles.
6. Blade Seals: Extruded vinyl, mechanically attached to blade edge.

R. Roof Hoods:

1. Manufacturers: Penn, Cook, Jenn-Air.
2. Exhaust or Relief: Extruded aluminum with perimeter dampers, bird screen and weather shield. Hoods sized for maximum pressure drop of 0.15-inches WG. Relief system maximum pressure drop subjected to maximum space pressure allowable.
3. Intake: Same as for exhaust, except no perimeter dampers and size for maximum intake pressure drop 0.10-inches WG.
4. Insulated roof curb.

S. Sound Traps:

1. Manufacturers: IAC, Rink, Dyna Sonics, Air Buesnsod, Gale.
2. Scheduled and indicate on drawings. 22 gauge galvanized steel outer casing, 26 gauge perforated steel inner surface and glass fiberfill. Units tested and certified in accordance with ASTM E477.

T. Volume Dampers

1. Manufacturer: Titus AG-45 with Young #1 operator; Rossi ; Ruskin; McGill; Price,
2. All volume dampers shall comply with UL requirements SMACNA fig 2-14 or 2-15
3. End bearings (each end),
4. Positive locking device or thread locking compound on wing nut retainers
5. Seals at ends of shafts or rods.
6. Remote Damper Operator: 3/8-inch concealed adjustable cover regulator, chrome plated cover. Manufacturer: Young No. 301

U. Motor Actuated Control Dampers:

1. Manufacturers: Ruskin, Prefco, Air Balance Inc, Price, National Controlled Air, Cesco, or approved equal.
2. Airfoil blades, UL label for use in dynamic systems.
3. Actuators: UL 555 (Coordinate with 200920) (Install actuators outside the ductwork for easy access.)

V. Duct Access Door: Conform to SMACNA HDCS Fig 2-12. Add seals and cam locks to meet pressure class. Ruskin, OmniContainment,Price

W. Accessories

1. Air Extractors: Adjustable blades, rotating shaft operator.
2. Elbows: Stamped or gored standard radius. Hard 90 or vaned square are not allowed. Adjustable elbows not allowed.
3. Turning Vanes: Conform to SMACNA HDCS Fig 2.3. Only allowed in positive pressure duct systems.

END OF SECTION