PART 18

# Air Distribution Systems

## 18.01 Ductwork Systems

### A. Ductwork System Sizing:

| | |
|---|---|
| 1. Low Pressure: | 0.10 (0.15) In.W.G./100 Ft.; 1,500–1,800 Fpm Maximum |
| 2. Medium Pressure: | 0.20 (0.25) In.W.G./100 Ft.; 2,000–2,500 Fpm Maximum |
| 3. High Pressure: | 0.40 (0.45) In.W.G./100 Ft.; 2,500–3,500 Fpm Maximum |
| 4. Transfer Ducts: | 0.03–0.05 In.WG./100 Ft. 1,000 Fpm Maximum |
| 5. Transfer Grilles: | 0.03–0.05 In.WG. pressure drop |
| 6. Outside Air Shafts: | 0.05–0.10 In. W.G./100 Ft. 1,000 Fpm Maximum |
| 7. Gravity Relief Air Shafts: | 0.03–0.05 In. W.G./100 Ft. 1,000 Fpm Maximum |

8. Decrease or increase duct size whenever duct changes by 4″ or more in one or two dimensions. Do *NOT* use fractions of an inch for duct sizes.
9. Try to change only one duct dimension at a time because it is easier to fabricate fittings and therefore generally less expensive, i.e., 36 × 12 to 30 × 12 in lieu of 36 × 12 to 32 × 10.
10. Duct taps should be 2″ smaller than main duct to properly construct and seal duct. Duct size should be 2″ wider than diffusers, registers, and grilles.
11. All 90 degree square elbows should be provided with double radius turning vanes. Elbows in dishwasher, kitchen, and laundry exhaust should be unvaned smooth radius construction with radius equal to 1½ times width of duct.
12. Provide flexible connections at point of connection to equipment in all ductwork systems (supply, return, and exhaust) connected to air handling units, fans, and other equipment.
13. Provide access doors to access all fire dampers, smoke dampers, smoke detectors, volume dampers, motor operated dampers, humidifiers, coils (steam, hot water, chilled water, electric), and other items located in ductwork which require service and/or inspection.
14. All rectangular duct taps should be made with shoe (45 degree) fittings. Do *NOT* use splitter dampers or extractors.
15. Maximum ductwork hanger spacing:
    a. SMACNA Minimum Requirements:
        1) Horizontal: 8 feet maximum
        2) Vertical: 16 feet and at each floor
    b. Recommended:

| | |
|---|---|
| 1) Horizontal Ducts less than 4 square feet: | 8 feet maximum |
| 2) Horizontal Ducts 4 to 10 square feet: | 6 feet maximum |
| 3) Horizontal Ducts greater than 10 square feet: | 4 feet maximum |
| 4) Vertical Round Ducts: | 12 feet maximum |
| 5) Vertical Rectangular Ducts: | 10 feet maximum |

### B. Friction Loss Estimate:

1. 1.5 × System Length (Ft./100) × Friction Rate (In.W.G./100 Ft.).

### C. Ductwork Sizes:

1. 4″ × 4″ smallest rectangular size.
2. 8″ × 4″ smallest recommended size.

3. Rectangular ducts: Use even duct sizes, i.e., 24 × 12, 10 × 6, 72 × 36, 48 × 12.
4. 4 : 1 Maximum recommended aspect ratio.
5. 3″ smallest round size, odd and even sizes available.
6. Round ducts available in 0.5 inch increments for duct sizes through 5.5 inch diameter, 1 inch increments for duct sizes 6 inches through 20 inches, and 2 inch increments for duct sizes 22 inches and greater.

## 18.02 Duct Construction

### A. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) Duct Construction Manuals:

1. *SMACNA—HVAC Duct Construction Standards Metal and Flexible,* First Edition, referred to herein as *SMACNA-HVAC.*
2. *SMACNA—Fibrous Glass Duct Construction Standards,* Fifth Edition, referred to herein as *SMACNA-FG.*
3. *SMACNA—Rectangular Industrial Duct Construction Standard,* First Edition, referred to herein as *SMACNA-IDC.*
4. *SMACNA—Round Industrial Duct Construction Standard,* First Edition, referred to herein as *SMACNA-RIDC.*
5. *SMACNA—Thermoplastic Duct (PVC) Construction Manual,* First Edition, referred to herein as *SMACNA-PVC.*

### B. *SMACNA-HVAC* Pressure Ratings:

1. ±½″; ±1″; ±2″; ±3″; +4″; +6″; +10″

### C. *SMACNA-IDC* and *SMACNA-RIDC* Pressure Ratings:

1. +12″ to +100″ by multiples of 2″
2. −4″ to −100″ by multiples of −2″

### D. Ductwork Testing:

1. −3″ W.G. and Lower: 1.5 × Pressure Rating
2. −2″ to +2″ W.G.: Generally not tested
3. +3″ W.G. and Higher: 1.5 × Pressure Rating

### E. *SMACNA-HVAC* Ductwork Leakage Classes:

1. Seal Class A: 2–5% Total System Leakage (All Transverse joints, longitudinal seams, and duct penetrations).
2. Seal Class B: 3–10% Total System Leakage (All Transverse joints and longitudinal seams).
3. Seal Class C: 5–20% Total System Leakage (All Transverse joints).
4. Unsealed: 10–40% Total System Leakage.
5. All ducts should be sealed for SMACNA Seal Class B minimum—Engineer must specify.

### F. Ductwork Materials:

1. Galvanized Steel: HVAC Applications; Most Common; Galvanized steel sheets meeting *ASTM A90, A525,* and *A527, Lock Forming Quality.*
2. Carbon Steel: Breechings, Flues and Stacks; Carbon steel meeting *ASTM A569* for stacks and breechings 24″ and larger; Galvanized sheet steel meeting *ASTM A527* with *ANSI/ASTM A525 G90* zinc coating for stacks and breechings less than 24″.

3. Aluminum: Moisture Laden Air Streams; Aluminum base alloy sheets meeting *ASTM B209, Lock Forming Quality.*
4. Stainless Steel: Kitchen Hood and Fume Hood Exhaust; Stacks and Breechings (Prefabricated); Type 304, 304L, 316, or 316L stainless steel sheets meeting *ASTM A167:*
   a. 304 and 316: Non-welded applications.
   b. 304L and 316L: Welded applications.
   c. Kitchen Exhaust Finish:
      1) Concealed: None.
      2) Exposed: No. 2B, No 4, or Match Equipment (No. 4 preferred).
   d. Lab Fume Exhaust Finish:
      1) Concealed: No 2B.
      2) Exposed: No 2B.
5. Fiberglass: HVAC Applications; 1″ thick glass duct board meeting *U.L. 181.*
6. Fiberglass Reinforced: Chemical Exhaust; Plastic (FRP)
7. Polyvinyl Chloride (PVC): Chemical Exhaust, Underground Ducts; PVC conforming to *NFPA 91, ASTM D1784, D1785, D1927,* and *D2241.*
8. Concrete: Underground Ducts, Air Shafts; Reinforced concrete pipe meeting *ASTM C76, Class IV.*
9. Sheet Rock: Air Shafts (Generally Provided by Architects).
10. Copper: Ornamental.
11. Polyvinyl Steel and Stainless Steel (PVS and PVSS): Chemical Exhaust, Common Type: Halar Coated Stainless Steel.
12. Sheet Metal Gauges (Applies to item numbers 1, 3, 4, and 10 above):
    a. 16, 18, 20, 22, 24, 26 SMACNA or Welded Construction.
    b. 10, 11, 12, 13, 14 Welded Construction Only.
13. For ductwork system weights, see Appendix A.

**G. Flexible Duct:**

1. 5–8 Ft. Maximum recommended length.
2. Insulated, Uninsulated.

## 18.03 Kitchen Exhaust Ducts and Hoods

**A. *1990 BOCA Code:***

1. Exhaust/Makeup Air:
   a. 1500–2200 Ft./Min Duct Velocity.
   b. Supply shall be approximately equal to exhaust.
   c. Δ T shall not be greater than 10°F. unless part of AC system or will not cause a decrease in comfort conditions.
   d. Terminate 40″ above the roof.
2. Duct Sheet Metal Gauge:
   a. 16 ga. Galvanized Steel.
   b. 18 ga. 304 Stainless Steel.
3. Cleanouts:
   a. Base of Riser.
   b. Every 20 feet.
4. Hoods:
   a. Hood Construction 18 ga. Minimum.

b. Hood Exhaust:
   1) Canopy Hoods (attached to wall): 100 CFM/Sq.Ft.
   2) Canopy Hoods (Exposed all sides): 150 CFM/Sq.Ft.
   3) Non-Canopy: 300 CFM/Lineal Ft. of cooking surface.
   4) As listed above or per *U.L. 710.*

**B. *1993 BOCA Code:***

1. Exhaust/Makeup Air:
   a. 1500–2200 Ft./Min Duct Velocity.
   b. Supply shall be approximately equal to exhaust.
   c. Δ T shall not be greater than 10°F. unless part of AC system or will not cause a decrease in comfort conditions.
   d. Terminate 40″ above the roof.
2. Duct Sheet Metal Gauge:
   a. 16 ga. Galvanized Steel.
   b. 18 ga. 304 Stainless Steel.
3. Cleanouts:
   a. Base of Riser.
   b. Every 20 feet.
4. Hoods:
   a. Hood Construction:
      1) Galvanized Steel: 18 ga. Minimum.
      2) Stainless Steel: 20 ga. Minimum.
   b. Hood Exhaust:
      1) Canopy Hoods (attached to wall): 100 CFM/Sq.Ft.
      2) Canopy Hoods (exposed all sides): 150 CFM/Sq.Ft.
      3) Non-Canopy: 300 CFM/Lineal Ft. of cooking surface.
      4) As listed above or per *U.L. 710.*

**C. *1988 SBCCI Code***

1. Exhaust Air:
   a. 1500 Ft./Min. Minimum Duct Velocity.
   b. Terminate 40″ above the roof.
2. Duct Sheet Metal Gauge:
   a. 16 ga. Galvanized Steel.
   b. 18 ga. 304 Stainless Steel.
3. Duct Slope: 1″ per foot toward hood.
4. Hoods:
   a. Hood Construction:
      1) 18 ga. Galvanized Steel.
      2) 20 ga. 304 Stainless Steel.
   b. Hood Exhaust:
      1) Canopy Hoods (attached to wall): 100 CFM/Sq.Ft.
      2) Canopy Hoods (exposed all sides): 150 CFM/Sq.Ft.
      3) Non-Canopy: 300 CFM/Lineal Ft. of cooking surface.

**D. *1988 UBC Code:***

1. Exhaust/Makeup Air:
   a. 1500–2500 Ft./Min Duct Velocity.
   b. Supply shall be equal to exhaust.

2. Duct Sheet Metal Gauge:
   a. 16 ga. Galvanized Steel.
   b. 18 ga. 304 Stainless Steel.
3. Duct Slope:
   a. Lengths 75 and less: ¼″ per foot toward hood.
   b. Lengths greater than 75 feet: 1″ per foot toward hood.
4. Hoods:
   a. Hood Construction:
      1) 22 ga. Galvanized Steel.
      2) 22 ga. 304 Stainless Steel.
   b. Hood Exhaust:
      1) Canopy Hoods (attached to wall).
         200 CFM/Sq.Ft. over charbroilers.
         100 CFM/Sq.Ft. over high temperature appliances.
         75 CFM/Sq.Ft. over medium temperature appliances.
         50 CFM/Sq.Ft. over low temperature appliances.
      2) Canopy Hoods (exposed all sides).
         300 CFM/Sq.Ft. over charbroilers.
         150 CFM/Sq.Ft. over high temperature appliances.
         100 CFM/Sq.Ft. over medium temperature appliances.
         75 CFM/Sq.Ft. over low temperature appliances.
      3) Non-Canopy: 300 CFM/Lineal Ft. of cooking surface.

**E. *1991 NFPA 96:***

1. Exhaust/Makeup Air:
   a. 1500 Ft./Min. Minimum Duct Velocity.
2. Duct Sheet Metal Gauge:
   a. 16 ga. Galvanized Steel.
   b. 18 ga. 304 Stainless Steel.
   c. Ducts shall not pass through fire walls or partitions.
   d. Ducts shall lead directly as possible to the outside.
   e. Ducts shall not be connected with other ventilating or exhaust systems.
   f. Ducts shall terminate a minimum of 40″ above roof surface, 10 feet from outside air intakes and property lines, and 3 feet above any air intake within 10 feet.
3. Duct Slope: toward hood.
4. Hood Construction:
   a. 18 ga. Galvanized Steel.
   b. 20 ga. 304 Stainless Steel.

## 18.04 Louvers

**A. Louvers: Use stationary louvers only. Do not use operable louvers because they become rusty or become covered with snow and ice and may not operate:**

1. Intake (Outdoor Air): 500 Ft./Min. Maximum Velocity through Free Area.
2. Exhaust or Relief: 700 Ft./Min. Maximum Velocity through Free Area.
3. Free Area Range:
   a. Metal: 40–70% of Gross Area.
   b. Wood: 20–25% of Gross Area.
4. Pressure Loss: 0.01–0.10″ W.G.

## 18.05 Volume Dampers

**A. Volume Dampers: Frames of duct mounted dampers shall be totally recessed out of the air stream:**

1. Opposed Blade: Balancing, Mixing, and Modulating Control Applications.
2. Parallel Blade: 2 Position Applications (Open/Closed).
3. Pressure Loss (MOD): 0.15″ W.G. @ 2000 Fpm (Full Open).
4. Standard Dampers: 10–15 CFM/Sq.Ft. @ 1″ W.G. Differential.
5. Low Leakage Dampers: 10 CFM/Sq.Ft. @ 4″ W.G. Differential Max.
6. Ultra Low Leakage Dampers: 6 CFM/Sq.Ft. @ 4″ W.G. Differential Max.
7. Size dampers at a flow rate of approximately 1200 to 1500 CFM/Sq.Ft. rather than on duct size.

## 18.06 Fire Dampers

**A. Fire Dampers: Interlocking blade or expanding curtain type. Frame and damper storage should be totally recessed out of air stream.**

1. Fire Damper Types:
   a. Type A: Frame and damper storage are located in the airstream.
   b. Type B: Damper storage is totally recessed out of the airstream.
   c. Type C: Frame and damper storage are totally recessed out of the airstream.

**B. Fire Damper Requirements:**

1. *1990 BOCA Code:*
   a. 1 Hr. Construction: Fire dampers are not required if building is fully equipped with automatic sprinklers. 1 Hr. dampers required otherwise.
   b. 2, 3, and 4 Hr. Construction: 2 and 3 Hr. dampers are required.
2. *1993 BOCA Code:*
   a. 1 Hr. Construction: 1 Hr. dampers are required.
   b. 2, 3, and 4 Hr. Construction: 2 and 3 Hr. dampers are required.
   c. Exception. Fire dampers are not required:
      1) In steel exhaust air subducts extending at least 22″ vertically in an exhaust shaft and where there is continuous airflow upward to the outside.
      2) In penetrations of walls with a required 1 hour fire-resistance rating or less by a ducted HVAC system in areas of other than Use Group H where the building is equipped throughout with an automatic sprinkler system.
      3) In garage exhaust or supply shafts which are separated from all other building shafts by not less than a 2 hour fire-resistance rated fire separation assembly.
3. *1988 SBCCI Code:*
   a. 1 Hr. Construction: 1 Hr. dampers are required.
   b. 2, 3, and 4 Hr. Construction: 2 and 3 Hr. dampers are required.
4. *1988 UBC Code:*
   a. 1 Hr. Construction: 1 Hr. dampers are required.
   b. 2, 3, and 4 Hr. Construction: 2 and 3 Hr. dampers are required.
5. *1991 NFPA 90A:*
   a. 1 Hr. Construction: Dampers are not required.
   b. 2, 3, and 4 Hr. Construction: 2 and 3 Hr. dampers are required.
6. *U.L. 555:*

a. *U.L. 555* requires fire dampers to bear an affixed label stating whether the damper is static or dynamic rated.
b. Dynamic rated fire dampers must be U.L. tested and show airflow and maximum static pressure against which the damper will operate (fully close). Fire dampers are tested to 4″ static pressure for "no duct" applications and 8″ static pressure or "in duct" applications.
c. Static rated fire dampers have not been U.L. tested against airflow and may not close under medium to high airflow conditions that may be encountered in HVAC systems which do not shut down in event of fire (i.e., smoke control systems).
d. Recommend using dynamically rated fire dampers in all applications.

## 18.07 Smoke Dampers

### A. Smoke Damper Requirements:

1. *1991 NFPA 90A:*
   a. Smoke dampers shall be installed in systems over 15,000 CFM in the supply and return. Exceptions:
      1) When AHU is located on the floor it serves and only serves that floor.
      2) When the AHU is located on the roof and only serves the floor immediately below it.
   b. Smoke dampers shall be installed at or adjacent (2 feet maximum distance from barrier) to the point where air ducts pass through required smoke barriers. See *NFPA 90A* for exceptions.

## 18.08 Combination Fire/Smoke Dampers

### A. Operable Fire Dampers, Smoke Dampers and Combination Fire/Smoke Dampers:

1. Blowout panels should be considered for ductwork systems whenever human operation of fire, smoke, and/or combination fire/smoke dampers is required by code, by local authorities, or for smoke evacuation systems, in the event that the fire department personnel or Owner's operating personnel inadvertently close all the dampers, and system pressures exceed construction pressures of the ductwork.

## 18.09 Smoke Detectors

### A. Smoke Detector Requirements:

1. *1990 BOCA:*
   a. Air distribution systems with capacity greater than 2,000 CFM shall be equipped with smoke detector in return upstream of any filters, decontamination equipment, or outside air intake.
   b. Air distribution systems connecting two or more floors shall have smoke detectors for each return duct on each floor.
   c. Systems that exhaust greater 50% of the supply air shall have smoke detectors in both the return and exhaust.
   d. Activation shall shut down fan, except smoke control equipment shall switch to smoke control mode.

2. *1993 BOCA:*
   a. Supply air distribution systems with capacity greater than 2,000 CFM shall be equipped with smoke detectors downstream of any filters and ahead of any branch connections.
   b. Return air distribution systems with capacity greater than 15,000 CFM shall be equipped with smoke detectors in return air duct or plenum upstream of any filters, exhaust air connections, outdoor air connections, or decontamination equipment.
   c. Systems that exhaust greater than 50% of the supply air shall have smoke detectors in both the return and exhaust.
   d. Smoke detectors shall be installed at each story, upstream of the connection between a return riser serving two or more stories, and air ducts or plenums in return air systems with a design capacity greater than 15,000 CFM.
   e. Activation shall shut down fan, except smoke control equipment shall switch to smoke control mode.
3. *1988 SBCCI:*
   a. Recirculating systems with fan capacity of 2,000 CFM and greater shall be equipped with smoke detector in return upstream of any filters, decontamination equipment, or outside air intake.
   b. Recirculating systems with fan capacity less than 2,000 CFM, but serving an area used for egress, shall be equipped with smoke detector in return upstream of any filters, decontamination equipment or outside air intake.
   c. Activation shall shut down fan. System shall not restart until manually reset.
4. *1988 UBC:*
   a. Air distribution systems with capacity greater than 2,000 CFM shall be equipped with smoke detector in return upstream of any filters, decontamination equipment, or outside air intake.
   b. Activation shall shut down fan.
5. *1991 NFPA 90A:*
   a. Air distribution systems with capacity greater than 2,000 CFM shall be equipped with smoke detector downstream of any filters and ahead of any branch connections in supply air system.
   b. At each story prior to the connection to a common return and prior to any recirculation or fresh air inlet connection in return systems over 15,000 CFM capacity and serving more than 1 story.
   c. Activation shall shut down fan, except smoke control equipment shall switch to smoke control mode.

## 18.10 Sound Attenuators

### A. Types:

1. Rectangular: 3, 5, 7, and 10 foot lengths
2. Round: 2 or 3 times the diameter

### B. Locating:

1. Centrifugal and Axial Fans
   Discharge: 1 duct diameter from discharge for every 1,000 FPM
   Intake: 0.75 duct diameters from intake for ever 1,000 FPM
2. Elbows: 3 duct diameters up and down stream
3. Terminal Boxes: 1 duct diameter down stream

4. Mechanical Equipment Rooms: Install in or close to mechanical equipment room wall opening

## 18.11 Terminal Units

### A. Variable Air Volume (VAV) Terminal Units:

1. VAV w/o Reheat:
   a. Controls space temperature by varying the quantity of supply air.
   b. Supply temperature is constant.
   c. Energy savings is due to reduced supply air quantities and therefore reduced horsepower.
2. VAV w/Reheat:
   a. Integrates heating at the VAV terminal unit to offset heating load, limit maximum humidity, provide reasonable air movement, and provide ventilation air.
3. Minimum CFM for VAV Boxes:
   a. 20% of design flow: Perimeter Spaces.
   b. 0% of design flow: Interior Spaces.
   c. When interior spaces are occupied or lights are on, the VAV terminal unit will maintain a minimum flow to offset the heat gain. Therefore, the only time a VAV terminal unit serving an interior space will be closed is when the space is unoccupied and lights are off.

### B. Fan Powered Terminal Units:

1. Parallel Fan Powered Terminal Units:
   a. Primary air is modulated in response to cooling demand and fan is energized at a predetermined reduced primary airflow.
   b. Fan is located outside the primary airstream to allow intermittent fan operation.
2. Series Fan Powered Terminal Units:
   a. A constant volume fan mixes primary air with air from the ceiling plenum.
   b. Fan is located within the primary airstream and runs continuously.

### C. Induction Terminal Units:

1. Reduces cooling capacity by reducing primary air and inducing room or ceiling plenum air.
2. Incorporates reduced supply air quantity energy savings of VAV system and air volume to space is constant to reduce effect of stagnant air.

### D. Constant Volume Reheat (CVR) Terminal Units:

1. CVR terminal units provide zone/space control for areas of unequal loading, simultaneous cooling/heating, and close tolerance of temperature control.
2. Conditioned air is delivered to each terminal unit at a fixed temperature then reheated to control space temperature.
3. Energy inefficient system.

### E. Constant Volume Bypass Terminal Units:

1. Variation of CVR system. Constant volume primary air system with VAV secondary system.
2. Supply air to space varied by dumping air to return air plenum.

**F. Dual Duct Terminal Units:**

1. Constant volume of supply air is delivered to the space.
2. Space temperature is maintained by mixing varying amounts of hot and cold air.
3. Energy inefficient system.

**G. VAV Dual Duct Terminal Units:**

1. Variable volume of supply air is delivered to space.
2. Space temperature is maintained by supplying either hot or cold air in varying amounts and limiting the amount of hot and cold air mixing.
3. More energy efficient the standard dual duct systems.

**H. Single Zone Systems:**

1. Supply unit serves single temperature zone and varies supply air temperature to control space temperature.

**I. Multizone Systems:**

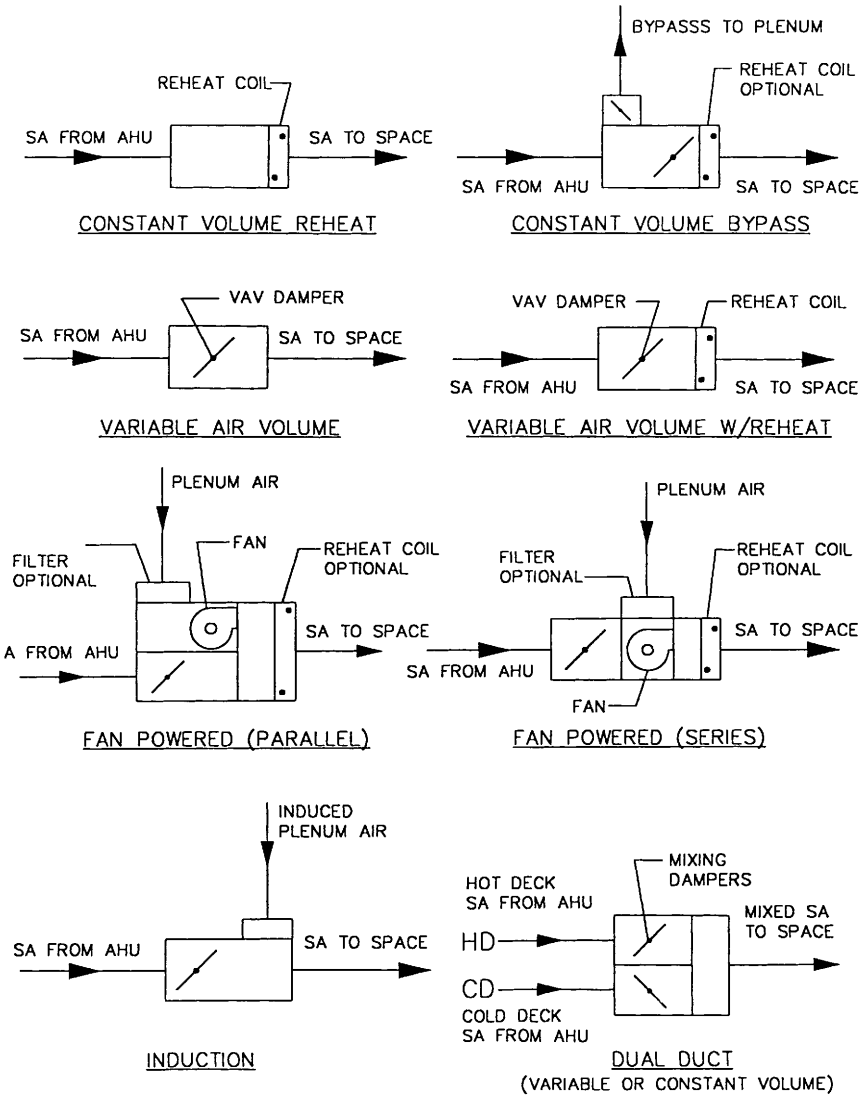
1. Supply unit serves two or more temperature zones and varies supply air temperature to each zone by mixing hot and cold air with zone dampers at the unit to control space temperature.
2. Each zone is served by separate ductwork system.
3. Similar to dual duct system but mixing occurs at unit.
4. Limited number of zones, inflexible system, energy inefficient, and not a recommended system.

**J. Terminal Unit Types:**

1. Pressure Independent Terminal Units: Terminal unit airflow is independent of pressure upstream of box. Recommend using pressure independant terminal units.
2. Pressure Dependant Terminal Units: Terminal unit airflow is dependant on pressure upstream of box.

**K. Terminal Unit Installation:**

1. Locate all terminal units for unobstructed access to unit access panels, controls, and valving.
2. Minimum straight duct length upstream of terminal units:
   a. Manufacturer's generally recommend 1.5 duct diameters based on terminal unit inlet size.
   b. 2.0 duct diameters recommended minimum.
   c. 3.0 to 5.0 duct diameters preferred.
   d. Best to use 3 feet of straight duct upstream of terminal units because you do not have to concern yourself with box size when producing ductwork layout (the maximum terminal unit inlet size is 16 inches with 2 duct diameters, which results in 32 inches, and most of the time you are not using 16 inches terminal units).
3. Duct runout to terminal unit should never be smaller than terminal units inlet size; it may be larger than inlet size. Terminal unit inlet and discharge ductwork should be sized based on ductwork sizing criteria and not the terminal unit inlet and discharge connection sizes. The transition from the inlet and discharge connection sizes to the air terminal unit should be made at the terminal unit. A minimum of 3 feet of straight duct should be provided upstream of all terminal units.




**TERMINAL UNIT TYPES**

**L. Zoning:**

1. Partitioned Offices:
   a. 1, 2, 3, or 4 offices/terminal unit.
   b. 2 or 3 offices/terminal unit most common.
   c. 1 office/terminal unit; most desirable, also most expensive.
2. Open Offices:
   a. 400–1,200 Sq.Ft./terminal Unit.
3. Perimeter and interior spaces should be zoned separately.

4. Group spaces/zones/rooms/areas of similar thermal occupancy:
   a. Offices with offices.
   b. Don't put offices with conference rooms or other dissimilar rooms.
   c. Don't put east offices with south offices, etc.
   d. Corner offices or spaces should be treated separately.

## 18.12 Process Exhaust Systems

**A. Ductwork material must be selected to suit the material or chemical being exhausted–carbon steel, 304 or 316 stainless steel, Teflon or Halar coated stainless steel, fiberglass reinforced plastic (FRP), and polyvinyl chloride (PVC) are some examples. Sprinklers are generally required in FRP and PVC ductwork systems in all sizes larger than 8 inch in diameter.**

**B. Process exhaust ductwork cannot penetrate fire walls, fire separation assemblies, or smoke walls.**

**C. Process exhaust systems should be provided with a blast gate or butterfly damper at each tap for a hood or equipment, at each lateral, and at each submain. At all fans, large laterals, and submains, a tight shutoff style butterfly damper should be provided for balancing and positive shutoff in addition to the blast gate. Blast gates should be specified with a wiper gasket, of EPDM or other suitable material, to provide as tight a seal as possible for blast gates; otherwise blast gates tend to experience high leakage rates. Wind loading on blast gates installed on the roof or outside the building need to be considered, especially in large blast gates. Blast gate blades will act as a sail in the wind and cause considerable stress on the ductwork system.**

**D. Process exhaust ductwork should be sloped a minimum of 1⁄8 inch per foot with a drain provided at the low point. The drain should be piped to the appropriate waste system.**

**E. Process exhaust systems are required, in most cases, to undergo a treatment process–scrubbing, abatement, burning, or filtering.**

**F. Duct sizing must be based on capture velocities and entrainment velocities of the material or chemical being exhausted. For most chemical or fume exhaust systems, the mains, risers, submains, and large laterals should be sized for 2,000 to 3,000 feet per minute, and small laterals and branches should be sized for 1,500 to 2,500 feet per minute. Discharge stacks should be sized for 3,000 to 4,000 feet per minute discharge velocity and should terminate a minimum of 8 feet above the roof and a minimum of 10 feet from any openings or intakes. Properly locate discharge stacks and coordinate discharge height to prevent contamination of outside air intakes, CT intakes, and combustion air intakes. Clearly indicate termination heights.**

**G. The connection to a fume hood or other piece of equipment will generally require between 1.0 and 3.0 inches WC negative pressure.**

**H. Branches and laterals should be connected above duct centerline. If branches and laterals are connected below the duct centerline, drains will be required at the low**

**point. Hoods, tools, and equipment must be protected from the possibility of drainage contaminating or entering equipment when taps are connected below the centerline.**

**I. Specify proper pressure class upstream and downstream of scrubbers and other abatement equipment.**

**J. When ductwork is installed outside or in unconditioned spaces, verify if condensation will occur on the outside or inside this duct. Insulate duct and/or heat trace if required.**

**K. Process exhaust fans are required to be on emergency power by code.**

**L. Process exhaust ductwork cannot penetrate fire rated construction. Fire dampers are generally not desirable. If penetrating fire rated construction cannot be avoided, process exhaust ductwork must be enclosed in a fire rated enclosure until it exits the building or sprinkler protection in side the duct may be used if approved by authority having jurisdiction.**

**M. Provide pressure ports at the end of all laterals, submains, and mains.**

**N. Generally, drains are required in fan scroll, scrubber, and other abatement equipment.**

**O. Provide flexible connections at fans and specify flexible connection suitable for application.**

**P. If adjustable or variable frequency drives are required or used, locate and coordinated with electrical engineer. Use direct drive fans with adjustable or variable frequency drives.**