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SECTION 3 OUTLINE EXAMPLE

MODULE DEFINITIONS:

Load calculation: Building load calculations consider a variety of issues: location (Boston's weather is different than that of Los Angeles), orientation (southwest glass gets much more sun than north glass), construction materials (Rvalue of insulation, brick or siding, etc.), building size, etc. Heating and cooling needs are expressed in British Thermal Units per hour or Btu/h. A "block load" looks at the whole building's requirements as one large room. A "room-by-room" load calculation refines the calculation to determine individual room's or zone's requirements.

Ton (of air conditioning): A "ton" of air conditioning refers to capacity in relation to melting one ton of ice in 24 hours. The capacity is measured in British Thermal Units (Btu); 288,000 Btu are required to melt one ton of ice in 24- hours (or 12,000 Btu/hr). A 2-ton air conditioner has a nominal capacity of about 24,000 Btu/h.

Manufacturer's performance data: This is information provided by the manufacturer to specify the capacity for a particular model. You may hear cooling terms like 2-ton or 3.5-ton. These are nominal capacities at standard rating points. For heating systems, the Btu/h are expressed by how much heating capacity goes into the furnace (i.e., an 80% efficient, 80,000 Btu/h furnace receives enough fuel to create 64,000 Btu/h of output heat).

Equipment selection: Equipment is manufactured to meet standardized performance requirements. Manufacturers publish expanded performance data that details how the equipment performs at actual operating conditions. Applying the manufacturer's performance data to your home's load is essential to saving energy with the right unit.

Efficiency: Performance descriptors for cooling are Seasonal Energy Efficiency Ratio (SEER) and Energy Efficiency Ration (EER). Heating application descriptors are Coefficient of Performance (COP) and Heating Seasonal Performance Factor (HSPF). These are determined under laboratory conditions.

Certified matched system: The Air Conditioning, Heating, and Refrigeration Institute (AHRI; www.ahrinet.org) puts heating and cooling equipment through rigorous certification processes to ensure systems deliver the promised performance at certain test conditions.

Combustion analysis: When fossil fuels are used to heat a home, furnaces and boilers should be adjusted to ensure that they are efficiently consuming fuel and that they have sufficient oxygen to properly combust the fuel. A combustion analysis test, with a properly calibrated meter, is an optimal approach to verify the combustion rate.

Vent system: When fossil fuels are used to heat a home they produce carbon monoxide (CO). You must verify that the vent piping is the correct size and properly installed. A CO test is supplemental to ensure that the furnace or boiler is venting properly, exhausting all of the harmful gases away from the occupants.

IMC CHAPTER 3 SECTION 305 PIPING SUPPORT [2012] Code Excerpts

305.1 General.

All mechanical system piping shall be supported in accordance with this section.

305.2 Materials.

Pipe hangers and supports shall have sufficient strength to withstand all anticipated static and specified dynamic loading conditions associated with the intended use. Pipe hangers and supports that are in direct contact with piping shall be of approved materials that are compatible with the piping and that will not promote galvanic action.

305.3 Structural attachment.

Hangers and anchors shall be attached to the building construction in an approved manner.

305.4 Interval of support.

Piping shall be supported at distances not exceeding the spacing specified in Table 305.4, or in accordance with MSS SP-69.

TABLE 305.4 PIPING SUPPORT SPACING

305.5 Protection against physical damage.

In concealed locations where piping, other than cast-iron or steel, is installed through holes or notches in studs, joists, rafters or similar members less than 1-1/2 inches (38 mm) from the nearest edge of the member, the pipe shall be protected by shield plates. Protective steel shield plates having a minimum thickness of 0.0575 inch (1.463 mm) (No. 16 gage) shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 2 inches (51 mm) above sole plates and below top plates.

IMC CHAPTER 3 SECTION 306 ACCESS AND SERVICE SPACE [2012] Code Excerpts

306.1 Access for maintenance and replacement.

Appliances shall be accessible for inspection, service, repair and replacement without disabling the function of a fire-resistance-rated assembly or removing permanent construction, other appliances, venting systems or any other piping or ducts not connected to the appliance being inspected, serviced, repaired or replaced. A level working space at least 30 inches deep and 30 inches wide (762 mm by 762 mm) shall be provided in front of the control side to service an appliance.

306.1.1 Central furnaces.

Central furnaces within compartments or alcoves shall have a minimum working space clearance of 3 inches (76 mm) along the sides, back and top with a total width of the enclosing space being at least 12 inches (305 mm) wider than the furnace. Furnaces having a firebox open to the atmosphere shall have at least 6 inches (152 mm) working space along the front combustion chamber side. Combustion air openings at the rear or side of the compartment shall comply with the requirements of Chapter 7.

Exception: This section shall not apply to replacement appliances installed in existing compartments and alcoves where the working space clearances are in accordance with the equipment or appliance manufacturer’s installation instructions.

306.2 Appliances in rooms.

Rooms containing appliances shall be provided with a door and an unobstructed passageway measuring not less than 36 inches (914 mm) wide and 80 inches (2032 mm) high.

Exception: Within a dwelling unit, appliances installed in a compartment, alcove, basement or similar space shall be accessed by an opening or door and an unobstructed passageway measuring not less than 24 inches (610 mm) wide and large enough to allow removal of the largest appliance in the space, provided that a level service space of not less than 30 inches (762 mm) deep and the height of the appliance, but not less than 30 inches (762 mm), is present at the front or service side of the appliance with the door open.

306.3 Appliances in attics.

Attics containing appliances shall be provided with an opening and unobstructed passageway large enough to allow removal of the largest appliance. The passageway shall not be less than 30 inches (762 mm) high and 22 inches (559 mm) wide and not more than 20 feet (6096 mm) in length measured along the centerline of the passageway from the opening to the appliance. The passageway shall have continuous solid flooring not less than 24 inches (610 mm) wide. A level service space not less than 30 inches (762 mm) deep and 30 inches (762 mm) wide shall be present at the front or service side of the appliance. The clear access opening dimensions shall be a minimum of 20 inches by 30 inches (508 mm by 762 mm), and large enough to allow removal of the largest appliance.

Exceptions:

1. The passageway and level service space are not required where the appliance is capable of being serviced and removed through the required opening.
2. Where the passageway is unobstructed and not less than 6 feet (1829 mm) high and 22 inches (559 mm) wide for its entire length, the passageway shall be not greater than 50 feet (15 250 mm) in length.

306.3.1 Electrical requirements.

A luminaire controlled by a switch located at the required passageway opening and a receptacle outlet shall be provided at or near the appliance location in accordance with NFPA 70.

IMC CHAPTER 3 SECTION 307 CONDENSATE DISPOSAL [2012] Code Excerpts

307.1 Fuel-burning appliances.

Liquid combustion by-products of condensing appliances shall be collected and discharged to an approved plumbing fixture or disposal area in accordance with the manufacturer’s installation instructions. Condensate piping shall be of approved corrosion-resistant material and shall not be smaller than the drain connection on the appliance. Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than one-eighth unit vertical in 12 units horizontal (1-percent slope).

307.2 Evaporators and cooling coils.

Condensate drain systems shall be provided for equipment and appliances containing evaporators or cooling coils. Condensate drain systems shall be designed, constructed and installed in accordance with Sections 307.2.1 through 307.2.4.

307.2.1 Condensate disposal.

Condensate from all cooling coils and evaporators shall be conveyed from the drain pan outlet to an approved place of disposal. Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than one-eighth unit vertical in 12 units horizontal (1-percent slope). Condensate shall not discharge into a street, alley or other areas so as to cause a nuisance.

307.2.2 Drain pipe materials and sizes.

Components of the condensate disposal system shall be cast iron, galvanized steel, copper, cross-linked polyethylene, polybutylene, polyethylene, ABS, CPVC or PVC pipe or tubing. All components shall be selected for the pressure and temperature rating of the installation. Joints and connections shall be made in accordance with the applicable provisions of Chapter 7 of the International Plumbing Code relative to the material type. Condensate waste and drain line size shall be not less than 3/4-inch (19 mm) internal diameter and shall not decrease in size from the drain pan connection to the place of condensate disposal. Where the drain pipes from more than one unit are manifolded together for condensate drainage, the pipe or tubing shall be sized in accordance with Table 307.2.2.

TABLE 307.2.2 CONDENSATE DRAIN SIZING

307.2.3 Auxiliary and secondary drain systems.

In addition to the requirements of Section 307.2.1, where damage to any building components could occur as a result of overflow from the equipment primary condensate removal system, one of the following auxiliary protection methods shall be provided for each cooling coil or fuel-fired appliance that produces condensate:

1. An auxiliary drain pan with a separate drain shall be provided under the coils on which condensation will occur. The auxiliary pan drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The pan shall have a minimum depth of 1-1/2 inches (38 mm), shall not be less than 3 inches (76 mm) larger than the unit or the coil dimensions in width and length and shall be constructed of corrosion-resistant material. Galvanized sheet steel pans shall have a minimum thickness of not less than 0.0236 inch (0.6010 mm) (No. 24 gage). Nonmetallic pans shall have a minimum thickness of not less than 0.0625 inch (1.6mm).
2. A separate overflow drain line shall be connected to the drain pan provided with the equipment. Such overflow drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The overflow drain line shall connect to the drain pan at a higher level than the primary drain connection.
3. An auxiliary drain pan without a separate drain line shall be provided under the coils on which condensate will occur. Such pan shall be equipped with a water-level detection device conforming to UL 508 that will shut off the equipment served prior to overflow of the pan. The auxiliary drain pan shall be constructed in accordance with Item 1 of this section.
4. A water-level detection device conforming to UL 508 shall be provided that will shut off the equipment served in the event that the primary drain is blocked. The device shall be installed in the primary drain line, the overflow drain line, or in the equipment- supplied drain pan, located at a point higher than the primary drain line connection and below the overflow rim of such pan.

Exception: Fuel-fired appliances that automatically shut down operation in the event of a stoppage in the condensate drainage system.

Procedures For HVAC System Design and Installation

The goal for a Heating, Ventilation and Air Conditioning (HVAC) system is to provide proper air flow, heating, and cooling to each room. This page sets out key criteria that describe a quality system, and key design and installation considerations that should be met to achieve this goal.

Criteria for a Quality HVAC System

An HVAC system should:

- Be properly sized to provide correct air flow, and meet room-by-room calculated heating and cooling loads.

- Be installed so that the static air pressure drop across the handler is within manufacturer and design specifications to have the capacity to meet the calculated loads.

- Have sealed supply ductwork that will provide proper air flow.

- Be installed with a return system sized to provide correct return air flow.

- Have sealed return ductwork that will provide proper air flow to the fan, and avoid air entering the HVAC system from polluted zones (e.g., fumes from autos and stored chemicals, and attic particulates).

- Have balanced air flows between supply and return systems to maintain neutral pressure in the home.

- Minimize duct air temperature gain or loss between the air handler and room registers, and between return registers and the air handler.

- Be properly charged with refrigerant.

- Have proper burner operation and proper draft.

Design and Install an Air Distribution System

The following steps should be followed in the design and installation of the HVAC system to ensure efficiency and comfort:

- Determine room-by-room loads and air-flows.

- Layout duct system on floor plan, accounting for the direction of joists, roof hips, fire-walls, and other potential obstructions. Determine register locations and types, duct lengths, and connections required to produce layout given construction constraints.

- Size duct system.

- Size HVAC equipment.

- Install equipment and ducts according to design specifications.
- The duct system should be substantially air tight.

- Charge the system appropriately, and verify charge with the evaporator superheat method or subcooling method.

- Check for proper furnace burner operation and fire-box drafting.

- Test the system to ensure that it performs properly by determining (1) that the system is properly sized, (2) it does not leak substantially, and has either (3a) proper air handler fan flow, and proper plenum static pressures, or (3b) proper room and return air flows, and proper plenum static pressures.

DESIGN, FABRICATION AND INSTALLATION

The following are design, fabrication and installation guidelines, that, if carefully followed, will provide a duct installation that is substantially airtight:

General Issues

- Ducts, plenums, and fittings should be constructed of galvanized metal, duct board, or flexible duct.
- The air handler box should be air-tight;
- Air filters should be easily accessible for replacement, and evaporator coils should be easily accessible for cleaning;
- Ducts should be configured and supported so as to prevent use of excess material, prevent dislocation or damage, and prevent constriction of ducts below their rated diameter;
- Flexible duct bends should not be made across sharp corners or have incidental contact with metal fixtures, pipes, or conduits that can compress or damage the ductwork;
- Sheet metal collars and sleeves should be beaded to hold drawbands.

FABRICATE AND INSTALL AN AIRTIGHT DUCT SYSTEM

All Duct Types

All joints and seams of duct systems and their components should be sealed with mastic, mastic and embedded mesh, or pressure-sensitive tape approved for use by the duct manufacturer and meeting UL181 specifications ("approved tape"); this includes around junctions of collars to distribution boxes and plenums;

All sealants should be used in strict accordance with manufacturer's installation instructions and within sealants moisture and temperature limitations;

All tapes used as part of duct system installation should be applied to clean, dry surfaces and sealed with manufacturer's recommended amount of pressure or heat. If oil is present, taped surfaces should be prepared with a cleaner / degreaser prior to application;

It is recommended that all register boxes should be sealed to the drywall or floor with caulking or mastic.

Flexible Ducts

Flexible ducts should be joined by a metal sleeve, collar, coupling, or coupling system. At least 2 inches of the beaded sleeve, collar, or coupling must extend into the inner core while allowing a 1 inch attachment area on the sleeve, collar, or coupling for the application of tape;

The inner core should be mechanically fastened to all fittings, preferably using drawbands installed directly over the inner core and beaded fitting. If beaded sleeves and collars are not used, then the inner core should be fastened to the fitting using #8 screws equally spaced around the diameter of the duct, and installed to capture the wire coil of the inner liner (3 screws for ducts up to 12" diameter, and 5 screws for ducts over 12" diameter);

The inner core should be sealed to the fitting with mastic or approved tape;

Tape used for sealing the inner core should be applied with at least 1 inch of tape on the duct lining, 1 inch of tape on the fitting of flange, and wrapped at least three times;

The outer sleeve (vapor barrier) should be sealed at connections with a drawband and/or three wraps of approved tape;

The vapor barrier should be complete. All holes, rips, and seams must be sealed with mastic or approved tape.

Metal Ducts and Plenums

Metal-to-metal connections should be cleaned and sealed in accordance with manufacturer's specifications;

Openings greater than 1/16 inch should be sealed with mastic and mesh, or butyl adhesive tape;

Openings less than 1/16 inch should be sealed with mastic or UL-181A listed tape;

Special attention should be paid to collar connections to duct-board and/or sheet metal; seal around the connection with mastic;

Connections between collars and distribution boxes should be sealed with mastic or approved tape;

At least three equally-spaced #8 screws should be used to mechanically fasten round ducts (3 screws for ducts up to 12" diameter, and 5 screws for ducts over 12" diameter);

Crimp joints should have a contact lap of at least 1-1/2 inches;

Square or rectangular ducts should be mechanically fastened with at least one screw per side.

Duct Board

Duct board connections should be sealed with adhesive, mastic, or UL 181A listed pressure-sensitive or heat-activated tape in accordance with manufacturer's specifications.

Duct Support

Supports should be installed per manufacturer's specifications or per UMC requirements;

Supports for flexible ducts should be spaced at no more than 4 foot intervals;

Flexible ducts should be supported by strapping having a minimum width of 1-1/2 inches at all contact points with the duct;

Supports should not constrict the inner liner of the duct;

Flexible ducts should have maximum of 1/2 inch sag per foot between supports;

Flexible ducts may rest on ceiling joists or truss supports as long as they lie flat and are supported at no more that 4 foot intervals.

SECTION 3 EXAMPLE TEST QUESTIONS

Condensate from all cooling coils and evaporators shall be conveyed from the drain pan outlet to an approved place of disposal, and shall maintain a minimum horizontal slope in the direction of discharge of not less than:

- 5-percent slope.
- 3-percent slope.
- 2-percent slope.
- 1-percent slope.

The minimum depth of an auxiliary drain pan with a separate drain, used where damage to any building components could occur as a result of overflow from the equipment primary condensate removal system, is:

- 3-1/2 inches.
- 2-1/2 inches.
- 1-1/2 inches.
- none of the above.

A level working space at least _____ shall be provided in front of the control side to service an appliance.

- 20 inches deep and 20 inches wide.
- 30 inches deep and 30 inches wide.
- 60 inches deep and 60 inches wide.
- none of the above.

Supports for flexible ducts should be spaced at no more than:

- 8 foot intervals.
- 6 foot intervals.
- 4 foot intervals.
- none of the above.

Condensate waste and drain line size shall be not less than _____ internal diameter and shall not decrease in size from the drain pan connection to the place of condensate disposal.

- 1/2-inch.
- 3/4-inch.
- 7/8-inch.
- none of the above.