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BUILDING ENERGY EFFICIENCY STANDARDS

FOR RESIDENTIAL AND NONRESIDENTIAL BUILDINGS

TITLE 24, PART 6 AND ASSOCIATED
ADMINISTRATIVE REGULATIONS IN PART 1

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CALIFORNIA ENERGY COMMISSION
Edmund G. Brown Jr., Governor

SUBCHAPTER 3

NONRESIDENTIAL, HIGH-RISE RESIDENTIAL, HOTEL/MOTEL OCCUPANCIES, AND COVERED PROCESSES—MANDATORY REQUIREMENTS

SECTION 120.0— GENERAL

Sections 120.1 through 120.9 establish requirements for the design and installation of building envelopes, ventilation, space-conditioning and service water-heating systems and equipment in nonresidential, high-rise residential, and hotel/motel buildings as well as covered processes that are subject to Title 24, Part 6. All such buildings and covered processes shall comply with the applicable provisions of Sections 120.1 through 120.9.

SECTION 120.1 – REQUIREMENTS FOR VENTILATION

All nonresidential, high-rise residential, and hotel/motel occupancies shall comply with the requirements of Section 120.1(a) through 120.1(e).

(a) General Requirements.

1. All enclosed spaces in a building shall be ventilated in accordance with the requirements of this section and the CBC.

EXCEPTION to Section 120.1(a)1: Refrigerated warehouses and other spaces or buildings that are not normally used for human occupancy and work.

2. The outdoor air-ventilation rate and air-distribution assumptions made in the design of the ventilating system shall be clearly identified on the plans required by Section 10-103 of Title 24, Part 1.

(b) Design Requirements for Minimum Quantities of Outdoor Air.

Every space in a building shall be designed to have outdoor air ventilation according to Item 1 or 2 below:

1. Natural ventilation.

- A. Naturally ventilated spaces shall be permanently open to and within 20 feet of operable wall or roof openings to the outdoors, the openable area of which is not less than 5 percent of the conditioned floor area of the naturally ventilated space. Where openings are covered with louvers or otherwise obstructed, openable area shall be based on the free unobstructed area through the opening.

EXCEPTION to Section 120.1(b)1A: Naturally ventilated spaces in high-rise residential dwelling units and hotel/motel guest rooms shall be open to and within 25 feet of operable wall or roof openings to the outdoors.

- B. The means to open required operable openings shall be readily accessible to building occupants whenever the space is occupied.

2. **Mechanical ventilation.** Each space that is not naturally ventilated under Item 1 above shall be ventilated with a mechanical system capable of providing an outdoor air rate no less than the larger of:

- A. The conditioned floor area of the space times the applicable ventilation rate from TABLE 120.1-A; or
- B. 15 cfm per person times the expected number of occupants.

For meeting the requirement in Section 120.1(b)2B for spaces without fixed seating, the expected number of occupants shall be either the expected number specified by the building designer or one half of the maximum occupant load assumed for egress purposes in the CBC, whichever is greater. For spaces with fixed seating, the expected number of occupants shall be determined in accordance with the CBC.

EXCEPTION to Section 120.1(b)2: Transfer air. The rate of outdoor air required by Section 120.1(b)2 may be provided with air transferred from other ventilated spaces if:

- A. None of the spaces from which air is transferred have any unusual sources of indoor air contaminants; and
- B. The outdoor air that is supplied to all spaces combined, is sufficient to meet the requirements of Section 120.1(b)2 for each space individually.

(c) Operation and Control Requirements for Minimum Quantities of Outdoor Air.

1. **Times of occupancy.** The minimum rate of outdoor air required by Section 120.1(b)2 shall be supplied to each space at all times when the space is usually occupied.

EXCEPTION 1 to Section 120.1(c)1: Demand control ventilation. In intermittently occupied spaces that do not have processes or operations that generate dusts, fumes, mists, vapors or gasses and are not provided with local exhaust ventilation (such as indoor operation of internal combustion engines or areas designated for unvented food service preparation), the rate of outdoor air may be reduced if the ventilation system

serving the space is controlled by a demand control ventilation device complying with Section 120.1(c)4 or by an occupant sensor ventilation control device complying with Section 120.1(c)5.

EXCEPTION 2 to Section 120.1(c)1: Temporary reduction. The rate of outdoor air provided to a space may be reduced below the level required by Section 120.1(b)2 for up to 30 minutes at a time if the average rate for each hour is equal to or greater than the required ventilation rate.

2. **Pre-occupancy.** The lesser of the minimum rate of outdoor air required by Section 120.1(b)2 or 3 complete air changes shall be supplied to the entire building during the 1-hour period immediately before the building is normally occupied.
3. **Required Demand Control Ventilation.** HVAC systems with the following characteristics shall have demand ventilation controls complying with 120.1(c)4:
 - A. They have an air economizer; and
 - B. They serve a space with a design occupant density, or a maximum occupant load factor for egress purposes in the CBC, greater than or equal to 25 people per 1000 ft² (40 square foot or less per person); and
 - C. They are either:
 - i. Single zone systems with any controls; or
 - ii. Multiple zone systems with Direct Digital Controls (DDC) to the zone level.

EXCEPTION 1 to Section 120.1(c)3: Classrooms, call centers, office spaces served by multiple zone systems that are continuously occupied during normal business hours with occupant density greater than 25 people per 1000 ft² per Section 120.1(b)2B, healthcare facilities and medical buildings, and public areas of social services buildings are not required to have demand control ventilation.

EXCEPTION 2 to Section 120.1(c)3: Where space exhaust is greater than the design ventilation rate specified in Section 120.1(b)2B minus 0.2 cfm per ft² of conditioned area.

EXCEPTION 3 to Section 120.1(c)3: Spaces that have processes or operations that generate dusts, fumes, mists, vapors, or gases and are not provided with local exhaust ventilation, such as indoor operation of internal combustion engines or areas designated for unvented food service preparation, or beauty salons shall not install demand control ventilation.

EXCEPTION 4 to Section 120.1(c)3: Spaces with an area of less than 150 square feet, or a design occupancy of less than 10 people per Section 120.1(b)2B.

EXCEPTION 5 to Section 120.1(c)3: Spaces with an area of less than 1,500 square feet complying with Section 120.1(c)5.

4. **Demand Control Ventilation Devices.**
 - A. For each system with demand control ventilation, CO₂ sensors shall be installed in each room that meets the criteria of Section 120.1(c)3 with no less than one sensor per 10,000 ft² of floor space. When a zone or a space is served by more than one sensor, signal from any sensor indicating that CO₂ is near or at the setpoint within a space, shall trigger an increase in ventilation to the space;
 - B. CO₂ sensors shall be located in the room between 3 ft and 6 ft above the floor or at the anticipated height of the occupants heads;
 - C. Demand ventilation controls shall maintain CO₂ concentrations less than or equal to 600 ppm plus the outdoor air CO₂ concentration in all rooms with CO₂ sensors;

EXCEPTION to Section 120.1(c)4C: The outdoor air ventilation rate is not required to be larger than the design outdoor air ventilation rate required by Section 120.1(b)2 regardless of CO₂ concentration.
 - D. Outdoor air CO₂ concentration shall be determined by one of the following:
 - i. CO₂ concentration shall be assumed to be 400 ppm without any direct measurement; or
 - ii. CO₂ concentration shall be dynamically measured using a CO₂ sensor located within 4 ft of the outdoor air intake.

- E. When the system is operating during hours of expected occupancy, the controls shall maintain system outdoor air ventilation rates no less than the rate listed in TABLE 120.1-A times the conditioned floor area for spaces with CO₂ sensors, plus the rate required by Section 120.1(b)2 for other spaces served by the system, or the exhaust air rate whichever is greater;
 - F. CO₂ sensors shall be certified by the manufacturer to be accurate within plus or minus 75 ppm at a 600 and 1000 ppm concentration when measured at sea level and 25°C, factory calibrated, and certified by the manufacturer to require calibration no more frequently than once every 5 years. Upon detection of sensor failure, the system shall provide a signal which resets to supply the minimum quantity of outside air to levels required by Section 120.1(b)2 to the zone serviced by the sensor at all times that the zone is occupied.
 - G. The CO₂ sensor(s) reading for each zone shall be displayed continuously, and shall be recorded on systems with DDC to the zone level.
5. **Occupant Sensor Ventilation Control Devices.** When occupancy sensor ventilation devices are required by Section 120.2(e)3 or when meeting EXCEPTION 5 to Section 120.1(c)3, occupant sensors shall be used to reduce the rate of outdoor air flow when occupants are not present in accordance with the following:
- A. Occupant sensors shall meet the requirements in Section 110.9(b)4 and shall have suitable coverage and placement to detect occupants in the entire space ventilated. Occupant sensors controlling lighting may be used for ventilation as long as the ventilation signal is independent of daylighting, manual lighting overrides or manual control of lighting. When a single zone damper or a single zone system serves multiple rooms, there shall be an occupancy sensor in each room and the zone is not considered vacant until all rooms in the zone are vacant.
 - B. One hour prior to normal scheduled occupancy, the occupancy sensor ventilation control shall allow pre-occupancy purge as described in Section 120.1(c)2.
 - C. Within 30 minutes after being vacant for all rooms served by a zone damper on a multiple zone system, and the space temperature is between the heating and cooling setpoints, then no outside air is required and supply air shall be zero.
 - D. Within 30 minutes after being vacant for all rooms served by a single zone system, the single zone system shall cycle off the supply fan when the space temperature is between the heating and cooling setpoints.
 - E. In spaces equipped with an occupant sensor, when vacant during hours of expected occupancy and the occupied ventilation rate required by Section 120.1(b)2 is not provided, then the system or zone controls shall cycle or operate to maintain the average outdoor air rate over an averaging period of 120 minutes equal to 25percent of the rate listed in TABLE 120.1-A.

Exception to 120.1(c)5: If Demand Control Ventilation is implemented as required by Section 120.1(4).

- (d) **Ducting for Zonal Heating and Cooling Units.** Where a return plenum is used to distribute outdoor air to a zonal heating or cooling unit which then supplies the air to a space in order to meet the requirements of Section 120.1(b)2, the outdoor air shall be ducted to discharge either:
 - 1. Within 5 feet of the unit; or
 - 2. Within 15 feet of the unit, substantially toward the unit, and at a velocity not less than 500 feet per minute.
- (e) **Design and Control Requirements for Quantities of Outdoor Air.**
 - 1. All mechanical ventilation and space-conditioning systems shall be designed with and have installed ductwork, dampers, and controls to allow outside air rates to be operated at the larger of (1) the minimum levels specified in Section 120.1(b) or (2) the rate required for make-up of exhaust systems that are required for an exempt or covered process, for control of odors, or for the removal of contaminants within the space.
 - 2. All variable air volume mechanical ventilation and space-conditioning systems shall include dynamic controls that maintain measured outside air ventilation rates within 10 percent of the required outside air ventilation rate at both full and reduced supply airflow conditions. Fixed minimum damper position is not considered to be dynamic and is not an allowed control strategy.

3. Measured outdoor air rates of constant volume mechanical ventilation and space-conditioning systems shall be within 10 percent of the required outside air rate.

TABLE 120.1-A MINIMUM VENTILATION RATES

| TYPE OF USE | CFM PER SQUARE FOOT OF CONDITIONED FLOOR AREA |
|--|--|
| Auto Repair Workshops | 1.50 |
| Barber Shops | 0.40 |
| Bars, cocktail lounges, and casinos | 0.20 |
| Beauty shops | 0.40 |
| Coin-operated dry cleaning | 0.30 |
| Commercial dry cleaning | 0.45 |
| High-rise residential | Ventilation Rates Specified by the CBC |
| Hotel guest rooms (less than 500 ft ²) | 30 cfm/guest room |
| Hotel guest rooms (500 ft ² or greater) | 0.15 |
| Retail stores | 0.20 |
| All others | 0.15 |

SECTION 120.2 – REQUIRED CONTROLS FOR SPACE-CONDITIONING SYSTEMS

Space-conditioning systems shall be installed with controls that comply with the applicable requirements of Subsections (a) through (i).

- (a) **Thermostatic Controls for Each Zone.** The supply of heating and cooling energy to each space-conditioning zone or dwelling unit shall be controlled by an individual thermostatic control that responds to temperature within the zone and that meets the applicable requirements of Section 120.2(b).

EXCEPTION to Section 120.2(a): An independent perimeter heating or cooling system may serve more than one zone without individual thermostatic controls if:

1. All zones are also served by an interior cooling system;
2. The perimeter system is designed solely to offset envelope heat losses or gains;
3. The perimeter system has at least one thermostatic control for each building orientation of 50 feet or more; and
4. The perimeter system is controlled by at least one thermostat located in one of the zones served by the system.

- (b) **Criteria for Zonal Thermostatic Controls.** The individual thermostatic controls required by Section 120.2(a) shall meet the following requirements as applicable:

1. Where used to control comfort heating, the thermostatic controls shall be capable of being set, locally or remotely, down to 55°F or lower.
2. Where used to control comfort cooling, the thermostatic controls shall be capable of being set, locally or remotely, up to 85°F or higher.
3. Where used to control both comfort heating and comfort cooling, the thermostatic controls shall meet Items 1 and 2 and shall be capable of providing a temperature range or dead band of at least 5°F within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

EXCEPTION to Section 120.2(b)3: Systems with thermostats that require manual changeover between heating and cooling modes.

4. Thermostatic controls for all unitary single zone, air conditioners, heat pumps, and furnaces, shall comply with the requirements of Section 110.2(c) and Reference Joint Appendix JA5 or, if equipped with DDC to the Zone level, with the Automatic Demand Shed Controls of Section 120.2(h).

EXCEPTION 1 to Section 120.2(b)4: Systems serving exempt process loads that must have constant temperatures to prevent degradation of materials, a process, plants or animals.

EXCEPTION 2 to Section 120.2(b)4: Gravity gas wall heaters, gravity floor heaters, gravity room heaters, non-central electric heaters, fireplaces or decorative gas appliances, wood stoves, room air conditioners, and room air-conditioner heat pumps.

- (c) **Hotel/Motel Guest Room and High-rise Residential Dwelling Unit Thermostats.**

1. Hotel/motel guest room thermostats shall:
 - A. Have numeric temperature setpoints in °F and °C; and
 - B. Have setpoint stops, which are accessible only to authorized personnel, such that guest room occupants cannot adjust the setpoint more than ±5°F (±3°C); and
 - C. Meet the requirements of Section 150.0(i).

EXCEPTION to Section 120.2(c)1: Thermostats that are integrated into the room heating and cooling equipment.

2. High-rise residential dwelling unit thermostats shall meet the requirements of Section 150.0(i).

- (d) **Heat Pump Controls.** All heat pumps with supplementary electric resistance heaters shall be installed with controls that comply with Section 110.2(b).
- (e) **Shut-off and Reset Controls for Space-conditioning Systems.** Each space-conditioning system shall be installed with controls that comply with the following:

1. The control shall be capable of automatically shutting off the system during periods of nonuse and shall have:
 - A. An automatic time switch control device complying with Section 110.9, with an accessible manual override that allows operation of the system for up to 4 hours; or
 - B. An occupancy sensor; or
 - C. A 4-hour timer that can be manually operated.

EXCEPTION to Section 120.2(e)1: Mechanical systems serving retail stores and associated malls, restaurants, grocery stores, churches, and theaters equipped with 7-day programmable timers.

2. The control shall automatically restart and temporarily operate the system as required to maintain:
 - A. A setback heating thermostat setpoint if the system provides mechanical heating; and

EXCEPTION to Section 120.2(e)2A: Thermostat setback controls are not required in nonresidential buildings in areas where the Winter Median of Extremes outdoor air temperature determined in accordance with Section 140.4(b)4 is greater than 32°F.

- B. A setup cooling thermostat setpoint if the system provides mechanical cooling.

EXCEPTION to Section 120.2(e)2B: Thermostat setup controls are not required in nonresidential buildings in areas where the Summer Design Dry Bulb 0.5 percent temperature determined in accordance with Section 140.4(b)4 is less than 100°F.

3. Multipurpose room less than 1000 ft², classrooms greater than 750 ft² and conference, convention, auditorium and meeting center rooms greater than 750 ft² that do not have processes or operations that generate dusts, fumes, vapors or gasses shall be equipped with occupant sensor(s) to accomplish the following during unoccupied periods:
 - A. Automatically setup the operating cooling temperature set point by 2°F or more and setback the operating heating temperature set point by 2°F or more; and
 - B. Automatically reset the minimum required ventilation rate with an occupant sensor ventilation control device according to Section 120.1(c)5.

EXCEPTION 1 to Sections 120.2(e)1, 2, and 3: Where it can be demonstrated to the satisfaction of the enforcing agency that the system serves an area that must operate continuously.

EXCEPTION 2 to Sections 120.2(e)1, 2, and 3: Where it can be demonstrated to the satisfaction of the enforcing agency that shutdown, setback, and setup will not result in a decrease in overall building source energy use.

EXCEPTION 3 to Sections 120.2(e)1, 2, and 3: Systems with full load demands of 2 kW or less, if they have a readily accessible manual shut-off switch.

EXCEPTION 4 to Sections 120.2(e)1 and 2: Systems serving hotel/motel guest rooms, if they have a readily accessible manual shut-off switch.

Exception 5 to Sections 120.2(e)3: If Demand Control Ventilation is implemented as required by Section 120.1(c)3 and 120.1(4).

4. Hotel and motel guest rooms shall have captive card key controls, occupancy sensing controls, or automatic controls such that, no longer than 30 minutes after the guest room has been vacated, setpoints are setup at least +5°F (+3°C) in cooling mode and set-down at least -5°F (-3°C) in heating mode.

- (f) **Dampers for Air Supply and Exhaust Equipment.** Outdoor air supply and exhaust equipment shall be installed with dampers that automatically close upon fan shutdown.

EXCEPTION 1 to Section 120.2(f): Where it can be demonstrated to the satisfaction of the enforcing agency that the equipment serves an area that must operate continuously.

EXCEPTION 2 to Section 120.2(f): Gravity and other nonelectrical equipment that has readily accessible manual damper controls.

EXCEPTION 3 to Section 120.2(f): At combustion air intakes and shaft vents.

EXCEPTION 4 to Section 120.2(f): Where prohibited by other provisions of law.

(g) **Isolation Area Devices.** Each space-conditioning system serving multiple zones with a combined conditioned floor area of more than 25,000 square feet shall be designed, installed, and controlled to serve isolation areas.

1. Each zone, or any combination of zones not exceeding 25,000 square feet, shall be a separate isolation area.
2. Each isolation area shall be provided with isolation devices, such as valves or dampers that allow the supply of heating or cooling to be reduced or shut-off independently of other isolation areas.
3. Each isolation area shall be controlled by a device meeting the requirements of Section 120.2(e)1.

EXCEPTION to Section 120.2(g): A zone need not be isolated if it can be demonstrated to the satisfaction of the enforcement agency that the zone must be heated or cooled continuously.

(h) **Automatic Demand Shed Controls.** HVAC systems with DDC to the Zone level shall be programmed to allow centralized demand shed for non-critical zones as follows:

1. The controls shall have a capability to remotely setup the operating cooling temperature set points by 4 degrees or more in all non-critical zones on signal from a centralized contact or software point within an Energy Management Control System (EMCS).
2. The controls shall have a capability to remotely setdown the operating heating temperature set points by 4 degrees or more in all non-critical zones on signal from a centralized contact or software point within an EMCS.
3. The controls shall have capabilities to remotely reset the temperatures in all non-critical zones to original operating levels on signal from a centralized contact or software point within an EMCS.
4. The controls shall be programmed to provide an adjustable rate of change for the temperature setup and reset.
5. The controls shall have the following features:
 - A. Disabled. Disabled by authorized facility operators; and
 - B. Manual control. Manual control by authorized facility operators to allow adjustment of heating and cooling set points globally from a single point in the EMCS; and
 - C. Automatic Demand Shed Control. Upon receipt of a demand response signal, the space-conditioning systems shall conduct a centralized demand shed, as specified in Sections 120.2(h)1 and 120.2(h)2, for non-critical zones during the demand response period.

- (i) **Economizer Fault Detection and Diagnostics (FDD)**. All newly installed air-cooled unitary direct-expansion units, equipped with an economizer and with mechanical cooling capacity at AHRI conditions of greater than or equal to 54,000 Btu/hr, shall include a Fault Detection and Diagnostics (FDD) system in accordance with Subsections 120.2(i)1 through 120.2(i)9. Air-cooled unitary direct expansion units include packaged, split-systems, heat pumps, and variable refrigerant flow (VRF), where the VRF capacity is defined by that of the condensing unit.
1. The following temperature sensors shall be permanently installed to monitor system operation: outside air, supply air, and when required for differential economizer operation, a return air sensor; and
 2. Temperature sensors shall have an accuracy of $\pm 2^{\circ}\text{F}$ over the range of 40°F to 80°F ; and
 3. Refrigerant pressure sensors, if used, shall have an accuracy of ± 3 percent of full scale; and
 4. The controller shall have the capability of displaying the value of each sensor; and
 5. The controller shall provide system status by indicating the following conditions:
 - A. Free cooling available
 - B. Economizer enabled
 - C. Compressor enabled
 - D. Heating enabled
 - E. Mixed air low limit cycle active
 6. The unit controller shall manually initiate each operating mode so that the operation of compressors, economizers, fans, and heating system can be independently tested and verified; and
 7. Faults shall be reported to a fault management application accessible by day-to-day operating or service personnel, or annunciated locally on zone thermostats; and
 8. The FDD system shall detect the following faults:
 - A. Air temperature sensor failure/fault
 - B. Not economizing when it should
 - C. Economizing when it should not
 - D. Damper not modulating
 - E. Excess outdoor air
 9. The FDD System shall be certified by the Energy Commission as meeting requirements of Sections 120.2(i)1 through 120.2(i)8 in accordance with Section 100(h).

SECTION 120.3 – REQUIREMENTS FOR PIPE INSULATION

The piping for all space-conditioning and service water-heating systems with fluid temperatures listed in TABLE 120.3-A shall have the amount of insulation specified in Subsection (a) or (b). Insulation conductivity shall be determined in accordance with ASTM C335 at the mean temperature listed in TABLE 120.3-A, and shall be rounded to the nearest 1/100 Btu-inch per hour per square foot per °F.

Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind, including but not limited to, the following:

Insulation exposed to weather shall be suitable for outdoor service by either being rated by the manufacturer for outdoor use or by being covered e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

Insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall include a vapor retardant located outside the insulation (unless the insulation is inherently vapor retardant), all penetrations and joints of which shall be sealed.

EXCEPTION 1 to Section 120.3: Factory-installed piping within space-conditioning equipment certified under Section 111 or 112.

EXCEPTION 2 to Section 120.3: Piping that conveys fluids with a design operating temperature range between 60°F and 105°F.

EXCEPTION 3 to Section 120.3: Gas piping, cold domestic water piping, condensate drains, roof drains, vents, or waste piping.

EXCEPTION 4 to Section 120.3: Where the heat gain or heat loss to or from piping without insulation will not increase building source energy use.

EXCEPTION 5 to Section 120.3: Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Metal piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to assure that no contact is made with the metal framing.

- (a) For insulation with a conductivity in the range shown in TABLE 120.3-A for the applicable fluid temperature range, the insulation shall have the applicable thickness shown in TABLE 120.3-A.
- (b) For insulation with a conductivity outside the range shown in TABLE 120.3-A for the applicable fluid temperature range, the insulation shall have a minimum thickness as calculated with:

INSULATION THICKNESS EQUATION

$$T = PR \left[\left(1 + \frac{t}{PR} \right)^{\frac{K}{k}} - 1 \right]$$

WHERE:

- T = Minimum insulation thickness for material with conductivity *K*, inches.
- PR = Pipe actual outside radius, inches.
- t = Insulation thickness from TABLE 120.3-A, inches.
- K = Conductivity of alternate material at the mean rating temperature indicated in TABLE 120.3-A for the applicable fluid temperature range, in Btu-inch per hour per square foot per °F.
- k = The lower value of the conductivity range listed in TABLE 120.3-A for the applicable

fluid temperature range, Btu-inch per hour per square foot per °F.

TABLE 120.3-A PIPE INSULATION THICKNESS

| FLUID TEMPERATURE RANGE (°F) | CONDUCTIVITY RANGE (in Btu-inch per hour per square foot per °F) | INSULATION MEAN RATING TEMPERATURE (°F) | NOMINAL PIPE DIAMETER (in inches) | | | | |
|--|--|---|---|-----------|------------|----------|--------------|
| | | | 1 and less | 1 to <1.5 | 1.5 to < 4 | 4 to < 8 | 8 and larger |
| | | | INSULATION THICKNESS REQUIRED (in inches) | | | | |
| Space heating, Hot Water systems (steam, steam condensate and hot water) and Service Water Heating Systems | | | | | | | |
| Above 350 | 0.32-0.34 | 250 | 4.5 | 5.0 | 5.0 | 5.0 | 5.0 |
| 251-350 | 0.29-0.31 | 200 | 3.0 | 4.0 | 4.5 | 4.5 | 4.5 |
| 201-250 | 0.27-0.30 | 150 | 2.5 | 2.5 | 2.5 | 3.0 | 3.0 |
| 141-200 | 0.25-0.29 | 125 | 1.5 | 1.5 | 2.0 | 2.0 | 2.0 |
| 105-140 | 0.22-0.28 | 100 | 1.0 | 1.5 | 1.5 | 1.5 | 1.5 |
| Space cooling systems (chilled water, refrigerant and brine) | | | | | | | |
| 40-60 | 0.21-0.27 | 75 | 0.5 | 0.5 | 1.0 | 1.0 | 1.0 |
| Below 40 | 0.20-0.26 | 50 | 1.0 | 1.5 | 1.5 | 1.5 | 1.5 |

SECTION 120.4 – REQUIREMENTS FOR AIR DISTRIBUTION SYSTEM DUCTS AND PLENUMS

- (a) **CMC Compliance.** All air distribution system ducts and plenums, including, but not limited to, building cavities, mechanical closets, air-handler boxes and support platforms used as ducts or plenums, shall be installed, sealed and insulated to meet the requirements of the 2010 CMC Sections 601.0, 602.0, 603.0, 604.0, 605.0, and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible 3rd Edition, incorporated herein by reference. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened. Openings shall be sealed with mastic, tape, aerosol sealant, or other duct-closure system that meets the applicable requirements of UL 181, UL 181A, or UL 181B. If mastic or tape is used to seal openings greater than 1/4 inch, the combination of mastic and either mesh or tape shall be used.

Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum installed level of R-8:

1. Outdoors; or
2. In a space between the roof and an insulated ceiling; or
3. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces; or
4. In an unconditioned crawlspace; or
5. In other unconditioned spaces.

Portions of supply-air ducts that are not in one of these spaces, including ducts buried in concrete slab, shall be insulated to a minimum installed level of R-4.2 (or any higher level required by CMC Section 605.0) or be enclosed in directly conditioned space.

- (b) **Duct and Plenum Materials.**

1. **Factory-fabricated duct systems.**

- A. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections, and splices, and be labeled as complying with UL 181. UL 181 testing may be performed by UL laboratories or a laboratory approved by the Executive Director.
- B. All pressure-sensitive tapes, heat-activated tapes, and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181 and UL 181A.
- C. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 and UL 181B.
- D. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

2. **Field-fabricated duct systems.**

- A. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants, or other closure systems used for installing field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A, and UL 181B.
- B. Mastic sealants and mesh.
 - i. Sealants shall comply with the applicable requirements of UL 181, UL 181A, and UL 181B, and be nontoxic and water resistant.
 - ii. Sealants for interior applications shall pass ASTM tests C731 (extrudability after aging) and D2202 (slump test on vertical surfaces), incorporated herein by reference.
 - iii. Sealants for exterior applications shall pass ASTM tests C731, C732 (artificial weathering test), and D2202, incorporated herein by reference.

- iv. Sealants and meshes shall be rated for exterior use.
- C. Pressure-sensitive tape. Pressure-sensitive tapes shall comply with the applicable requirements of UL 181, UL 181A, and UL 181B.
- D. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.
- E. Drawbands used with flexible duct.
 - i. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.
 - ii. Drawbands shall have a minimum tensile strength rating of 150 pounds.
 - iii. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.
- F. Aerosol-sealant closures.
 - i. Aerosol sealants shall meet the requirements of UL 723 and be applied according to manufacturer specifications.
 - ii. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.
- (c) All duct insulation product R-values shall be based on insulation only (excluding air films, vapor retarder, or other duct components) and tested C-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C518 or ASTM C177, incorporated herein by reference, and certified pursuant to Section 110.8.
- (d) The installed thickness of duct insulation used to determine its R-value shall be determined as follows:
 - 1. For duct board, duct liner, and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
 - 2. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.
 - 3. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.
- (e) Insulated flexible duct products installed to meet this requirement must include labels, in maximum intervals of 3 feet, showing the thermal performance R-value for the duct insulation itself (excluding air films, vapor retarder, or other duct components), based on the tests in Section 120.4(c) and the installed thickness determined by Section 120.4(d)3.
- (f) **Protection of Insulation.** Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind but not limited to the following: Insulation exposed to weather shall be suitable for outdoor service e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

SECTION 120.5 – REQUIRED NONRESIDENTIAL MECHANICAL SYSTEM ACCEPTANCE

(a) Before an occupancy permit is granted the following equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements:

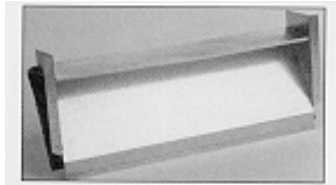
1. Outdoor air ventilation systems shall be tested in accordance with NA7.5.1
2. Constant volume, single zone unitary air conditioning and heat pump unit controls shall be tested in accordance with NA7.5.2.
3. Duct systems shall be tested in accordance with NA7.5.3 where either:
 - A. They are new duct systems that meet the criteria of Sections 140.4(l)1, 140.4(l)2, and 140.4(l)3; or
 - B. They are part of a system that meets the criteria of Section 141.0(b)2D.
4. Air economizers shall be tested in accordance with NA7.5.4.

EXCEPTION to Section 120.5(a)4: Air economizers installed by the HVAC system manufacturer and certified to the Commission as being factory calibrated and tested are exempt from the Functional Testing section of the Air Economizer Controls acceptance test as described in NA7.5.4.2.

5. Demand control ventilation systems required by Section 120.1(c)3 shall be tested in accordance with NA7.5.5
6. Supply fan variable flow controls shall be tested in accordance with NA7.5.6
7. Hydronic system variable flow controls shall be tested in accordance with NA7.5.7 and NA7.5.9
8. Boiler or chillers that require isolation controls per Section 140.4(k)2 or 140.4(k)3 shall be tested in accordance with NA7.5.7
9. Hydronic systems with supply water temperature reset controls shall be tested in accordance with NA7.5.8
10. Automatic demand shed controls shall be tested in accordance with NA7.5.10.
11. Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion Units shall be tested in accordance with NA7.5.11.
12. Automatic fault detection and diagnostics (FDD) for air handling units and zone terminal units shall be tested in accordance with NA7.5.12.
13. Distributed Energy Storage DX AC Systems shall be tested in accordance with NA7.5.13.
14. Thermal Energy Storage (TES) Systems shall be tested in accordance with NA7.5.14.
15. Supply air temperature reset controls shall be tested in accordance with NA7.5.15.
16. Water-cooled chillers served by cooling towers with condenser water reset controls shall be tested in accordance with NA7.5.16.
17. When an Energy Management Control System is installed, it shall functionally meet all of the applicable requirements of Part 6.

Ventilation System Packages

Bard Wall-Mounts are designed to provide optional ventilation packages to meet all of your ventilation and indoor air quality requirements. All units are equipped with a barometric fresh air damper as the standard ventilation package. All ventilation packages can be built-in at the factory, or field-installed at a later date.



Barometric Fresh Air Damper

BAROMETRIC FRESH AIR DAMPER - BFAD

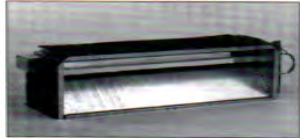
STANDARD

The barometric fresh air damper is a standard feature on all models. It is installed on the inside of the service door and allows outside ventilation air, up to 25% of the total airflow rating of the unit, to be introduced through the air inlet openings and to be mixed with the conditioned air. The damper opens during blower operation and closes when the blower is off. Adjustable blade stops allow different amounts of outside air to be introduced into the building and can be easily locked closed if required.

BLANK OFF PLATE - BOP

OPTIONAL

A blank off plate is installed on the inside of the service door. It covers the air inlet openings which restricts any outside air from entering into the unit. The blank off plate should be utilized in applications where outside air is not required to be mixed with the conditioned air.



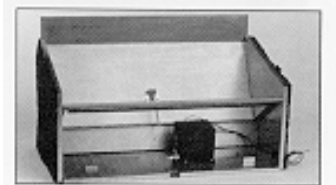
Motorized Fresh Air Damper

MOTORIZED FRESH AIR DAMPER - MFAD

OPTIONAL

The motorized fresh air damper is internally mounted behind the service door and allows outside ventilation air, up to 25% of the total airflow rating of the unit, to be introduced through the air inlet openings and to be mixed with the conditioned air. The two position damper can be fully open or closed. The damper blade is powered open by a 24VAC motor with spring return on power loss. The damper can be controlled by indoor blower operation or can be field connected to be managed based on building occupancy.

NOTE: The above vent systems are intake only without built-in exhaust capability. Building will likely require separate field installed barometric relief or mechanical exhaust elsewhere within the conditioned space. Balancing dampers in the return air grille may be required to achieve specified amount of outdoor air intake.



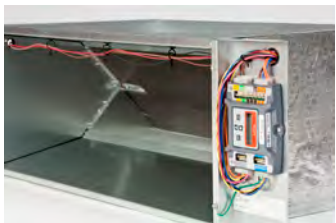
Commercial Room Ventilator

COMMERCIAL ROOM VENTILATOR - CRV

OPTIONAL

The built-in commercial room ventilator is internally mounted behind the service door and allows outside ventilation air, up to 50% of the total airflow rating of the unit, to be introduced through the air inlet openings. It includes a built-in exhaust air damper.

The commercial room ventilator (CRV) is a simple and innovative approach to improving the indoor air quality by providing fresh air intake and exhaust capability through the CRV. The damper can be easily adjusted to control the amount of fresh air supplied into the building. The CRV can be controlled by indoor blower operation or field controlled based on room occupancy. Two versions available (except on 1.5 and 2-Ton models). The CRV and CRVS are power open - spring return on power loss, and CRVP is power open and power close. Complies with ANSI/ASHRAE Standard 62.1 "Ventilation for Acceptable Indoor Air Quality."



Economizer

ECONOMIZER - ECONWM-Series

OPTIONAL

The built-in economizer system is internally mounted behind the service door and allows outdoor air to be introduced through the air inlet openings. The amount of outdoor air varies in response to the system controls and settings defined by the end user. It includes a built-in exhaust air damper. The economizer is designed to provide "free cooling" when outside air conditions are cool and dry enough to satisfy cooling requirements without running the compressor. This in turn provides lower operating costs, while extending the life of the compressor.

- ECONWMT Equipment Building versions have extended 11" air intake hood to deliver up to 100% of cooling rated airflow.
- ECONWMS Standard versions have 3" air intake hood to deliver up to 75% of cooling rated airflow.

Standard Features:

- Fully modulating
- Honeywell Direct Drive Hi-Torque Actuator
- No linkage required
- Simple single blade design
- Positive shut-off with non-stick gaskets
- Electronic DB and/or Enthalpy sensors depending upon version
- Honeywell JADE electronic economizer module with precision settings and diagnostics
- DB or Enthalpy economizer versions available

WALL-MOUNT ENERGY RECOVERY VENTILATOR - ERVF

OPTIONAL

The wall-mount energy recovery ventilator (ERV) is a highly innovative approach to meeting indoor air quality ventilation requirements as established by ANSI/ASHRAE Standard 62.1. The ERV allows from 200 to 450 CFM (depending upon model) of fresh air and exhaust through the unit while maintaining superior indoor comfort and humidity levels. In most cases this can be accomplished without increasing equipment sizing or operating costs. Heat transfer efficiency is up to 67% during summer and 75% during winter conditions.

The ERV consists of a unique "rotary energy recovery cassette" that provides effective sensible and latent heat transfer capabilities during summer and winter conditions. Various control schemes are addressed including limiting ventilation during building occupancy only.

The ERV is designed to be internally mounted behind the service door in the W**A, W**H or W**L model wall-mount units. It can be built-in at the factory or field installed as an option. ERVF-*3 and ERVF-*5 can be independently adjusted for intake and exhaust rates.



Energy Recovery Ventilator