

120.0 120.6 NR Mandatory Equipment

SUBCHAPTER 3

NONRESIDENTIAL, HIGH-RISE RESIDENTIAL, ~~AND HOTEL/MOTEL OCCUPANCIES, AND COVERED PROCESSES AND INSULATION~~— MANDATORY REQUIREMENTS ~~FOR SPACE-CONDITIONING AND SERVICE WATER-HEATING SYSTEMS AND EQUIPMENT~~

~~SECTION 120.0—SPACE-CONDITIONING AND SERVICE WATER-HEATING SYSTEMS AND EQUIPMENT~~— GENERAL

Sections ~~120.1~~ through 120.109 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 120.8.

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 ~~that are normally used by humans~~ 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~~ ~~TABLE 121-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 ~~121~~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 ~~121~~120.1(b)2 shall be supplied to each space at all times when the space is usually occupied.

EXCEPTION 1 to Section ~~121~~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 ~~121~~120.1(c)4 or by an occupant sensor ventilation control device complying with Section 120.1(c)5 or both.

EXCEPTION 2 to Section ~~121~~120.1(c)1: Temporary reduction. The rate of outdoor air provided to a space may be reduced below the level required by Section ~~121~~120.1(b)2 for up to 5 minutes each hour if the average rate for each hour is equal to or greater than the required ventilation rate.

~~NOTE: VAV must comply with Section 121(c)1 at minimum supply airflow.~~

2. **Pre-occupancy.** The lesser of the minimum rate of outdoor air required by Section ~~121~~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 ~~121~~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 ~~121~~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 ~~121~~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 ~~121~~120.1(c)3: Where space exhaust is greater than the design ventilation rate specified in Section ~~121~~120.1(b)2B minus 0.2 cfm per ft² of conditioned area.

EXCEPTION 3 to Section ~~121~~120.1(c)3: Spaces that 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, or beauty salons shall not install demand control ventilation.

EXCEPTION 4 to Section ~~121~~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 ~~121~~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 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 ~~121~~120.1(c)3B 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 ~~121~~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 ~~121~~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~~TABLE 121-A times the conditioned floor area for spaces with CO₂ sensors, plus the rate required by Section ~~121~~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 or calibrated at start-up, 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 ~~121~~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 EXCEPTION 5 to Section 120.1(c)3, occupant sensors may be used to reduce the rate of outdoor air required to zero when occupants are not present in accordance with the following:

- A. Occupant sensors shall meet 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 serve 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 of vacancy in all rooms served by a zone damper on a multiple zone system, and there is no call for cooling or heating, then no outside air is required and supply air shall be zero. When there is a heating or cooling load, supply air shall be controlled to minimize energy consumption.

D. Within 30 minutes of vacancy in all rooms served by a single zone system, the single zone system shall cycle off the supply fan when there is no call for cooling or heating.

- (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 ~~122~~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.** 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)1 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.

TABLE ~~122~~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 ~~122~~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 (h).

- (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 ~~122~~120.2(b).

EXCEPTION to Section ~~122~~120.2(a): An independent perimeter heating or cooling system may serve more than one zone without individual thermostatic controls if:

- A. All zones are also served by an interior cooling system;
- B. The perimeter system is designed solely to offset envelope heat losses or gains;
- C. The perimeter system has at least one thermostatic control for each building orientation of 50 feet or more; and
- D. 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 122120.2(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 122120.2(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 setback thermostat requirements of Section 110.2(c) or, if equipped with DDC to the Zone level, with the Automatic Demand Shed Controls of Section 122120.2(h).

EXCEPTION to Section 122120.2(b)4: Systems serving zones-exempt process loads that must have constant temperatures to prevent degradation of materials, a process, plants or animals.

(c) **Hotel/Motel Guest Room and High-rise Residential Dwelling Unit Thermostats.** Hotel/motel guest room thermostats shall have:

1. Numeric temperature setpoints in °F; and
2. Setpoint stops accessible only to authorized personnel, to restrict over-heating and over-cooling.

High-rise residential dwelling unit thermostats shall meet the control 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 Items 1 and 2 belowthe 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(c), 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 122120.2(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 122120.2(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 144(b)4 is greater than 32°F.

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

EXCEPTION to Section 122120.2(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 rooms less than 1000 ft², classrooms greater than 750 ft² and conference rooms greater than 750 ft² 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 to zero or turn the supply fan off when the zone is unoccupied with an occupant sensor ventilation control device according to Section 120.1(c)5.

EXCEPTION 1 to Section 122120.2(e): 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 Section 122120.2(e): 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 Section 122120.2(e): Systems with full load demands of 2 kW or less, if they have a readily accessible manual shut-off switch.

EXCEPTION 4 to Section 122120.2(e): Systems serving hotel/motel guest rooms, if they have a readily accessible manual shut-off switch.

- (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 122120.2(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 122120.2(f): Gravity and other nonelectrical equipment that has readily accessible manual damper controls.

EXCEPTION 3 to Section 122120.2(f): At combustion air intakes and shaft vents.

EXCEPTION 4 to Section 122120.2(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 122120.2(e)1.

EXCEPTION to Section 122120.2(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 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.

- (i) **Economizer Fault Detection and Diagnostics (FDD).** All air-cooled unitary direct-expansion units with an economizer and mechanical cooling capacity at AHRI conditions greater than or equal to 54,000 Btu/hr shall include a Fault Detection and Diagnostics (FDD) system in accordance with NA9 – Fault Detection and Diagnostics. 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.

SECTION ~~123~~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 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 ~~123~~120.3: Factory-installed piping within space-conditioning equipment certified under Section 111 or 112.

EXCEPTION 2 to Section ~~123~~120.3: Piping that conveys fluids with a design operating temperature range between 60°F and 105°F.

EXCEPTION 3 to Section ~~123~~120.3: Piping that serves ~~process loads~~, gas piping, cold domestic water piping, condensate drains, roof drains, vents, or waste piping.

EXCEPTION 4 to Section ~~123~~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 ~~123~~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 ~~EQUATION 120.3-A~~:

EQUATION ~~123~~120.3-A 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 ~~123~~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)					
			Runouts up to 2 1 and less	1-25-21 to <1-1/2	2-50-41-1/2 to <4	5-64 to <8	8 and larger	
			INSULATION THICKNESS REQUIRED (in inches)					
Space heating <u>and Hot Water</u> systems (steam, steam condensate and hot water <u>heating and Domestic Water Systems</u>)								
Above 350	0.32-0.34	250	4-5 <u>2-54.5</u>	2-55.0	3-05.0	5.03-5	5.03-5	
251-350	0.29-0.31	200	4-5 <u>3.02-0</u>	2-54.0	2-54.5	3-54.5	3-54.5	
201-250	0.27-0.30	150	4-0 <u>4-52.5</u>	4-52.5	2-02.5	2-03.0	3-53.0	
141-200	0.25-0.29	125	0-5 1.5	1.5	4-52.0	4-52.0	2-04.5	
105-140	0. 2224 -0.28	100	0-5 1.0	1.0	4-01.5	1.5	1.5	
Service water heating systems (recirculating sections, all piping in electric trace tape systems, and the first 8 feet of piping from the storage tank for nonrecirculating systems)								
Above 105	0.24-0.28	100	0-5	1-0	1-0	1-5	1-5	1-5
Space cooling systems (chilled water, refrigerant and brine)								
40-60	0.2 13 -0.27	75	0-5 0.5	0.5	1.0	1.0	1.0	
Below 40	0.2 30 -0.27 6	75 <u>50</u>	4-0 1.0	1.5	1.5	1.5	1.5	

SECTION ~~124~~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 2007 CMC Sections 601, 602, 603, 604, 605, and Standard 6-5, 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) 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 ~~barriers~~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~~barriers, or other duct components), based on the tests in Section ~~424~~120.4(c) and the installed thickness determined by Section ~~424~~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 ~~125~~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(k)1, 140.4(k)2, and 140.4(k)3; or
 - B. They are part of a system that meets the criteria of Section ~~140.9~~141.0(b)1D.
 4. Air economizers shall be tested in accordance with NA7.5.4.

EXCEPTION to Section ~~125~~120.5(a)4: Air economizers installed by the HVAC system manufacturer and certified to the Commission as being factory calibrated and tested are exempted from the Functional Testing section of the Air Economizer Controls acceptance test as described in not required to be field tested per NA7.5.4.2.
 5. Demand control ventilation systems required by Section ~~121~~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(j)2 or 140.4(j)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. When an Energy Management Control System is installed to function as a thermostat for compliance with Title 24, Part 6, it functionally meets all of the applicable requirements of Section xxxxx

SECTION 120.6 – MANDATORY REQUIREMENTS FOR REFRIGERATED WAREHOUSES COVERED PROCESSES

(a) Mandatory Requirements for Refrigerated Warehouses

~~A refrigerated warehouse with total cold storage and frozen storage area of 3,000 square feet or larger shall meet the requirements of this section. Enclosed spaces greater than 3,000 square feet with operating temperatures less than 55°F shall satisfy subsections 1, 2, 3, 6 and 7 of Section 120.6. Refrigeration systems (compressors and condensers) serving a total of 3,000 square feet or more of cold storage space, even if individual spaces served by the system are all less than 3,000 square feet, shall satisfy subsections 4, 5 and 6 of Section 120.6.~~

~~An enclosed space with an area less than 3,000 square feet with an operating temperature less than 55°F shall meet the space requirements of the Appliance Efficiency Regulations for walk-in refrigerators or freezers (California Code of Regulations, Title 20, Sections 1601 through 1608).~~

~~**EXCEPTION 1 to Section 126:** A refrigerated space less than 3,000 square feet shall meet the Appliance Efficiency Regulations for walk-in refrigerators or freezers.~~

~~**EXCEPTION 12 to Section 120.6(a):** Areas within refrigerated warehouses that are designed solely for the purpose of quick chilling or freezing of products with design cooling capacities of greater than 240 Btu/hr-ft² (2 tons per 100 ft²).~~

~~**EXCEPTION 2 to Section 120.6(a):** Compressors and condensers on a refrigeration system, defined by a common refrigerant charge, whose design refrigeration cooling load from quick chilling or freezing of products (areas with design cooling capacities of greater than 240 Btu/hr-ft²) is more than 20 percent of the total design refrigeration system cooling load.~~

~~(a)1. **Insulation Requirements.** Exterior surfaces of refrigerated warehouses shall be insulated at least to the R-values in TABLE 120.6(a)-A-~~TABLE 126-A-A~~.~~

~~TABLE 120.6(a)-A-A REFRIGERATED WAREHOUSE INSULATION~~

SPACE	SURFACE	MINIMUM R-VALUE (°F-hr-sf/Btu)
Frozen Storage <u>Freezers</u>	Roof/Ceiling	R- 36 <u>40</u>
	Wall	R-36
	Floor	R- 36 <u>35</u>
	<u>Floor with all heating from productive refrigeration capacity*</u>	<u>R-20</u>
Cold Storage <u>Coolers</u>	Roof/Ceiling	R-28
	Wall	R-28

~~*If all underslab heating is provided by a heat exchanger that provides refrigerant subcooling or other means that result in productive refrigeration capacity on the associated refrigerated system.~~

~~(b)2. **Underslab heating.** Electric resistance heat shall not be used for the purposes of underslab heating.~~

EXCEPTION to Section 120.6(ba)2: Underslab heating systems controlled such that the electric resistance heat is thermostatically controlled and disabled during the summer on-peak period defined by the local electric utility.

~~(e)3.~~ **Evaporators.** Fan-powered evaporators used in coolers and freezers shall conform to the following:

~~1A.~~ Single phase fan motors less than 1 hp and less than 460 Volts shall ~~be electronically commutated motors~~ meet the requirements of 140.4(c) 4.

~~2B.~~ Evaporator fans served either by a suction group with multiple compressors, or by a single compressor with variable capacity capability shall be variable speed and the speed shall be controlled in response to space ~~temperature or humidity~~ conditions.

EXCEPTION to Section 120.6(ae)3. B2: Coolers within refrigerated warehouses that maintain a Controlled Atmosphere long term storage for which a licensed engineer has certified that the types of products stored will require constant operation at 100 percent of the design airflow. Evaporators served by a single compressor without unloading capability.

C. Evaporator fans served by a single compressor that does not have variable capacity shall utilize controls to reduce airflow by at least 40 percent for at least 75 percent of the time when the compressor is not running.

~~(d)4.~~ **Condensers.** Fan-powered condensers shall conform to the following:

~~1.~~ ~~Condensers for systems utilizing ammonia shall be evaporatively cooled.~~

~~2A.~~ Design saturated Ccondensing temperatures for evaporative-cooled condensers ~~under design conditions, including but not limited to~~ and water-cooled condensers served by fluid coolers or cooling towers shall be less than or equal to:

~~Ai.~~ The design wetbulb temperature plus 20° F in locations where the design wetbulb temperature is less than or equal to 76° F; or

~~Bii.~~ The design wetbulb temperature plus 19° F in locations where the design wetbulb temperature is between 76° F and 78° F; or

~~Ciii.~~ The design wetbulb temperature plus 18° F in locations where the design wetbulb temperature is greater than or equal to 78° F.

~~3B.~~ Design saturated Ccondensing temperatures for air-cooled condensers ~~under design conditions~~ shall be less than or equal to the design drybulb temperature plus 10° F for systems serving ~~frozen storage freezers~~ and shall be less than or equal to the design drybulb temperature plus 15° F for systems serving ~~cold storage coolers.~~

EXCEPTION to Section 120.6(a)(d4.) 3B: Unitary CCondensing units with a total compressor horsepower less than 100 HP.

~~4C.~~ All condenser fans for evaporative-cooled condensers or fans on cooling towers or fluid coolers shall be continuously variable speed, and the condensing temperature control system shall control the speed of all ~~condenser~~ fans serving a common condenser ~~loop high side~~ in unison. The minimum condensing temperature setpoint shall be less than or equal to 70° F.

~~5D.~~ All condenser fans for air-cooled condensers shall be continuously variable speed and the condensing temperature or pressure control system shall control the speed of all condenser fans serving a common condenser ~~loop high side~~ in unison. The minimum condensing temperature setpoint shall be less than or equal to 70° F, ~~or reset in response to ambient drybulb temperature or refrigeration system load.~~

~~6.~~ All single phase condenser fan motors less than 1 hp and less than 460 V shall be either permanent split capacitor or electronically commutated motors.E. Condensing temperature reset. The condensing temperature set point of systems served by air-cooled condensers shall be reset in response to ambient drybulb temperature. The condensing temperature set point of systems served by evaporative-cooled condensers or water-cooled condensers (via cooling towers or fluid coolers) shall be reset in response to ambient wetbulb temperatures.

EXCEPTION to Section 120.6(a)4. E: Condensing temperature control strategies approved by the Executive Director that have been demonstrated to provide at least equal energy savings.

F. Fan-powered condensers shall meet the condenser efficiency requirements listed in Table 120.6(a)-B. Condenser efficiency is defined as the Total Heat of Rejection (THR) capacity divided by all electrical input power including fan power at 100 percent fan speed, and power of spray pumps for evaporative condensers.

TABLE 126(a)-B FAN-POWERED CONDENSERS – MINIMUM EFFICIENCY REQUIREMENTS

<u>Condenser Type</u>	<u>Refrigerant Type</u>	<u>Minimum Efficiency</u>	<u>Rating Condition</u>
Outdoor Evaporative-Cooled with THR Capacity > 8,000 MBH	All	350 Btuh/Watt	100°F Saturated Condensing Temperature (SCT), 70°F Outdoor Wetbulb Temperature
Outdoor Evaporative-Cooled with THR Capacity < 8,000 MBH and Indoor Evaporative-Cooled	All	160 Btuh/Watt	
Outdoor Air-Cooled	<u>Ammonia</u>	75 Btuh/Watt	<u>105°F Saturated Condensing Temperature (SCT), 95°F Outdoor Drybulb Temperature</u>
	<u>Halocarbon</u>	65 Btuh/Watt	
<u>Indoor Air-Cooled</u>	All	Exempt	

G. Air-cooled condensers shall have a fin density no greater than 10 fins per inch.

EXCEPTION to Section 120.6(a)4. G: Micro-channel condensers.

(e)5. Compressors. Compressor systems utilized in refrigerated warehouses shall conform to the following:

1A. Compressors shall be designed to operate at a minimum condensing temperature of 70° F or less.

2B. ~~The compressor speed of a~~An open-drive screw compressor with a design saturated suction temperature (SST) of 28°F or lower that discharges to the system condenser pressure greater than 50 hp shall control compressor speed be controllable in response to the refrigeration load or the input power to the compressor shall be controlled to be less than or equal to 60 percent of full load input power when operated at 50 percent of full refrigeration capacity.

EXCEPTION to Section 120.6(a)e5.-2B: Refrigeration plants with more than one dedicated compressor per suction group.

C. Screw compressors with nominal electric motor power greater than 150 HP shall include the ability to automatically vary the compressor volume ratio (Vi) in response to operating pressures.

6. Infiltration Barriers. Passageways between freezers and higher-temperature spaces, and passageways between coolers and non-refrigerated spaces, shall have an infiltration barrier consisting of strip curtains, an automatically-closing door, or an air curtain designed by its manufacturer for use in the passageway and temperature for which it is applied.

EXCEPTION 1 to Section 120.6(a) 6: Openings with less than 16 ft2 of opening size.

EXCEPTION 2 to Section 120.6(a) 6: Dock doorways for trailers.

7. Refrigeration System Acceptance. Before an occupancy permit is granted for a new refrigerated warehouse, or before a new refrigeration system serving a refrigerated warehouse is operated for normal use, 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:

- A. Electric resistance underslab heating systems shall be tested in accordance with NA 7.9.1.
- B. Evaporators fan motor controls shall be tested in accordance with NA 7.9.2.
- C. Evaporative condensers shall be tested in accordance with NA 7.9.3.1.
- D. Air-cooled condensers shall be tested in accordance with NA 7.9.3.2.
- E. Variable speed compressors shall be tested in accordance with NA 7.9.4.

(b) Mandatory Requirements for Commercial Refrigeration

Retail food stores with 8,000 square feet or more of conditioned area or more, and that utilize either refrigerated display cases, or walk-in coolers or freezers connected to remote compressor units or condensing units, shall meet the requirements of Subsections 1 through 4.

1. Condensers. Fan-powered condensers shall conform to the following requirements.

- A. All condenser fans for air-cooled condensers, evaporative-cooled condensers, air- or water-cooled fluid coolers or cooling towers shall be continuously variable speed, with the speed of all fans serving a common condenser high side controlled in unison.
- B. The refrigeration system condenser controls for systems with air-cooled condensers shall use variable-setpoint control logic to reset the condensing temperature setpoint in response to ambient drybulb temperature.
- C. The refrigeration system condenser controls for systems with evaporative-cooled condensers shall use variable-setpoint control logic to reset the condensing temperature setpoint in response to ambient wetbulb temperature.

EXCEPTION to Section 120.6(b)1. B and C: Condensing temperature control strategies approved by the Executive Director that have been demonstrated to provide equal energy savings

D. The minimum condensing temperature setpoint shall be less than or equal to 70°F.

E. Fan-powered condensers shall meet the specific efficiency requirements listed in Table 120.6(b)-A:

TABLE 120.6(b)-A - FAN-POWERED CONDENSERS –SPECIFIC EFFICIENCY REQUIREMENTS

<u>Condenser Type</u>	<u>Minimum Specific Efficiency^a</u>	<u>Rating Condition</u>
<u>Evaporative-Cooled</u>	<u>160 (Btu/h)/W</u>	<u>100°F Saturated Condensing Temperature (SCT), 70°F Entering Wetbulb Temperature</u>
<u>Air-Cooled</u>	<u>65 (Btu/h)/W</u>	<u>105°F Saturated Condensing Temperature (SCT), 95°F Entering Drybulb Temperature</u>

^a Condenser specific efficiency is the Total Heat of Rejection (THR) capacity divided by the fan input electric power at 100% fan speed (plus spray pump electric input power for evaporative condensers).

EXCEPTION 1 to Section 120.6(b)1. E: Condensers with a THR capacity of less than 150 MBH at the specific efficiency rating condition.

EXCEPTION 2 to Section 120.6(b)1. E: Stores located in Climate Zone CTZ01.

EXCEPTION 3 to Section 120.6(b)1. E: Existing condensers that are reused for an expansion or remodel.

F. Air-cooled condensers shall have a fin density no greater than 10 fins per inch.

EXCEPTION 1 to Section 120.6(b)1. F: Micro-channel condensers.

EXCEPTION 2 to Section 120.6(b)1. F: Existing condensers that are reused for an expansion or remodel.

2. Compressor Systems. Refrigeration compressor systems and condensing units shall conform to the following requirements.

A. Compressors and multiple-compressor suction groups shall include control systems that use floating suction pressure logic to reset the target saturated suction temperature based on the temperature requirements of the attached refrigeration display cases or walk-ins.

EXCEPTION 1 to Section 120.6(b)2. A: Single compressor systems that do not have continuously variable capacity capability.

EXCEPTION 2 to Section 120.6(b)2. A: Suction groups that have a design saturated suction temperature of 30°F or higher, or suction groups that comprise the high stage of a two-stage or cascade system or that primarily serve chillers for secondary cooling fluids.

B. Liquid subcooling shall be provided for all low temperature parallel compressor systems with a design saturated suction temperature of -10°F or lower, with the subcooled liquid temperature maintained continuously at 50°F or less at the exit of the subcooler, using compressor economizer port(s) or a separate parallel medium or high temperature suction group operating at a saturated suction temperature of 18°F or higher.

EXCEPTION 1 to Section 120.6(b)2. B: Single compressor systems.

EXCEPTION 2 to Section 120.6(b)2. B: Low temperature cascade systems that condense into another refrigeration system rather than condensing to ambient temperature.

EXCEPTION 3 to Section 120.6(b)2. B: Existing compressors that are reused for an expansion or remodel.

3. Display Cases.

A. Lighting in refrigeration display cases, and lights on glass doors installed on walk-in coolers and freezers shall be controlled by either A or B:

B. Automatic time switch controls to turn off lights during non-business hours. Use of timed overrides to turn the lights for stocking shall not exceed one hour for any case line-up or walk-in and if manually imitated shall time-out automatically.

C. Motion sensor controls on each case that reduce display case lighting power by at least 50% within 30 minutes after the area near the case is vacated.

EXCEPTION to Section 120.6(b)3. A: Stores which are normally open for business 140 hours or more per week.

D. Upright low temperature display cases that are designed for a supply air temperature of 5°F or lower shall utilize reach-in glass doors.

4. Refrigeration Heat Recovery.

A. HVAC systems shall utilize heat recovery from refrigeration system(s) for space heating, using no less than 25% of the sum of the design Total Heat of Rejection of all refrigeration systems that have individual Total Heat of Rejection values of 150,000 BTU/Hr or greater at design conditions.

EXCEPTION 1 to Section 120.6(b)4. A: Stores located in Climate Zone CTZ15.

EXCEPTION 2 to Section 120.6(b)4. A: HVAC systems that are reused for an expansion or remodel.

B. The increase in HFC refrigerant charge associated with refrigeration heat recovery equipment and piping shall be no greater than 0.35 lbs per 1,000 BTU/Hr of heat recovery heating capacity.

(c) Mandatory Requirements for Enclosed Parking Garages.

Mechanical ventilation systems for enclosed parking garages where the total design exhaust rate for the garage is greater than or equal to 10,000 cfm shall conform to all of the following:

1. Automatically detect contaminant levels and stage fans or modulate fan airflow rates to 50% or less of design capacity provided acceptable contaminant levels are maintained

2. Have controls and/or devices that will result in fan motor demand of no more than 30 percent of design wattage at 50% of design airflow
3. CO shall be monitored with at least one sensor per 5,000 ft², with the sensor located in the highest expected concentration locations, with at least two sensors per proximity zone. A proximity zone is defined as an area that is isolated from other areas either by floor or other impenetrable obstruction.
4. CO concentration at all sensors is maintained \leq 25 ppm at all times.
5. The ventilation rate shall be at least 0.15 cfm/ft² when the garage is scheduled to be occupied.
6. The system shall maintain the garage at negative or neutral pressure relative to other occupiable spaces when the garage is scheduled to be occupied.
7. CO sensors shall be:
 - A. Certified by the manufacturer to be accurate within plus or minus 5% of measurement.
 - B. Factory calibrated.
 - C. Certified by the manufacturer to drift no more than 5% per year.
 - D. Certified by the manufacturer to require calibration no more frequently than once a year.
 - E. Monitored by a control system. The system shall have logic that automatically checks for sensor failure by the following means. Upon detection of a failure, the system shall reset to design ventilation rates and transmit an alarm to the facility operators.
 - i. If any sensor has not been calibrated according to the manufacturer's recommendations within the specified calibration period, the sensor has failed.
 - ii. During unoccupied periods the systems compares the readings of all sensors. If any sensor is more than 30% above or below the average reading for a period of longer than 4 hours, the sensor has failed.
 - iii. During occupied periods the system compares the readings of sensors in the same proximity zone. If any sensor in a proximity zone is more than 30% above or below the average reading for a period of longer than 4 hours, the sensor has failed.
8. **Parking Garage Ventilation System Acceptance.** Before an occupancy permit is granted for a parking garage system subject to 120.6(c), 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 specified in NA 7.12.

EXCEPTION to Section 120.6(c): Any garage, or portion of a garage, where more than 20% of the vehicles expected to be stored have non gasoline combustion engines.

(d) Mandatory Requirements for Commercial and Process Boilers

1. Each commercial or process boiler, or group of boilers served by a common exhaust stack with a combined heat input capacity of 2.50 MMBtu/h (2,500,000 Btu/h) or greater shall be equipped with a combustion air positive shut-off. A flue damper or a vent damper is an acceptable method to positively shut off combustion air.
2. Each new commercial boiler or process boiler with combustion air fan motors rated at 10 horsepower or larger shall meet one of the following:
 - A. The fan motor shall be driven by a variable speed drive.
 - B. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.
3. Each new boiler with input capacity 5 MMBtu/h (5,000,000 Btu/h) or greater shall maintain excess (stack-gas) oxygen concentrations at no greater than 5.0 percent (%) by volume on a dry basis, except during start-up or shut

down periods. Combustion air volume shall be controlled with respect to firing rate or flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

EXCEPTION to Section 120.6(d)3: Commercial boilers with steady state full-load thermal efficiency 85% or higher.

4. New process boilers with input capacity greater than 10 MMBtu/h (10,000,000 Btu/h) shall maintain excess (stack-gas) oxygen concentrations at less than or equal to 3.0% by volume on a dry basis over the entire firing range, except during start up or shut down periods. Combustion air volume shall be controlled with respect to firing rate or flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

(e) Mandatory Requirements for Compressed Air Systems

All new compressed air systems, and all additions or alterations of compressed air systems where the total combined horsepower (hp) of the compressor(s) is 25 horsepower or more shall meet the requirements of Subsections 1 through 3.

1. Trim Compressor and Storage. The compressed air system shall be equipped with an appropriate sized trim compressor and primary storage to provide acceptable performance across the range of a system and to avoid control gaps. The system shall include a compressor or set of compressors with total effective trim capacity at least the size of the largest net increment between combinations of base compressors. The system shall also include primary storage of at least 2 gallons per actual cubic feet per minute (acfm) of the largest net increment.

EXCEPTION to Section 120.6(c)(1): Compressed air systems in existing facilities that are altering less than 50% of the total capacity of the system.

2. Controls. Compressed air systems with more than one compressor, having a combined horsepower rating of more than 100 hp, must operate with an approved controller that is able to choose the most energy efficient combination of compressors within the system based on the current air demand as measured by a sensor.

3. Compressed Air System Acceptance. Before an occupancy permit is granted for a compressed air system subject to 120.6(e), 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 specified in NA 7.13.

SECTION 120.7 – MANDATORY INSULATION REQUIRMENTS ~~RESERVED~~

Any new construction in a nonresidential, high-rise residential, and hotel/motel buildings shall meet the minimum requirements in this Section.

- (a) **Roof Insulation.** The opaque portions of the roof separating conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of either Item 1 or 2 below:
1. **Metal Building-** A minimum of R-19 insulation with thermal blocks of R-5 rigid insulation, or the weighted average U-factor of the roof assembly shall not exceed a U-factor of 0.065.
 2. **Wood Framed and Others-** A minimum of R-19 insulation between framing members, or the weighted average U-factor of the roof assembly shall not exceed the U-factor of 0.075.
- (b) **Wall Insulation.** The opaque portions of framed walls separating conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of either Item 1 through 4 below:
1. **Metal Building-** A minimum of R-13 insulation or the weighted average U-factor of the wall assembly shall not exceed the U-factor of 0.113.
 2. **Metal Framed-** A minimum of R-8 continuous rigid insulation, or the weighted average U-factor of the wall assembly shall not exceed the U-factor of 0.098.
 3. **Mass Walls-** A minimum 6 inch Concrete Masonry Unit having a U-factor not to exceed U-0.44.
 4. **Wood Framed and Others-** A minimum of R-11 insulation between framing members, or the weighted average U-factor of the wall assembly shall not exceed the U-factor of 0.110.
- (c) **Floor Insulation.** Raised framed floors separating conditioned space from unconditioned space or ambient air shall have a minimum of R-11 insulation, or the weighted average U-factor of the floor assembly shall not exceed the U-factor of U-0.071.

SECTION 120.8 – ~~RESERVED.~~BUILDING COMMISSIONING

For all new nonresidential buildings, elements of building commissioning shall be included in the design and construction processes of the building project to verify that the building energy systems and components meet the owner's or owner representative's project requirements. All building systems and components covered by Sections 110, 120, 130, and 140 shall be included in the scope of the commissioning requirements in this Section, excluding covered processes. For buildings less than 10,000 ft², only the design review requirements in Section 120.8(d) and 120.8(e) shall be completed.

- (a) **Summary of Commissioning Requirements.** The following items shall be completed:
1. **Owner's or Owner representative's project requirements;**
 2. **Basis of design;**
 3. **Design review checklist;**
 4. **Construction Documents design review;**
 5. **Commissioning plan;**
 6. **Functional performance testing;**

7. Documentation and training; and

8. Commissioning report.

(b) Owner's or Owner representative's Project Requirements (OPR). The energy-related expectations and requirements of the building shall be documented before the design phase of the project begins. This documentation shall include the following:

1. Energy efficiency goals;

3. Ventilation requirements;

4. Project program, including facility functions and hours of operation, and need for after hours operation; and

5. Equipment and systems expectations.

EXCEPTION to Section 120.8(b): Buildings less than 10,000 ft².

(c) Basis of Design (BOD). A written explanation of how the design of the building systems meets the OPR shall be completed at the design phase of the building project, and updated as necessary during the design and construction phases. The Basis of Design document shall cover the following systems:

1. Heating, ventilation, air conditioning (HVAC) systems and controls;

2. Indoor lighting system and controls; and

3. Water heating system.

EXCEPTION to Section 120.8(c): Buildings less than 10,000 ft².

(d) Design Review Checklist. During the schematic design phase of the building project, the plans and specifications shall be reviewed to ensure that required design features are included by completing a design review checklist. This checklist documents that the owner or owner's representative, design team and design reviewer have met to discuss the project scope, schedule and how the design reviewer will coordinate with the project team. For buildings larger than 50,000 ft² or for buildings with complex mechanical systems, an independent, third party review of these documents is required. Buildings between 10,000 and 50,000 ft² require completion of the design review checklist by an in-house engineer not associated with the building project. For buildings less than 10,000 ft², this review may be completed by the design engineer. The building owner or owner's representative shall include the Design Review Checklist compliance form in the Certificate of Compliance documentation (see Section 10-103).

(e) Construction Documents Design Review. The Construction Documents Design Review compliance form lists the items that shall be checked by the design reviewer during the construction document review. For buildings larger than 50,000 ft² or for buildings with complex mechanical systems, an independent, third party review of the Construction Documents is required. Buildings between 10,000 and 50,000 ft² require completion of the Construction Documents Design Review by an in-house engineer not associated with the building project. For buildings less than 10,000 ft², this review may be completed by the design engineer. The completed form shall be returned to the owner and design team for review and sign-off. The building owner or owner's representative shall include this Construction Documents Design Review compliance form in the Certificate of Compliance documentation (see Section 10-103).

(f) Commissioning Plan. Prior to permit issuance a commissioning plan shall be completed to document how the project will be commissioned and shall be started during the design phase of the building project. The Commissioning Plan shall include the following:

1. General project information;

2. Commissioning goals;

3. Systems to be commissioned. Plans to test systems and components shall include:

A. An explanation of the original design intent;

B. Equipment and systems to be tested, including the extent of tests;

C. Functions to be tested;

D. Conditions under which the test shall be performed;

E. Measurable criteria for acceptable performance;

F. Commissioning team information; and

G. Commissioning process activities, schedules and responsibilities. Plans for the completion of commissioning requirements listed in Sections 120.8(g) through 120.8(i) shall be included.

EXCEPTION to Section 120.8(f): Buildings less than 10,000 ft².

(g) Functional performance testing. Functional performance tests shall demonstrate the correct installation and operation of each component, system and system-to-system interface in accordance with the Construction Documents. Functional performance testing reports shall contain information addressing each of the building components tested, the testing methods utilized, and include any readings and adjustments made. All Acceptance Requirements for Code Compliance shall be completed as part of this functional performance testing.

EXCEPTION to Section 120.8(g): Buildings less than 10,000 ft².

(h) Documentation and training. A Systems Manual and Systems Operations Training shall be completed.

1. Systems manual. Documentation of the operational aspects of the building shall be completed within the Systems Manual and delivered to the building owner or representative and facilities operator. The Systems Manual shall include the following:

A. Site information, including facility description, history and current requirements;

B. Site contact information;

C. Basic operations and maintenance, including general site operating procedures, basic troubleshooting, recommended maintenance requirements, site events log;

D. Major systems;

E. Site equipment inventory and maintenance notes;

F. A copy of all special inspection verifications required by the enforcing agency or this code; and

G. Other resources and documentation.

2. Systems operations training. The training of the appropriate maintenance staff for each equipment type and/or system shall be documented in the commissioning report and shall include the following:

A. System/equipment overview (what it is, what it does and with what other systems and/or equipment it interfaces)

B. Review and demonstration of servicing/preventive maintenance

C. Review of the information in the Systems Manual

D. Review of the record drawings on the system/equipment

EXCEPTION to Section 120.8(h): Buildings less than 10,000 ft².

(i) Commissioning report. A complete report of commissioning process activities undertaken through the design, construction and reporting recommendations for post-construction phases of the building project shall be completed and provided to the owner or representative.

EXCEPTION to Section 120.8(i): Buildings less than 10,000 ft².

SECTION 120.9 – RESERVED.

