2016 Energy Standards Covered Processes Overview

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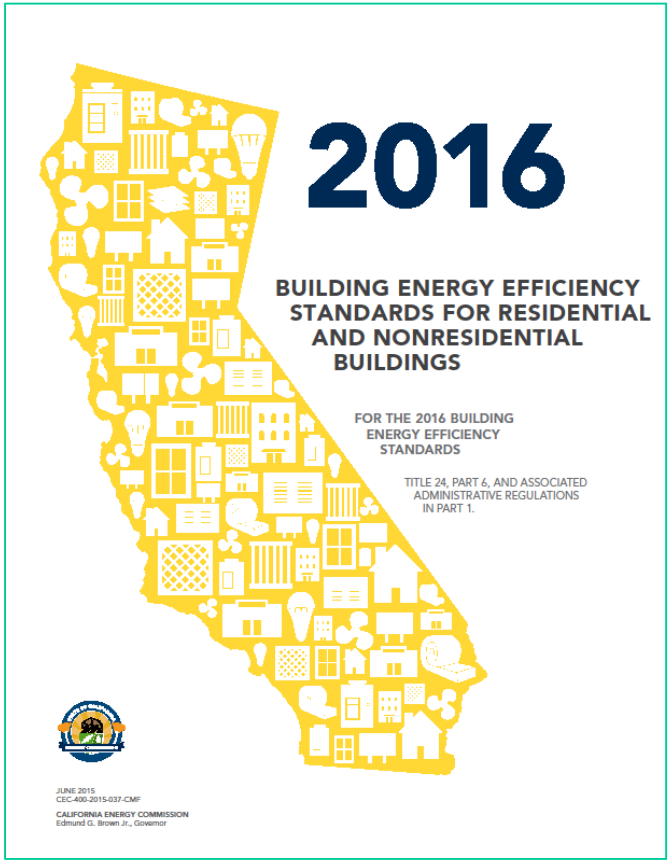
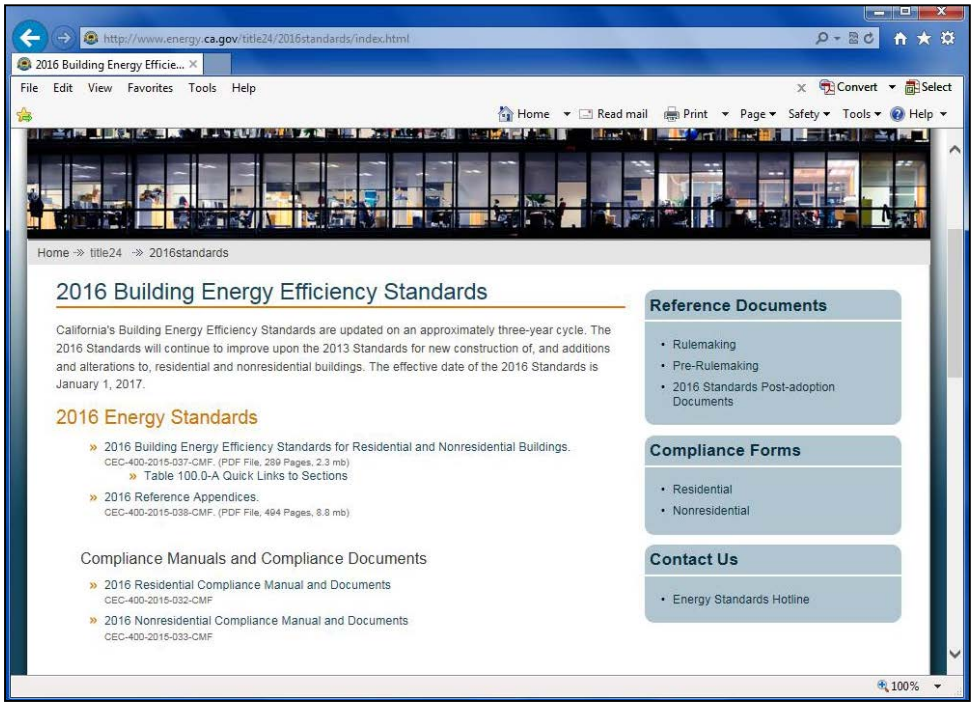
2016 Building Energy Efficiency Standards

- **Effective January 1, 2017**
  - Building permit applications submitted on or after this date
- **Applies to all projects**
  - Newly constructed buildings
  - Additions
  - Alterations



2016 Documents



- Building Energy Efficiency Standards
- Res. and Nonres. Compliance Manuals
- Reference Appendices
- All docs. available online at:

  www.energy.ca.gov/title24

2016 Nonresidential Energy Savings

- **Overall, 5% more efficient than 2013 Standards**
  - Electricity Savings = 192 GWHs
  - Demand Reduction = 80 MW
  - Gas Savings = (0.9) Mtherms

What the future holds

- AB 32 – Reduces GHGs and carbon footprint
- SB 350 – Doubles efficiency and increases renewable energy to 50%
- CPUC/CEC Strategic Plan:
  - ZNE goal for residential buildings by 2020
  - ZNE goal for nonresidential buildings by 2030

Energy Standards will "evolve/expand" and become more stringent to reach these goals

Goals for this Training

- Identify the individual covered processes.
- Get a little familiar with each covered process.
  - Know when the Standards apply to each covered process.
  - Understand key terminology related to each covered process.
  - Learn which covered processes are mandatory and which are prescriptive.
  - Gain a general understanding of the requirements for each covered process.

QUESTIONS…

- **Please feel free to ask at anytime:**
  - During class
  - During breaks
  - The end of class; or
  - After class

Covered Processes

What are “Covered Processes”??

- **Standards §100.1 Definitions:**
  - Covered Processes
    - Processes that are regulated under Part 6, serving computer rooms, data centers, elevators, escalators and moving walkways, laboratorie enclosed parking garages, commercial kitchens, refrigerated warehouses, commercial refrigeration, compressed air systems, and process boilers.
  - Covered Process Load
    - The energy consumption of and/or the heat generated by a piece of equipment or device that is part of a covered process.
  - Exempt Process
    - A process that is not a covered process.

What are “Covered Processes”??

- **Standards §100.1 Definitions - continued:**
  - Process
    - An **activity or treatment** that is **not related to** the space conditioning, lighting, service water heating or ventilation of a building as it relates to **human occupancy**.
  - Process Load
    - A load resulting from a process.
  - Process Space
    - A space that is thermostatically controlled to maintain a process environment temperature less than 55º F or to maintain a process environment temperature greater than 90º F for the whole space that the system serves, or that is a space with a space-conditioning system designed and controlled to be incapable of operating at temperatures above 55º F or incapable of operating at temperatures below 90º F at design conditions.

What are “Covered Processes”??

- **Standards §100.1 Definitions - continued :**
  - Conditioned Space
    - Space in a building that is either directly conditioned or indirectly conditioned.
  - Directly Conditioned Space
    - An enclosed space that is provided with wood heating, is provided with mechanical heating that has a capacity exceeding 10 Btu/hr-ft², or is provided with mechanical cooling that has a capacity exceeding 5 Btu/hr-ft², **unless the space-conditioning system is designed for process space or process load**.

Covered Processes History

2008	2013	2016
§126	§120.6	§120.6
• Refrigerated Warehouses	• Refrigerated Warehouses • Commercial Refrigeration • Enclosed Parking Garages • Process Boilers • Compressed Air Systems	• Refrigerated Warehouses • Commercial Refrigeration • Enclosed Parking Garages • Process Boilers • Compressed Air Systems • Elevators • Escalators and Moving Walkways
	§140.9	§140.9
	• Computer Rooms • Commercial Kitchens • Laboratory Exhaust Systems	• Computer Rooms • Commercial Kitchens • Laboratory Exhaust Systems

2016 Covered Processes Today

§120.6 Mandatory Requirements

§120.6(a) Refrigerated Warehouses

§120.6(b) Commercial Refrigeration

§120.6(c) Enclosed Parking Garages

§120.6(d) Process Boilers

§120.6(e) Compressed Air Systems

§120.6(f) Elevators

§120.6(g) Escalators and Moving Walkways

§140.9 Prescriptive Requirements

§140.9(a) Computer Rooms

§140.9(b) Commercial Kitchens

§140.9(c) Laboratory Exhaust Systems

§141.1 Addition and Alterations

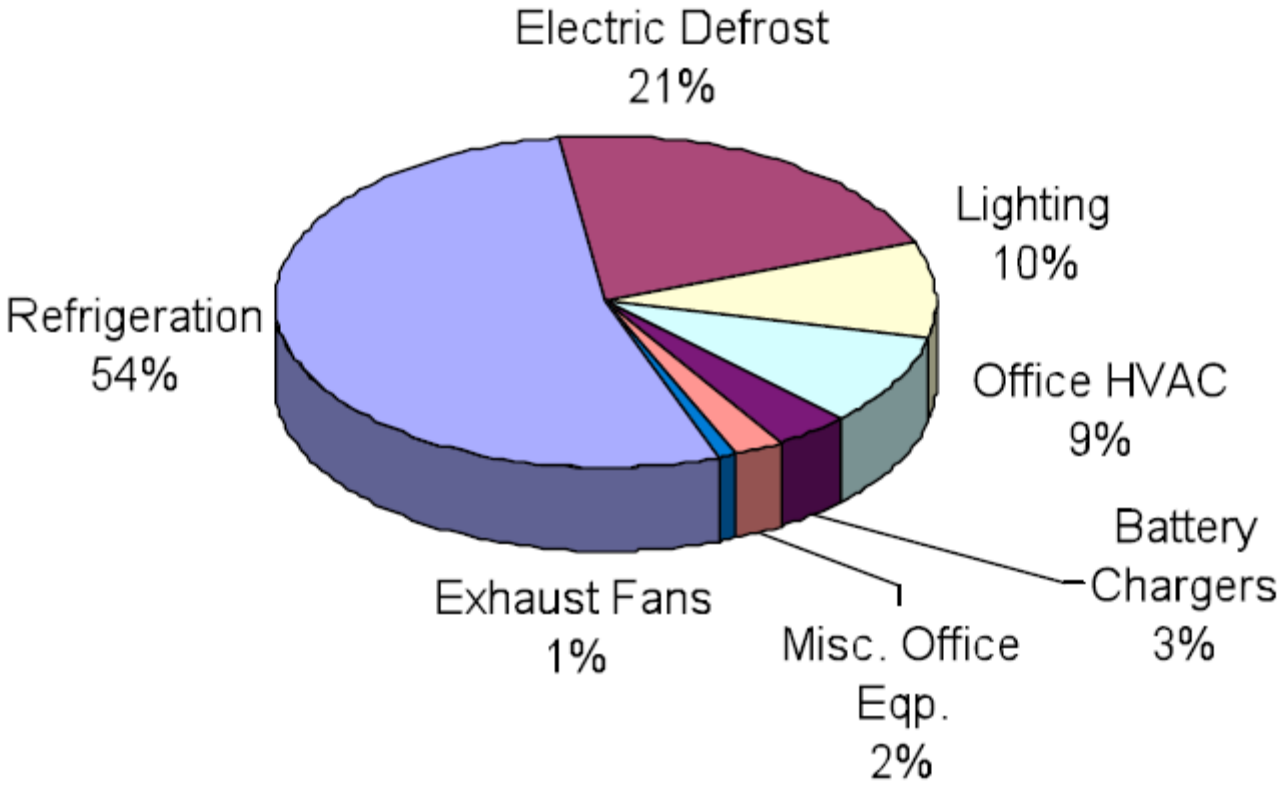
Covered Process Additions and Alterations

Refrigerated Warehouses

§120.6 (a)

Refrigerated Warehouses

Electrical Demand by End Use



What is a "Refrigerated Warehouse"??

- **Related Standards §100.1 Definitions:**
  - Refrigerated Warehouse
    - A building or a space **greater than or equal to 3,000 ft^2** constructed for storage or handling of products, where mechanical refrigeration is used to maintain the space temperature at **55° F or less**.
  - Refrigerated Space
    - A space constructed for storage or handling of products, where mechanical refrigeration is used to maintain the space temperature at 55° F or less.
  - Condenser Specific Efficiency
    - The full load condenser Total Heat of Rejection (THR) capacity at standardized conditions divided by the fan input electric power (including but not limited to spray pump electric input power for evaporative condensers) at 100 percent rated fan speed.

Refrigerated Warehouses

- **Standards Section §120.6(a) Applicability**
  - A refrigerated space **≥ to 3,000 ft²** must meet the applicable requirements of all sections in §120.6(a):
    - Insulation - §120.6(a)1
    - Underslab Heating - §120.6(a)2
    - Evaporators - §120.6(a)3
    - Condensers - §120.6(a)4
    - Compressors - §120.6(a)5
    - Infiltration Barriers - §120.6(a)6
    - Refrigeration System Acceptance - §120.6(a)7
  - Multiple refrigerated spaces that have a **summed total ≥ to 3,000 ft², and** are collectively served by the **same refrigeration system compressor(s) and condenser(s)** must also meet all the requirements of §120.6(a).
  - Refrigerated Spaces **< 3,000 ft² served by a stand alone system are not covered by T24, Part 6**. These spaces are considered walk-in coolers and freezers and are regulated by the Appliance Efficiency Regulations in T20 and federal standards.

Pop Quiz Time!

- A 15,000 ft^2 building has four 2,500 ft^2 refrigerated spaces.
  1. One 2,500 ft^2 space is served by a stand alone refrigeration system.
  2. Three 2,500 ft^2 spaces have their own evaporators but use a common condenser and compressor group.
- What sections of §120.6(a) apply to #1?
  - None. This space is regulated under Title 20.
- What sections of §120.6(a) apply to #2?
  - All sections apply: §120.6(a)1, 2, 3, 4, 5, 6, and 7
- Suppose each 2,500 ft^2 space is served by its own stand alone system. What sections of §120.6(a) apply to each space?
  - None. All spaces are regulated under Title 20.
- Suppose the 15,000 ft^2 building has one single 10,000 ft^2 refrigerated space but is served by four refrigeration systems that can be independently controlled. What sections of §120.6(a) apply?
  - Because it is one single refrigerated space >3,000 ft^2, all sections apply: §120.6(a)1, 2, 3, 4, 5, 6, and 7

Refrigerated Warehouses

- **Lets look into the subsections of §120.6(a)**
  - §120.6(a)1 - Insulation
  - §120.6(a)2 - Underslab Heating
  - §120.6(a)3 - Evaporators
  - §120.6(a)4 - Condensers
  - §120.6(a)5 - Compressors
  - §120.6(a)6 - Infiltration Barriers
  - §120.6(a)7 - Refrigeration System Acceptance

Refrigerated Warehouses

- §120.6(a)1 - Insulation
  - Insulation requirements are outlined in Table 120.6-A

TABLE 120.6-A REFRIGERATED WAREHOUSE INSULATION

SPACE	SURFACE	MINIMUM R-VALUE (°F·hr·sf/Btu)
Freezers	Roof/Ceiling	R-40
	Wall	R-36
	Floor	R-35
	Floor with all heating from productive refrigeration capacity[1]	R-20
Coolers	Roof/Ceiling	R-28
	Wall	R-28

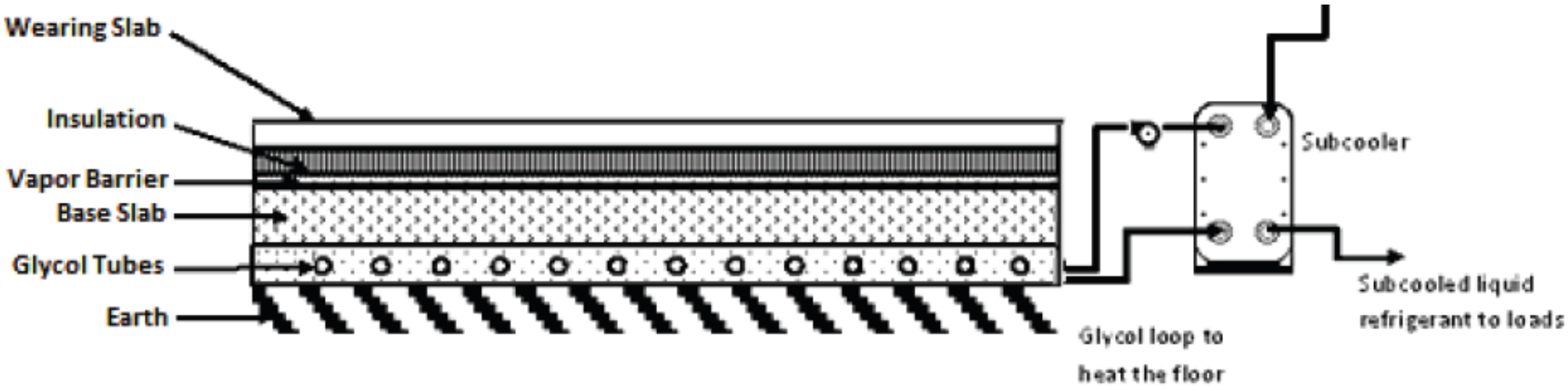
[1] All underslab heating is provided by a heat exchanger that provides refrigerant subcooling or other means that result in productive refrigeration capacity on the associated refrigerated system.

Refrigerated Warehouses

➢ §120.6(a)2 - Underslab Heating

- Electric resistance heat shall not be used for the purposes of underslab heating unless the electric resistance heat is thermostatically controlled and disabled during the summer on-peak period defined by the local electric utility.

Nonresidential Manual, Figure 10-27: Underslab Heating System with Refrigerant Subcooling



Refrigerated Warehouses

➢ §120.6(a)3 - Evaporators

- **Fan motors** less than 1 HP shall be **Electronically Commutated Motors** (ECM) or have a **minimum efficiency** of 70%.
- Evaporator **fans** served by a suction group with multiple compressors, or by a single compressor with variable capacity capability must be **variable speed** and have **controls responding to the space temperature or humidity**.
- 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**.
- There are exceptions. See section **120.6(a)3**.

Refrigerated Warehouses

➢ §120.6(a)4 - Condensers

- The design **maximum saturated condensing temperature** setpoint is to be based on **local design conditions**.
- Minimum condensing temperature setpoint must be 70°F or less.
- **Condensing temperature must be reset** in response to ambient conditions.
- Fans must be **continuously variable speed**.
- Fan power shall meet the **specific efficiency** requirements listed in TABLE 120.6-B.
- Air-cooled condensers shall have a **fin density** no greater than **10 fins per inch** unless it is a micro-channel condensers.
- There are exceptions. See section **§120.6(a)4**.

Refrigerated Warehouses

➢ §120.6(a)5 - Compressors

- Compressors shall be designed to operate at a **minimum condensing temperature** of 70°F or less.
- **Open-drive screw compressors** with a design saturated suction temperature (SST) of 28°F or lower that discharges to the system condenser pressure shall **control compressor speed in response to the refrigeration load**.
- **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.
- Of course, there are exceptions. See section **§120.6(a)5.**

Refrigerated Warehouses

➢§120.6(a)6 - Infiltration Barriers

- Passageways between freezers and higher-temperature spaces, and passageways between coolers and non-refrigerated spaces, must have **strip curtains, an automatically-closing door, or an air curtain**
- for use in the passageway and temperature for which it is applied.
- Of course, there are exceptions. See section **§120.6(a)6.**

Refrigerated Warehouses

➢ §120.6(a)7 - Refrigeration System Acceptance

- The following equipment and systems shall be certified as specified by the Reference Nonresidential Appendix NA7.10. A Certificate of Acceptance shall be submitted to the enforcement agency:
  - ➢ Electric resistance underslab heating systems tested in accordance with NA7.10.1.
  - ➢ Evaporator fan motor controls tested in accordance with NA7.10.2.
  - ➢ Evaporative condensers tested in accordance with NA7.10.3.1.
  - ➢ Air-cooled condensers tested in accordance with NA7.10.3.2.
  - ➢ Variable speed compressors tested in accordance with NA7.10.4.

Refrigerated Warehouses

➢ Note on Ventilation Requirements

- **§120.1 - Requirements for Ventilation**

Exception for **Refrigerated Warehouses** and other spaces or buildings that are not normally used for human occupancy and work.

- Even though **ventilation is not required** by the standards for refrigerated warehouses, there may be some instances where ventilation may be needed. It is left to the building owner and project engineer to determine if ventilation is needed.

Refrigerated Warehouses

➢ Takeaways

- The standards apply to all refrigerated spaces 3,000 sf or larger or the sum of spaces 3,000 sf or larger with a common refrigeration system.
- Insulation levels in walls ceilings and floors depend on space temperature.
- Controls on underslab electric heating or use an underslab heating system utilizing productive refrigeration.
- Evaporator fans must be continuously variable and have controls that respond to the space conditions.
- Condenser condensing temperature must be capable of resetting based on ambient conditions.
- Condenser fans must be continuously variable and meet specific efficiency requirements.
- Condenser fin density of no less than 10 fins per inch unless it is a microchannel type.

Refrigerated Warehouses

- Takeaways – cont.
  - Compressors have requirements for minimum condensing temperature setpoint, speed control and volume ratio control.
  - Passage ways between spaces of different temperatures must have infiltration barriers.
  - Refrigeration system acceptance testing is required.
  - These requirements are all mandatory.

QUESTIONS…

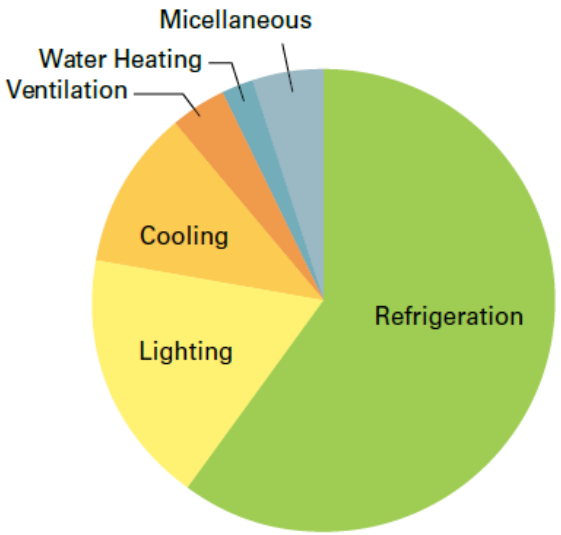
About Refrigerated Warehouses

Commercial Refrigeration
§120.6(b)

Commercial Refrigeration

Supermarket Electricity Use[1]

Refrigeration	60%
Lighting	18%
Cooling	11%[1]
Ventilation	4%[1]
Water Heating	2%
Miscellaneous	5%[1]



1 Source: National Renewable Energy Laboratory 2008 (average industry numbers)

What is "Commercial Refrigeration"??

- **Standards §100.1 Definitions:**
  - Refrigerated Case
    - A manufactured commercial refrigerator or freezer, including but nc limited to display cases, reach-in cabinets, meat cases, and frozen food and soda fountain units.
  - Freezer
    - A space designed to be capable of operation at less than 28°F.
  - Cooler
    - A space to be capable of operation at a temperature greater than or equal to 28°F but less than 55°F.

Commercial Refrigeration

- **Standards Section §120.6(b) Applicability**
  - Retail food stores ≥ 8,000 ft^2 of conditioned space must meet all requirements of **§120.6(b)**:
    - Condensers - §120.6(b)1
    - Compressor Systems - §120.6(b)2
    - Refrigerated Display Cases - §120.6(b)3
    - Refrigeration Heat Recovery - §120.6(b)4

Commercial Refrigeration

➢ §120.6(b)1 - Condensers

- Condenser **fans** must be **continuously variable speed**, with the speed of all fans serving a common condenser high side controlled in unison.
- Condenser **controls** for systems with **air-cooled** condensers must use **variable setpoint control logic** based on ambient **dry bulb** temperature.
- Condenser **controls** for systems with **evaporative-cooled** condensers shall use **variable setpoint control logic** based on ambient **wet bulb** temperature.
- The minimum condensing temperature setpoint must be ≤ 70°F.

Commercial Refrigeration

➢ §120.6(b)1 - Condensers – cont.

- Fan-powered condensers shall meet the **specific efficiency** requirements listed in Table 120.6-C

TABLE 120.6-C FAN-POWERED CONDENSERS –SPECIFIC EFFICIENCY REQUIREMENTS

CONDENSER TYPE	MINIMUM SPECIFIC-EFFICIENCY[a]	RATING CONDITION
Evaporative-Cooled	160 Btuh/W	100°F Saturated Condensing Temperature (SCT), 70°F Entering Wetbulb Temperature
Air-Cooled	65 Btuh/W	105°F Saturated Condensing Temperature (SCT), 95°F Entering Drybulb Temperature

[a] See Section 100.1 for definition of condenser specific efficiency.

- Air-cooled condensers must have a **fin density** no greater than 10 fins per inch unless it is a microchannel condensers .

Commercial Refrigeration

➢ §120.6(b)2 - Compressor Systems

- 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.
- **Liquid subcooling** must be provided for all low temperature compressor systems with a design cooling capacity of 100,000 Btuh or greater and with a design saturated suction temperature of -10°F or lower. The subcooled liquid temperature of 50°F or less must be maintained continuously at the exit of the subcooler. Subcooling load may be handled by compressor economizer ports, or by using a suction group operating at a saturated suction temperature of 18°F or higher.
- Of course, there are exceptions. See section **§120.6(b)1.**

Commercial Refrigeration

➢ §120.6(b)3 - Refrigerated Display Cases

- **Lighting** in refrigerated display cases, and lights on glass doors installed on walk-in coolers and freezers shall be **controlled by one of the following**:
  - ➢ **Automatic time switch controls** to turn off lights during nonbusiness hours. Timed overrides for any line-up or walk-in case may only be used to turn the lights on for up to one hour. Manual overrides shall time-out automatically to turn the lights off after one hour.
  - ➢ **Motion sensor controls** on each case that reduce display case lighting power by at least 50 percent within 30 minutes after the area near the case is vacated.
- Of course, there are exceptions. See section **§120.6(b)3.**

Commercial Refrigeration

Example 10-16

Question

A retail food store has two suction groups, a low temperature suction group A (-22°F design SST) and medium temperature suction group B (18°F design SST). Suction group A consists of three compressors. Suction group B has four compressors that serve a glycol chiller working at 23°F. Which of these suction groups are required to have floating suction pressure control?

Answer

Suction group A: The suction group has multiple compressors. Therefore, the suction group is required to have floating suction pressure control.

Suction group B: Although the suction group has multiple compressors, it serves a chiller for secondary cooling fluid (glycol). Therefore, the suction group is not required to have floating suction pressure control.

Example 10-17

Question

A retail food store is undergoing an expansion and has two refrigeration systems: an existing system and a new CO_2 cascade system. The existing system consists of four compressors and a design SST of 18°F. The cascade refrigeration system consists of four low temperature compressors operating at -20°F SST and three medium temperature compressors operating at 26°F SST. Which of these systems are required to have floating suction pressure control?

Answer

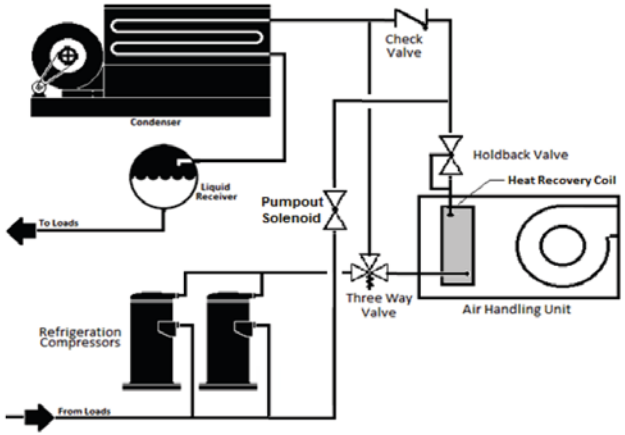
Existing system: Although the system has multiple compressors, the compressor system is being reused, and the existing rack controller and sensors may not support floating suction pressure control. Therefore, the system is not required to have floating suction pressure control.

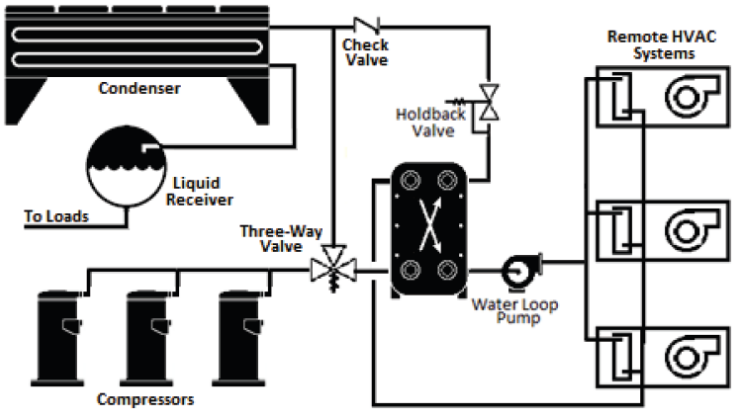
Cascade system: Only low temperature suction group of the system is required to have floating suction pressure control.

Commercial Refrigeration

➢ §120.6(b)4 - Refrigeration Heat Recovery

- HVAC systems must utilize **heat recovery** from refrigeration system(s) **for space heating**, using at least 25 percent of the design Total Heat of Rejection of all refrigeration systems that have individual Total Heat of Rejection of 150,000 Btu/h or greater at design conditions.
- The increase in **hydrofluorocarbon refrigerant charge** associated with refrigeration heat recovery equipment and piping shall be **no greater than 0.35 lbs per 1,000 Btu/h** of heat recovery heating capacity.
- Of course, there are exceptions. See section **§120.6(b)4.**





Commercial Refrigeration

- Quiz Question:
  - What is the minimum square footage of conditioned space a retail food store needs to have in order for the Standards to apply?

a) 3,000 ft^2
b) 5,000 ft^2
c) 8,000 ft^2
d) Any size

Commercial Refrigeration

- Quiz Question:
  - What is the minimum fin density per inch allowed for a condenser?

a) 1
b) 10
c) 100
d) No minimum with a microchannel
e) b or d

Commercial Refrigeration

- Takeaways
  - The standards apply to all retail food stores with conditioned space ≥ 8,000 ft^2 .
  - Condenser fans must be continuously variable speed and must meet the specific efficiency requirements listed in Table 120.6-C.
  - Condensers must have controls using variable setpoint control logic.
  - Condenser fin density of no less than 10 fins per inch unless microchannel type.
  - Compressors have floating suction pressure logic and liquid subcooling requirements.
  - Display cases have lighting control requirements.
  - Refrigeration system heat recovery for space heating is required for some systems.
  - All requirements are mandatory.

QUESTIONS…

About Commercial Refrigeration

Enclosed Parking Garages §120.6(c)

What is an "Enclosed Parking Garage"??

- **Standards §100.1 Definitions:**
  - Parking Garage Building
    - A building in which a minimum of 90 percent of the building floor area is for the purpose of parking vehicles, which consists of at least a roof over the parking area enclosed with walls on all sides. The building includes areas for vehicle maneuvering to reach designated parking spaces. If the roof of a parking structure is also used for parking, the section without an overhead roof is considered an outdoor parking lot instead of a parking garage.

Enclosed Parking Garages

- **Standards Section §120.6(c) Applicability**
  - 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**.
  - Of course, there are exceptions:
    - EXCEPTION 1 to Section 120.6(c): Any garage, or portion of a garage, where **more than 20 percent** of the vehicles expected to be stored have **non gasoline** combustion engines.
    - EXCEPTION 2 to Section 120.6(c): **Additions and alterations** to existing garages where **less than 10,000 cfm** of new exhaust capacity is being added.

Enclosed Parking Garages

- **Standards Section §120.6(c) Requirements**
  - Automatically **detect contaminant levels** and **stage fans or modulate fan airflow rates** to 50 percent or less of design capacity.
  - Have **controls** and/or devices that result in **fan motor demand** of no more than 30 percent of design wattage at 50 percent of design airflow.
  - Carbon Monoxide (CO) must be monitored with CO sensors:
    - At least one CO sensor per 5,000 ft^2.
    - At least two sensors per proximity zone. A proximity zone is an area that is isolated from other areas either by floor or other impenetrable obstruction.
    - Sensor located in the highest expected concentration locations.

Enclosed Parking Garages

- Quiz Question:
  - In a 5,000 ft^2 enclosed parking garage designed primarily for gas combustion engine vehicles, how many CO sensors are required?

a) None
b) Two
c) Four
d) Not enough information

- Is the design exhaust 10,000 cfm or more?
- Are there any partitioned spaces?

Enclosed Parking Garages

- Quiz Question:
  - In 15,000 ft^2 single proximity zone enclosed parking garage where 20% of the spaces are for electric vehicles and has a 20,000 cfm design exhaust flow, how many CO sensors are required?

a) Two
b) Three
c) Four
d) The standards do not apply
e) Not enough information

Enclosed Parking Garages

- **Standards Section §120.6(c) Requirements cont.**
  - **CO concentration** at all sensors is maintained at **25 ppm or less**.
  - The **ventilation rate** must be at least **0.15 cfm/ft^2** when the garage is scheduled to be **occupied**.
  - The system must maintain the garage at **negative or neutral pressure** relative to other occupiable spaces when the garage is scheduled to be occupied.
  - CO sensors have quality requirements:
    - **Certified** by the manufacturer to be **accurate** within plus or minus 5 percent of measurement.
    - Certified by the manufacturer to **drift** no more than 5 percent per year.
    - Certified by manufacturer to need **calibration** no more than once a year.
    - Factory **calibrated**.
    - Monitored by a control system that will reset to design ventilation rates and **transmit an alarm** to the facility operators. For details of the sensor failure criteria see §120.6(c)7E.

Enclosed Parking Garages

- **Standards Section §120.6(c) Requirements cont.**
  - Parking Garage Ventilation System Acceptance.
    - Before an occupancy permit is granted for a parking garage system subject to Section 120.6(c), the system 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 NA7.12.

Enclosed Parking Garages

Takeaways

- The Standards apply to parking garages with a design exhaust rate of 10,000 cfm or greater.
- There are speed and power reduction control requirements for exhaust fans.
- The exhaust fan controls must be linked to CO sensors.
- The CO sensors have location and quantity requirements.
- The CO sensors have quality requirements.
- There must be a control system to monitor sensor failure and transmit an alarm to the facility operators.
- The system must have acceptance testing.
- All requirements are mandatory.

QUESTIONS…

About Enclosed Parking Garage

Process Boilers
§120.6(d)

What is a "Process Boiler"??

- **Standards §100.1 Definitions:**
  - Process Boiler
    - A type of boiler with a capacity (rated maximum input) of 300,000 (Btu/h) or more that serves a process.

Process Boilers

- **Standards Section §120.6(d) Applicability**
  - Process boilers that have a **input capacity** of 2.5 MMBtu/h (2,500,000 Btu/h) with a **non-positive vent static pressure**.
  - Or process boilers where **one stack** serves **two or more** boilers that have a **combined** input capacity of 2.5 MMBtu/h (2,500,000 Btu/h).
  - Or process boilers with combustion air fan motors 10 HP or larger.
  - Believe it or not, there are no exceptions!

Process Boilers

- **Standards Section §120.6(d) Requirements**
  - **Combustion air positive shut**-off shall be provided on all newly installed process boilers as follows:
    - **All process boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h)** and above, in which the boiler is designed to operate with a **non-positive vent static pressure**.
    - All process boilers where **one stack serves two or more boilers** with a total **combined input capacity** per stack of 2.5 MMBtu/h.
  - Process boiler combustion air fans with **motors 10 horsepower or larger** shall meet one of the following for newly installed boilers:
    - The fan motor shall be driven by a **variable speed** drive; or
    - 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.

Process Boilers

- **Standards Section §120.6(d) Requirements cont.**
  - Newly installed process boilers with an **input capacity of 5 MMBtu/h (5,000,000 Btu/h) to 10 MMBtu/h (10,000,000 Btu/h)**:
    - Shall maintain **excess (stackgas) oxygen concentrations** at less than or equal to **5.0 percent** by volume on a dry basis over firing rates of 20 percent to 100 percent.
    - **Combustion air volume shall be controlled** with respect to **firing rate or measured flue gas oxygen concentration**. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

Process Boilers

- **Standards Section §120.6(d) Requirements cont.**
  - Newly installed process boilers with an 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 percent** by volume on a dry basis over firing rates of 20 percent to 100 percent.
    - **Combustion air volume shall be controlled** with respect to **measured flue gas oxygen concentration**. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

Process Boilers

- Takeaways
  - Combustion air positive shutoff requirements.
  - Combustion air fans with motors 10 horsepower or larger must be variable speed and have controls to reduce airflow and power.
  - Limits on excess oxygen levels in the exhaust gas.
  - The requirements for Process Boilers are all mandatory.

QUESTIONS…

About Process Boilers

Compressed Air Systems

§120.6(e)

What is a "Compressed Air System"??

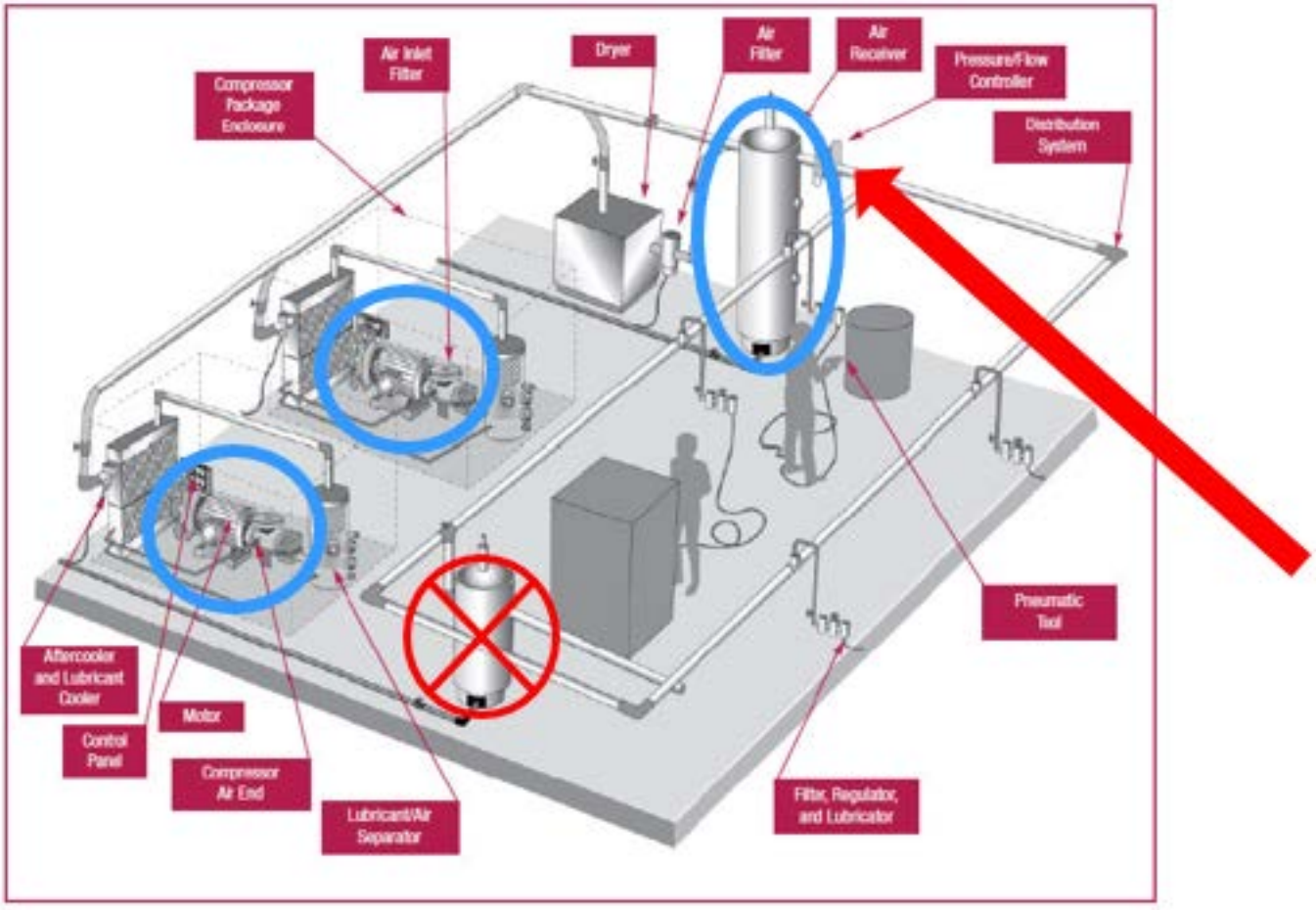
- **Standards §100.1 Definitions:**
  - Compressed Air System
    - A system of at least one compressor providing compressed air at **40 psig or higher**.
  - Trim Compressor
    - A compressor that is designated for **part-load operation**, handling t short term variable trim load of end uses, in addition to the fully loaded base compressors.
  - Primary Storage
    - Compressed air storage located **upstream of the distribution system** and any pressure flow regulators.

Compressed Air Systems

- **Standards Section §120.6(e) Applicability**
  - All new, and all additions or alterations of compressed air systems (as defined in §100.1) where the **total combined online horsepower (hp)** of the compressor(s) is **25 hp or more**. The requirements apply to the compressors and related controls that provide compressed air and **do not apply to any equipment or controls that use or process the compressed air**.
    - §120.6(e)1 - Trim Compressor and Storage
    - §120.6(e)2 – Controls
    - §120.6(e)3 – Compressed Air System Acceptance
  - Exception exempts alterations of existing compressed air systems that include one or more centrifugal compressors.

Compressed Air Systems

- **Standards Section §120.6(e) Applicability**



Source: Improving Compressed Air System Performance: A Sourcebook for Industry, USDOE 2003

Compressed Air Systems

➢ §120.6(e)1 - Trim Compressor and Storage

- The compressed air system shall be equipped with an appropriately sized **trim compressor** and **primary storage** to provide acceptable performance across the range of the system and to avoid control gaps.
- There are two ways to comply with trim compressor requirements.
  - ➢ The simplest way is to use a Variable Speed Drive (VSD) that is 1.25 times the size of the largest gap between the most efficient order of use of all compressors. See Nonresidential Manual Section 10.8.2.1A.
  - ➢ Without a VSD trim compressor, the requirements are very complicated. The Nonresidential Manual has detailed descriptions, graphics and examples. See Nonresidential Compliance Manual Section 10.8.2.1B for option 2 trim compressor compliance examples.

Compressed Air Systems

- §120.6(e)1 - Trim Compressor and Storage – cont.
  - The size of the primary air storage depends on weather or not there is a Variable Speed Drive (VSD) trim compressor.
    - If the system **has a VSD**, the primary storage must be **1 gallon per acfm** of the largest trim compressor.
    - If **no VSD** compressors, the system shall include primary storage of at least **2 gallons per acfm** of the largest trim compressor.
  - Of course, there are exceptions. See section §120.6(e)1 for details.

Compressed Air Systems

- §120.6(e)2 - Controls.
  - Compressed air systems with **more than one compressor** online, having a **combined** horsepower rating of **more than 100 HP**, must operate with a 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.
- §120.6(e)3 – Compressed Air System Acceptance.
  - Before an occupancy permit is granted the system must be tested and a Certificate of Acceptance submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA 7.13.

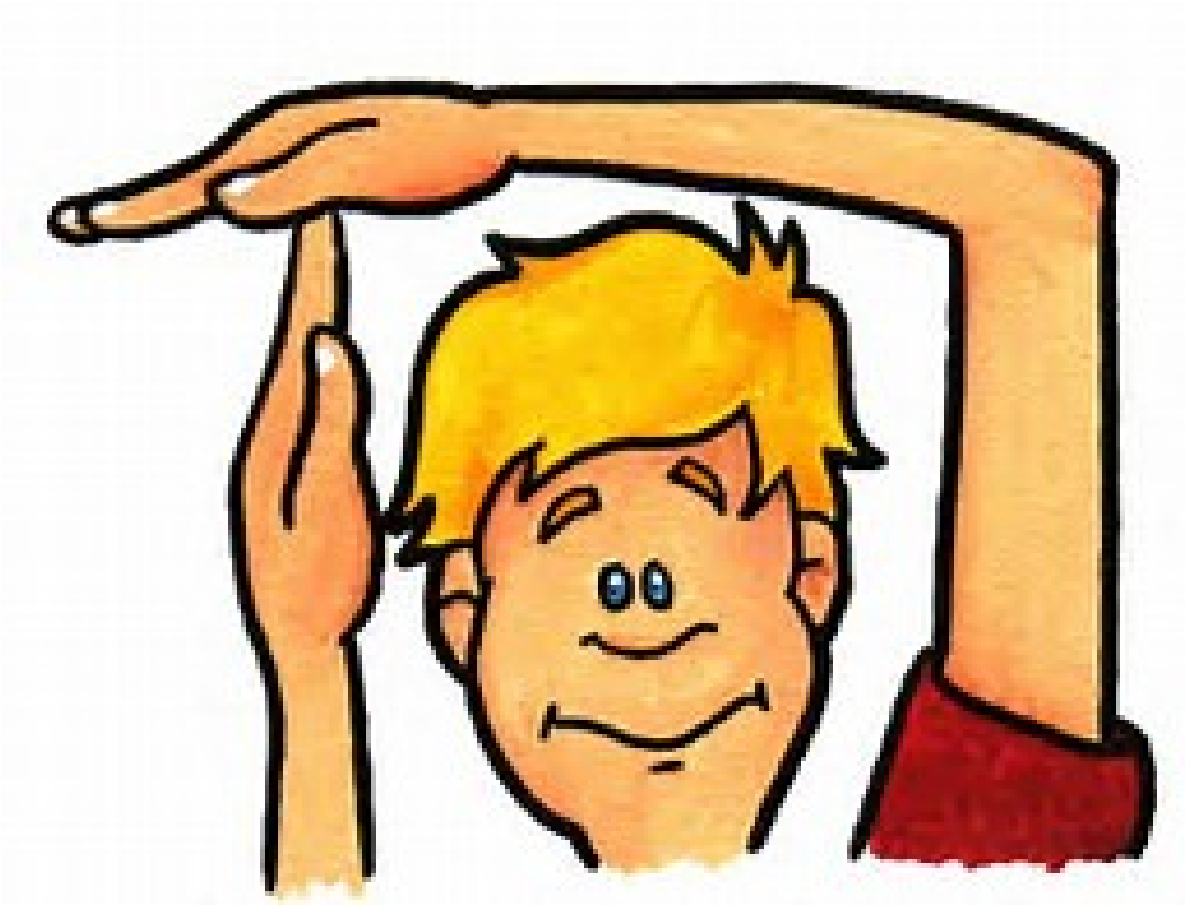
Compressed Air Systems

- Takeaways
  - There are trim compressor capacity requirements.
  - There are primary storage size requirements based on weather the system has a VSD trim compressors or not.
  - There are control requirements for large systems more than 100 HP to optimally stage compressors.
  - There are acceptance test requirements for all covered Compressed Air Systems.
  - Requirements for all covered Compressed Air Systems are mandatory.

QUESTIONS…

About Compressed Air Systems

Time for a Break?



Elevators

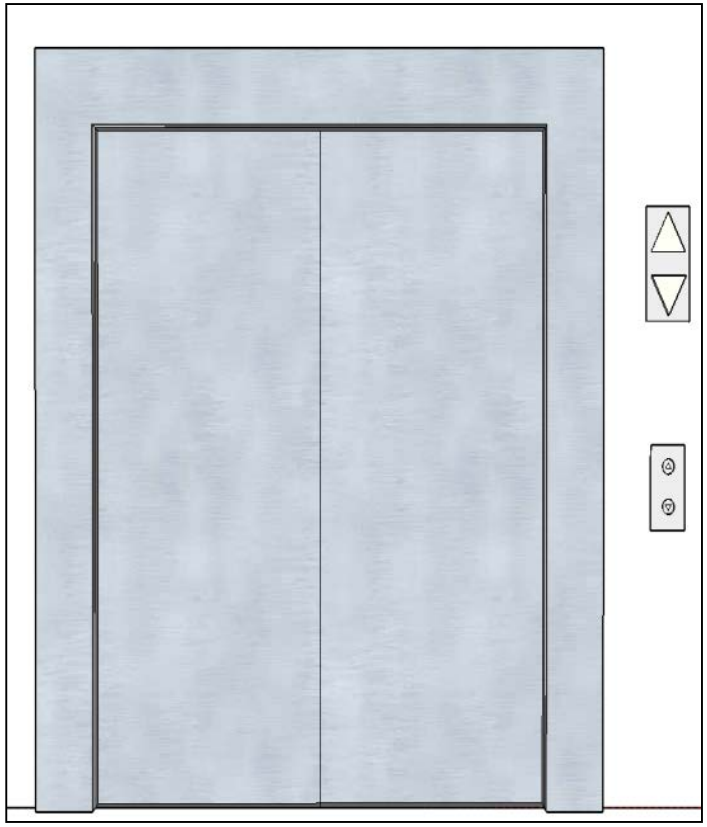
§120.6(f)

Elevators

- **Standards Section §120.6(f) Applicability**
  - Applies to all new elevators.

Elevators

- §120.6(f)
  - **LPD shall be ≤ 0.6 watts/ft²** (does not include interior signal lighting and interior display lighting).
  - **Ventilation fans** for cabs without A/C shall be **≤ 0.33 watts/cfm** at maximum speed.
  - **Automatic shutoff controls** for lights and ventilation when stopped and unoccupied for over 15 minutes.
    - Lighting & ventilation shall remain operational in the event that the cabin is stuck and occupied.
  - Acceptance testing per NA7.14 is required.



Elevators

- Takeaways
  - LPD shall be ≤ 0.6 watts/ft^2.
  - Ventilation fans for cabs without A/C shall be ≤ 0.33 watts/cfm.
  - Automatic shutoff controls for lights and ventilation when stopped and unoccupied.
  - Acceptance testing per NA7.14 is required.
  - All requirements are mandatory.

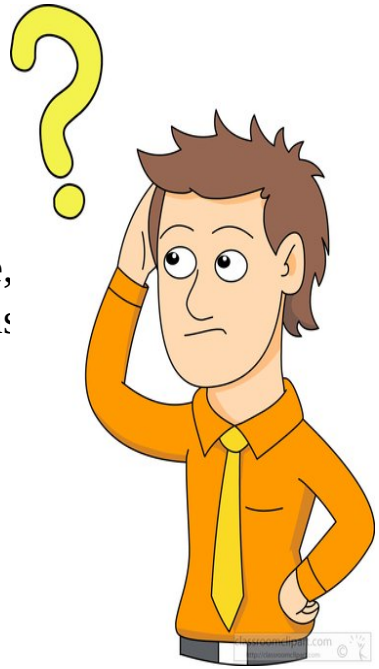
QUESTIONS…

About Elevators

Escalators and Moving Walkways §120.6(g)

What is an “Escalator or Moving Walkway”??

- **Standards §100.1 Definitions:**
  - Transportation Function Area:
    - The ticketing area, waiting area, baggage handling areas, concourse, in an airport terminal, bus or rail terminal or station, subway or trans station, or a marine terminal.



Escalators and Moving Walkways

- **Standards Section §120.6(g) Applicability**
  - Applies to Escalators and moving walkways located in airports, hotels, and **transportation function areas**.

Escalators and Moving Walkways

Source: wwwtelcosensors.com/solutions/industries/elevators

- §120.6(g)
  - Required to meet speed, acceleration, and passenger detection requirements per ASME A17.1-2013/CSA B44-13.
  - Acceptance testing per NA7.15 is required.

Escalators and Moving Walkways

- **ASME A17.1-2013/CSA B44-13 Requirements.**
  - **Applicable to both Moving Walkways and Escalators**
    - **Acceleration** shall not exceed **1.0 ft/s^2** while occupied.
    - **Passenger detection at both ends of the escalator/walkway** allowing time to reach full speed before the passenger arrives and sound a warning signal to passengers approaching from the wrong direction.
    - Must slow to a minimum speed of 10 ft/min when not conveying passengers after 3 times the time needed to go between landings.
  - Moving Walkways maximum speed
    - Walkways with slopes **less than or equal to 8 degrees**: maximum allowable speed is **180 ft/min**.
    - Walkways with slope **above 8 and less than or equal to 12 degrees**: maximum allowable speed is **140 ft/min**.
    - **Over 12 degree** slope is considered an escalator.
  - Escalators maximum speed
    - Maximum allowable speed is **100 ft/min**.

Escalators and Moving Walkways

- Takeaways
  - Applicable to transportation function areas.
  - There are maximum speed requirements based on the slope.
  - The maximum acceleration while occupied is 1.0 ft/s^2 .
  - Minimum speed is 10 ft/min when not conveying passengers.
  - Passenger detection is required at both ends.
  - Acceptance testing is required.
  - All requirements are mandatory.

QUESTIONS…

About Escalators and Moving Walkways

Computer Rooms
§140.9(a)

What is a "Computer Room"??

- **Standards §100.1 Definitions:**
  - Computer Room
    - A room whose primary function is to house electronic equipment and that has a design equipment **power density exceeding 20 watts/ft^2 (215 watts/m^2)** of conditioned floor area.
  - Data Center
    - A building whose primary function is to house computer room(s).
  - Recool
    - The cooling of air that has been previously heated by space-conditioning equipment or systems serving the same building.
  - Reheat
    - The heating of air that has been previously cooled by cooling equipment or supplied by an economizer.

Computer Rooms

- **Standards Section §140.9(a) Applicability**
  - This section is applicable to all spaces meeting the computer room definition (20 watts/ft^2) and using the prescriptive method of compliance.
    - §140.9(a)1 – Economizers
    - §140.9(a)2 – Reheat
    - §140.9(a)3 – Humidification
    - §140.9(a)4 - Power Consumption of Fans
    - §140.9(a)5 - Fan Control
    - §140.9(a)6 - Containment
  - If you do not wish to comply with all of these prescriptive requirements, the performance method must be utilized.

Computer Rooms

- §140.9(a)1 - Economizers.
  - Each individual cooling system primarily serving computer room(s) shall include either:
    - An integrated **air economizer capable of providing 100 percent of the expected system cooling** load as calculated in accordance with a method approved by the Commission, at outside air temperatures of 55°F dry-bulb/50°F wet-bulb and below; or
    - An integrated **water economizer capable of providing 100 percent of the expected system cooling load** as calculated in accordance with a method approved by the Commission, at outside air temperatures of 40°F dry-bulb/35°F wet-bulb and below.
  - Of course, there are exceptions. See section §140.9(a)1 for details.

Computer Rooms

- §140.9(a)2 - Reheat.
  - Each computer room zone shall have controls that **prevent reheating, recooling and simultaneous provisions of heating and cooling to the same zone**, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by cooling equipment or by economizer systems.
- §140.9(a)3 - Humidification.
  - Nonadiabatic humidification (e.g. steam, infrared) is prohibited. **Only adiabatic humidification (**e.g. direct evaporative, ultrasonic) is permitted.
- §140.9(a)4 - Power Consumption of Fans.
  - The total fan power at design conditions of each fan system shall not exceed 27 W/kBtu·h of net sensible cooling capacity.

Computer Rooms

➢ §140.9(a)5 - Fan Control.

- Each **unitary air conditioner** with mechanical cooling capacity **exceeding 60,000 Btu/hr** and **each chilled water fan system** shall be designed to:
  - ➢ **vary the airflow rate as a function of actual load** and
  - ➢ **shall have controls** and/or devices (such as two-speed or variable speed control) that will result in fan **motor demand of no more than 50 percent of design wattage at 66 percent of design fan speed**.

Computer Rooms

➢ §140.9(a)6 - Containment.

- Computer rooms with air-cooled computers in racks and with a design load exceeding **175 kW/room** shall include **air barriers** such that there is no significant air path for computer **discharge air to recirculate back to computer inlets** without passing through a cooling system.
- Of course, there are exceptions. See section §140.9(a)6 for details.
  - ➢ Expansion of existing computer rooms.
  - ➢ Computer racks with a design load less than 1 kW/rack.

Computer Rooms

Figure 10-5: Example of aisle containment using chimney racks

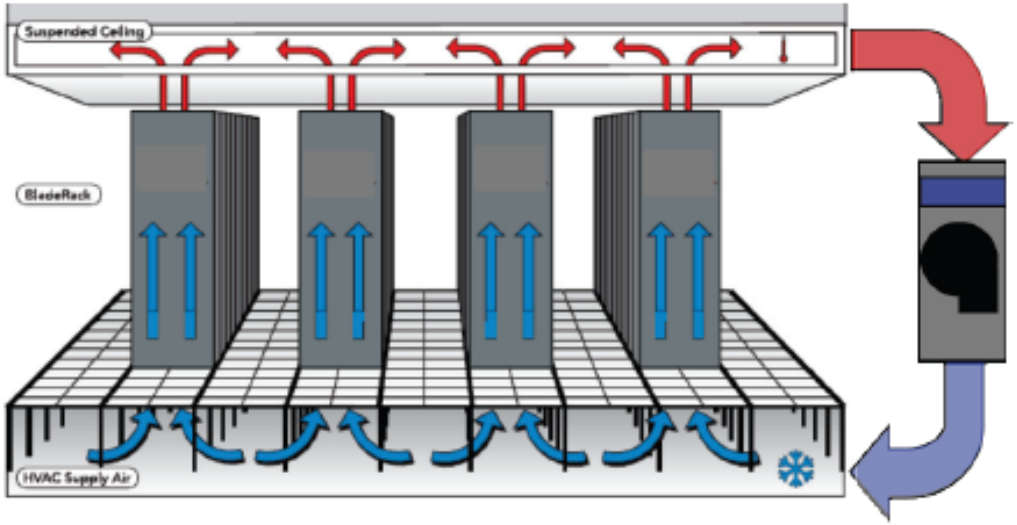


Figure 10-6: Example of aisle containment using hard partitions and doors

Computer Rooms

- Quiz Question:
  - Which of the following are mandatory requirements for computer rooms?

a) Economizer air
b) Prevention of reheating and recooling
c) Adiabatic humidification
d) A and B
e) A, B and C
f) None of the above

  - There are no mandatory requirements for computer rooms. They are all prescriptive.

Computer Rooms

- Quiz Question:
  - Which of the following are prescriptive requirements for computer rooms?

a) Economizer air
b) Prevention of reheating and recooling
c) Adiabatic humidification
d) A and B
e) A, B and C
f) None of the above

Computer Rooms

Takeaways

- The Standards apply if the power density exceeds 20 watts/ft^2.
- Reheating and recooling are not allowed.
- Only adiabatic humidification is allowed.
- Fan power shall not exceed 27 W/kBtu·h of net sensible cooling capacity.
- Fan controls to reduce fan speed based on load requirements.
- Containment systems are required in rooms greater than 175 kW/room.
- These are prescriptive requirements only.

QUESTIONS…

About Computer Rooms

Commercial Kitchens

§140.9(b)

What is a “Commercial Kitchen”??

- **Standards §100.1 Definitions:**
  - Kitchen/Food Preparation
    - A room or area with cooking facilities or an area where food is prepared.
  - Food Preparation Equipment
    - Cooking equipment intended for commercial use, including coffee machines, espresso coffee makers, conductive cookers, food warmer including heated food servers, fryers, griddles, nut warmers, ovens, popcorn makers, steam kettles, ranges, and cooking appliances for use in commercial kitchens, restaurants, or other business establishments where food is dispensed.

What is a "Commercial Kitchen"??

- **Standards §100.1 Definitions – cont.:**
  - Replacement Air
    - Air that is used to replace air removed from a building through an exhaust sy Replacement air may be derived from one or more of the following: makeup portions of supply air, transfer air, or infiltration air.
  - Makeup Air
    - Outdoor air that is intentionally conveyed by openings or ducts into the build from the outside; is supplied to the vicinity of an exhaust hood; and replaces vapor and contaminants being exhausted by the exhaust hood. Makeup air is generally filtered and fan-forced, and it may be heated or cooled. Makeup air may be delivered through openings or ducts integral to the exhaust hood.
  - Transfer Air
    - Air transferred, whether actively by fans or passively by pressure differentials, from one room to another within a building through openings.

What is a "Commercial Kitchen"??

- **ASHRAE Standard 154-2011 Definitions:**
  - Type I Hood
    - A hood used for collecting and removing convective heat, grease particulate, condensable vapor, and smoke.
  - Type II Hood:
    - A hood that collects and removes steam, heat, and products of combustion where grease or smoke is not present.
  - Appliance Duty Level
    - Light: cooking process requiring exhaust airflow rate < 200 cfm/ft
    - Medium: cooking process requiring exhaust rate of 200 to 300 cfm/ft
    - Heavy: cooking process requiring exhaust rate of 300 to 400 cfm/ft
    - Extra Heavy: cooking process requiring exhaust rate > 400 cfm/ft

Commercial Kitchen

- **Standards Section §140.9(b) Applicability**
  - This section is applicable to all commercial **kitchens with at least one exhaust hood**.
    - §140.9(b)1 – Kitchen Exhaust System
    - §140.9(b)2 – Kitchen Ventilation
    - §140.9(b)3 – Kitchen Exhaust System Acceptance
  - If it is desired not to comply with these prescriptive requirements, the performance method must be utilized.

Commercial Kitchen

- §140.9(b)1 – Kitchen Exhaust System.
  - Replacement air **directly into the hood cavity** of kitchen exhaust hoods (AKA short circuit hoods) **can't exceed 10 percent** of the hood airflow rate.
  - For **total** Type I and Type II hood exhaust airflow rates **greater than 5,000 cfm**, each **Type I hood must** have an exhaust rate that complies with TABLE 140.9-A.

TABLE 140.9-A MAXIMUM NET EXHAUST FLOW RATE, CFM PER LINEAR FOOT OF HOOD LENGTH

Type of Hood	Light Duty Equipment	Medium Duty Equipment	Heavy Duty Equipment	Extra Heavy Duty Equipment
Wall-mounted Canopy	140	210	280	385
Single Island	280	350	420	490
Double Island	175	210	280	385
Eyebrow	175	175	Not Allowed	Not Allowed
Backshelf / Passover	210	210	280	Not Allowed

Commercial Kitchen

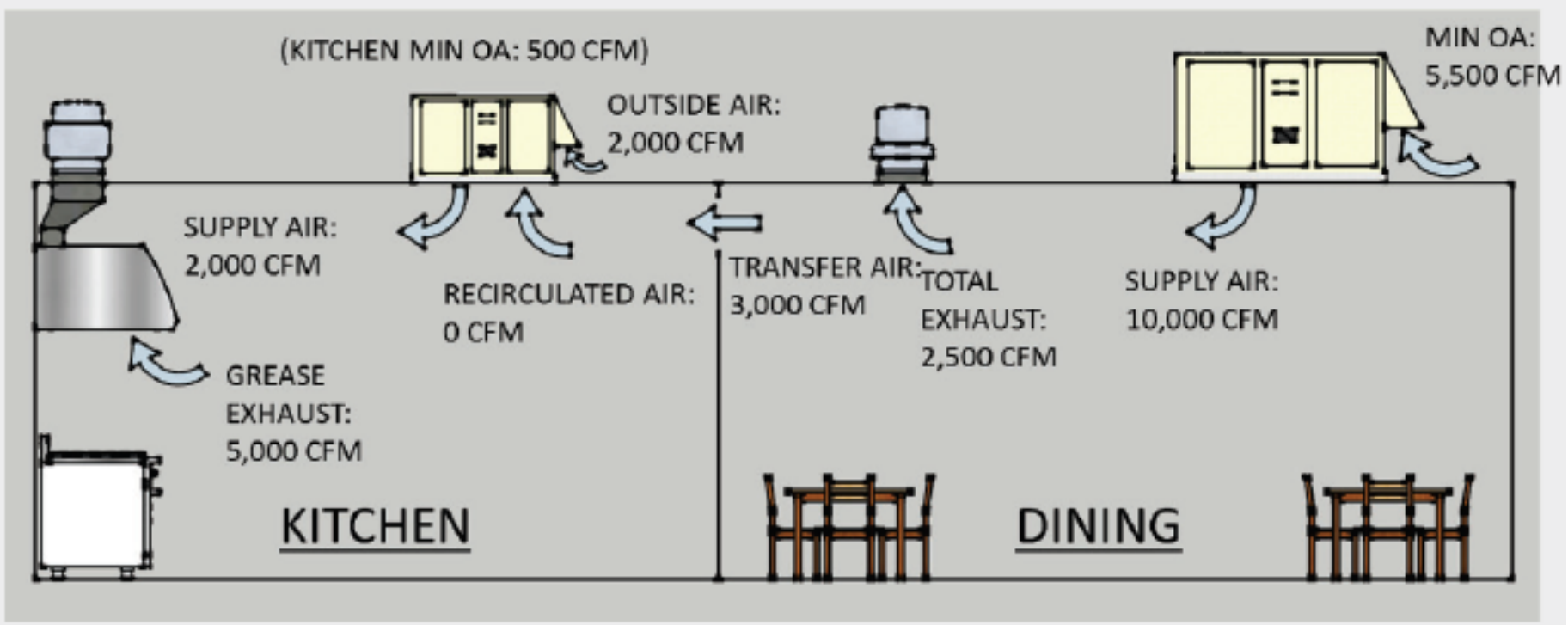
- §140.9(b)2.A – Kitchen Ventilation.
  - Mechanically **cooled or heated makeup air** delivered to any space with a kitchen hood **shall not exceed** the greater of:
    - The **supply flow required to meet the space heating and cooling** load; or
    - The **hood exhaust flow minus the available transfer air** from adjacent spaces.
      - ✓ Available transfer air is the outdoor ventilation air serving adjacent spaces that is not needed and **that would otherwise be relieved from the building**.
  - This requirement does not apply to existing makeup air units not being replaced as part of an addition or alteration.

Commercial Kitchen

- §140.9(b)2.B – Kitchen Ventilation - continued.
  - A kitchen/dining facility having a **total Type I and Type II** kitchen hood exhaust airflow rate **greater than 5,000 cfm** must have one of the following:
    - At least **50 percent of all replacement air is transfer air** that would otherwise be exhausted; **or**
    - Have a **demand ventilation system** on at least 75% of the exhaust air (and control requirements per §140.9(b)2.B.ii ; **or**
    - Listed **energy recovery devices** with a sensible heat recovery effectiveness of not less than 40 percent on at least 50 percent of the total exhaust airflow; **or**
    - A minimum of **75 percent of makeup air** volume that is **unheated** or heated to no more than 60°F and; **uncooled** or cooled without the use of mechanical cooling.

Commercial Kitchen

- Quiz question:
  - This kitchen requires 2000 cfm for cooling and has a demand ventilation system. Does it comply with the requirements in §140.9(b)2.A and B?



  - Yes.

Commercial Kitchen

- §140.9(b)3 – Kitchen Exhaust System Acceptance.
  - System Acceptance Testing applies only to **kitchens with Type I Hoods**. (See NA7.11)
  - The equipment and systems must be certified per the requirements in Reference Nonresidential Appendix NA7.11.

Commercial Kitchen

Takeaways

- The Standards apply if it is a commercial kitchen with at least one exhaust hood.
- There are maximum flow rates allowed for Type I exhaust hoods.
- There are maximum flow rates allowed for makeup air.
- For exhaust flows greater than 5,000 cfm, there are additional requirements to have makeup air, demand ventilation **OR** energy recovery devices.
- Acceptance testing is required for systems with Type I hoods.
- These are all prescriptive requirements.

QUESTIONS…

About Commercial Kitchens

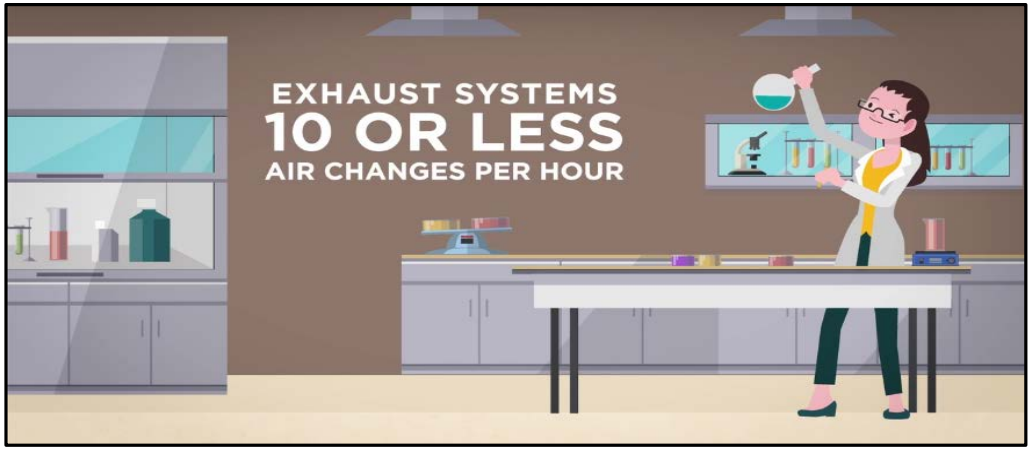
Laboratory Exhaust Systems §140.9(c)

What is a "Laboratory Exhaust System"??

- **Standards §100.1 Definitions:**
  - Scientific Laboratory
    - **A room or area where research, experiments, and measurement in medical and physical sciences are performed** requiring examination of fine details. The area may include workbenches, countertops, scientific instruments, and associated floor spaces. Scientific laboratory **does not refer to film, computer, and other laboratories where scientific experiments are not performed**.

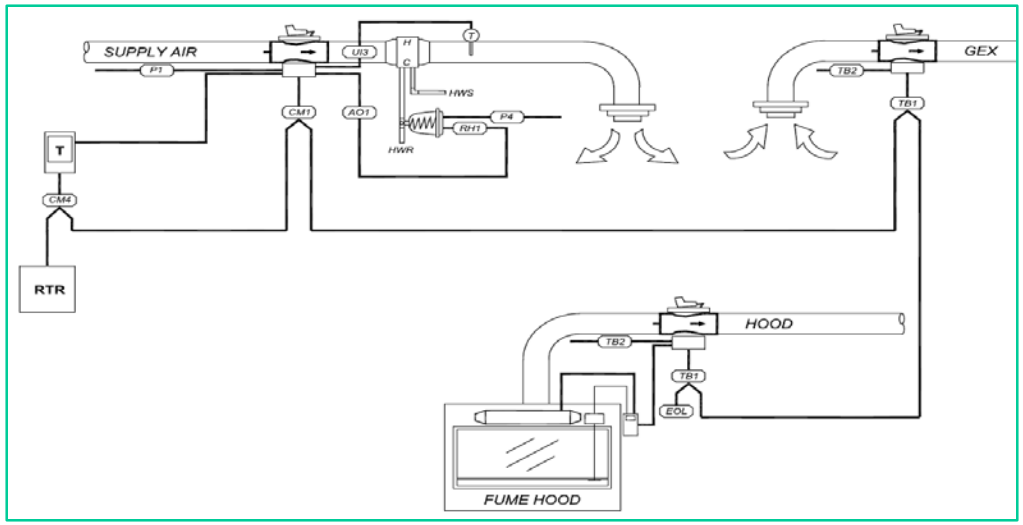
Laboratory Exhaust Systems

- **Standards Section §140.9(c) Applicability**
  - For buildings with laboratory exhaust systems where the minimum circulation rate to comply with code or accreditation standards is **10 ACH or less**.
  - Of course, there are exceptions:
    - EXCEPTION 1 to Section 140.9(c): Laboratory exhaust systems serving zones **where constant volume is required** by the Authority Having Jurisdiction, facility Environmental Health & Safety department or other applicable code.
    - EXCEPTION 2 to Section 140.9(c): New zones on an existing constant volume exhaust system.



Laboratory Exhaust Systems

- §140.9(c) – Laboratory Exhaust Systems.
  - The design exhaust airflow shall be **capable of reducing zone exhaust and makeup airflow rates to the larger of:**
    - to the regulated **minimum circulation rate**, or
    - the minimum required to **maintain pressurization requirements**.
  - **Variable exhaust and makeup airflow shall be coordinated** to achieve the required space pressurization at varied levels of demand and fan system capacity.



Laboratory Exhaust Systems

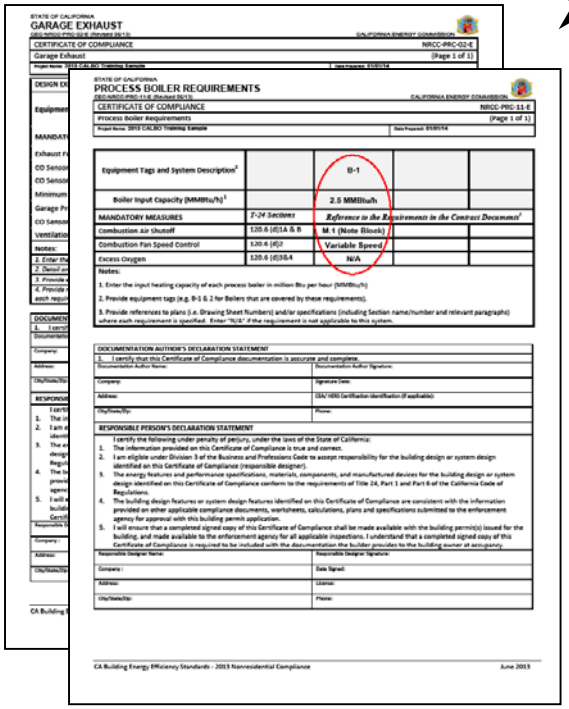
- Takeaways
  - The Standards apply if the system is designed for 10 ACH or less.
  - The Standards do not apply to systems requiring constant volume.
  - Controls to coordinate exhaust and makeup air are required to maintain minimum ACH or pressurization requirement.
  - These are prescriptive requirements.

QUESTIONS…

About Laboratory Exhaust Systems

Forms Review

Plans Examiner Forms Review



- Verify applicable Certificate of Compliance forms are on the plans
  - NRCC-PRC-01-E Process Compliance Forms and Worksheets
  - NRCC-PRC-02-E Parking Garage
  - NRCC-PRC-03-E Commercial Kitchens
  - NRCC-PRC-04-E Computer Rooms
  - NRCC-PRC-05-E Commercial Refrigeration
  - NRCC-PRC-06-E, 07, 08 for Refrigerated Warehouses
  - NRCC-PRC-09-E Laboratory Exhaust Systems
  - NRCC-PRC-10-E Compressed Air Systems
  - NRCC-PRC-11-E Process Boilers
- Verify required Acceptance Tests are shown on NRCC-PRC-01 and respective forms above.

Field Inspector Forms Review

- Verify Certificate of Installation
  - NRCI-PRC-01-E is required for all Covered Processes and is the only NRCI form for Covered Processes.

Field Inspector Forms Review - cont.

- Certificate of Acceptance NRCA forms that are required for covered processes: *
  - NRCA-PRC-01 - Compressed Air Systems
  - NRCA-PRC-02 - Kitchen Exhaust
  - NRCA-PRC-03 - Garage Exhaust
  - NRCA-PRC-04 - Refrigerated Warehouses Evaporator and Evaporator Fan Motor Controls
  - NRCA-PRC-05 - Refrigerated Warehouses Evaporative Condenser Controls
  - NRCA-PRC-06 - Refrigerated Warehouses Air Cooled Condenser Controls
  - NRCA-PRC-07 - Refrigerated Warehouses Variable Speed Compressor
  - NRCA-PRC-08 - Refrigerated Warehouses Electric Resistance Underslab Heating System

** Acceptance testing for covered processes does not require a certified ATT*

QUESTIONS…

About Covered Processes

The End

THANK YOU VERY MUCH!