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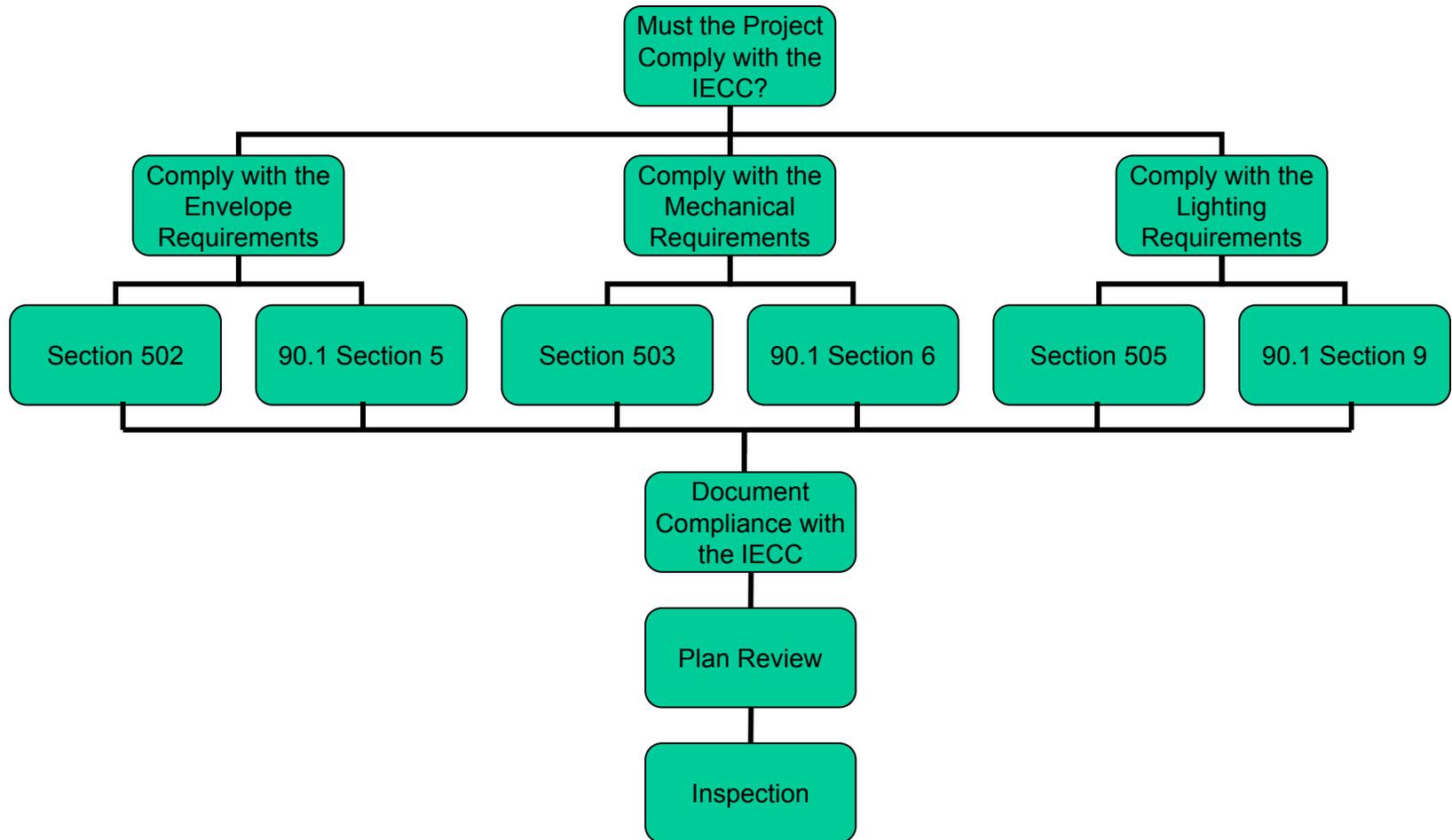
Commercial Mechanical Requirements of the 2006 International Energy Conservation Code

U.S. Department of Energy
Building Energy Codes Program

Mark Halverson, PNNL

Original Materials Developed By: Britt/Makela Group, Inc.

Introduction to the Energy Code Compliance Process



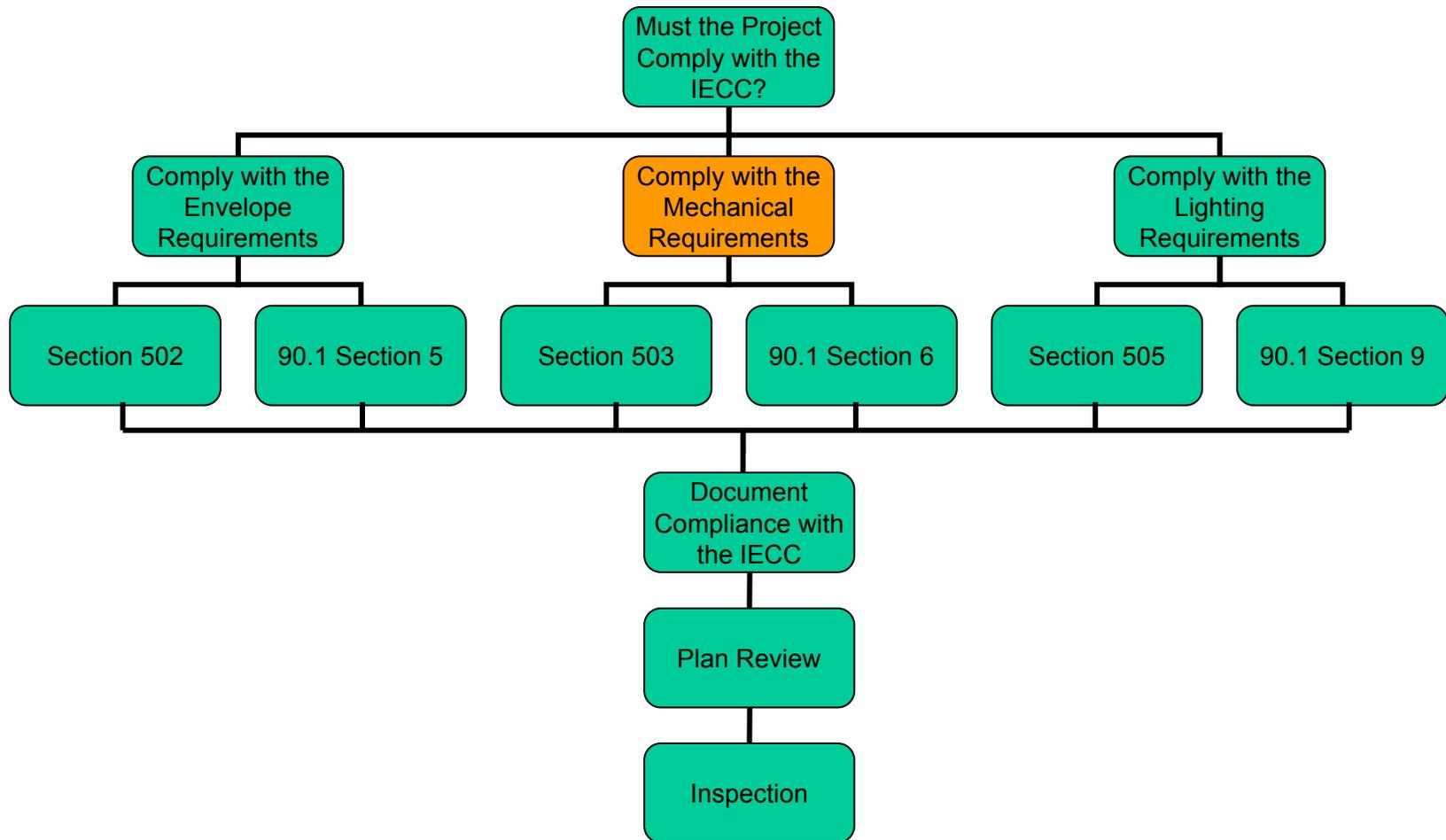
Does My Project Need to Comply with the IECC?



All Buildings Other Than:

- One- and two-family residential
- R-2, R-3, R-4 three stories or less in height

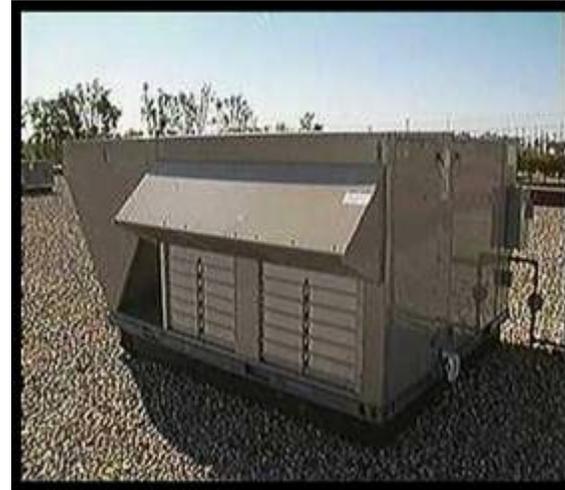
Introduction to the Energy Code Compliance Process



Section 503 Building Mechanical Systems

Simplified to Include Only Four Sections:

- What Provisions of the Code Apply (Section 503.1)
- Mandatory Provisions (Section 503.2)
- Simple HVAC Systems and Equipment (Section 503.3)
- Complex HVAC Systems and Equipment (Section 503.4)



What Provision of the Code Apply? (*Section 503.1*)

Mandatory Provisions – Section 503.2 PLUS

- Section 503.3 (Simple Systems) or
- Section 503.4 (Complex Systems)

Simple Versus Complex Systems

Simple systems

- Unitary or packaged HVAC equipment
- Serves one zone and controlled by a single thermostat

Section 503.3

Simple Systems

Buildings served by unitary or packaged HVAC each serving 1 zone controlled by 1 thermostat. Two-pipe heating systems serving multiple zones are included if no cooling system is installed

Simple Versus Complex Systems

Complex systems

- All equipment not covered under Section 503.3 Simple Systems

Section 503.4
**Complex
Systems**

All buildings served
by HVAC systems not
covered under 503.3

Mandatory Provisions (*Section 503.2*)

Provisions Applicable to ALL Mechanical Systems

- HVAC Load Calculations
- Equipment and System Sizing
- HVAC Equipment Performance Requirements
- HVAC System Controls
- Energy Recovery Ventilation Systems
- Duct and Plenum Insulation and Sealing
- Piping Insulation
- HVAC System Completion



HVAC Load Calculations (*Section 503.2.1*)

Heating and cooling load sizing calculations required

- ASHRAE Handbook of Fundamentals
- Other approved computation procedure
- Exterior design conditions
 - Specified by ASHRAE
- Interior design conditions
 - Specified by Section 302 of the IECC
 - $\leq 72^{\circ}\text{F}$ for heating load
 - $\geq 75^{\circ}\text{F}$ for cooling load

Equipment and System Sizing (Section 503.2.2)

Output capacity SHALL NOT exceed sizing –

- Select the system which serves the greater load, heating or cooling
 - Exceptions
 - Standby Equipment with Required Controls
 - Multiple Units with Combined Capacities Exceeding Loads
 - Sequencing Controls Required



HVAC Performance (Minimum Efficiency) Requirements (*Section 503.2.3*)

- Applies to all equipment used in heating and cooling of buildings
- Must comply with all listed efficiencies

Table 503.2.3(2)

TABLE 503.2.3(2)
UNITARY AND APPLIED HEAT PUMPS, ELECTRICALLY
OPERATED, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY*	TEST PROCEDURE*
Air cooled (Cooling mode)	< 65,000 Btu/h ^d	Split system	10.0 SEER	ARI 210/240
		Single package	9.7 SEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	10.1 EER ^c	ARI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	9.3 EER ^c	
	≥ 240,000 Btu/h	Split system and single package	9.0 EER ^c 9.2 IPLV ^c	
Water source (Cooling mode)	< 17,000 Btu/h	86°F entering water	11.2 EER	ARI/ASHRAE-13256-1
	≥ 17,000 Btu/h and < 135,000 Btu/h	86°F entering water	12.0 EER	ARI/ASHRAE-13256-1
Groundwater source (Cooling mode)	< 135,000 Btu/h	59°F entering water	16.2 EER	ARI/ASHRAE-13256-1
Ground source (Cooling mode)	< 135,000 Btu/h	77°F entering water	13.4 EER	ARI/ASHRAE 13256-1
Air cooled (Heating mode)	< 65,000 Btu/h ^d (Cooling capacity)	Split system	6.8 HSPF	ARI 210/240
		Single package	6.6 HSPF	
	≥ 65,000 Btu/h and < 135,000 Btu/h (Cooling capacity)	47°F db/43°F wb outdoor air	3.2 COP	ARI 340/360
≥ 135,000 Btu/h (Cooling capacity)	47°F db/43°F wb outdoor air	3.1 COP		
Water source (Heating mode)	< 135,000 Btu/h (Cooling capacity)	68°F entering water	4.2 COP	ARI/ASHRAE-13256-1
Groundwater source (Heating mode)	< 135,000 Btu/h (Cooling capacity)	50°F entering water	3.6 COP	ARI/ASHRAE-13256-1
Ground Source (Heating mode)	< 135,000 Btu/h (Cooling capacity)	32°F entering water	3.1 COP	ARI/ASHRAE-13256-1

For SI: °C = [(°F) - 32] / 1.8, 1 British thermal unit per hour = 0.2931 W.

db = dry-bulb temperature, °F; wb = wet-bulb temperature, °F.

a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b. IPLVs and Part load rating conditions are only applicable to equipment with capacity modulation.

c. Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

d. Single-phase air-cooled heat pumps < 65,000 Btu/h are regulated by the National Appliance Energy Conservation Act of 1987 (NAECA), SEER and HSPF values are those set by NAECA.

Table 503.2.3(3)

TABLE 503.2.3(3)
PACKAGED TERMINAL AIR CONDITIONERS AND
PACKAGED TERMINAL HEAT PUMPS

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY ^b	TEST PROCEDURE ^c
PTAC (Cooling mode) New construction	All capacities	95°F db outdoor air	12.5 - (0.213 · Cap/1000) EER	ARI 310/380
PTAC (Cooling mode) Replacements ^d	All capacities	95°F db outdoor air	10.9 - (0.213 · Cap/1000) EER	
PTHP (Cooling mode) New construction	All capacities	95°F db outdoor air	12.3 - (0.213 · Cap/1000) EER	
PTHP (Cooling mode) Replacements ^d	All capacities	95°F db outdoor air	10.8 - (0.213 · Cap/1000) EER	
PTHP (Heating mode) New construction	All capacities	—	3.2 - (0.026 · Cap/1000) COP	
PTHP (Heating mode) Replacements ^d	All capacities	—	2.9 - (0.026 · Cap/1000) COP	

For SI: °C - [(°F) - 32] / 1.8, 1 British thermal unit per hour - 0.2931 W

db = dry-bulb temperature, °F

wb = wet-bulb temperature, °F

a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b. Cap means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7,000 Btu/h, use 7,000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

c. Replacement units must be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY: NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16 inches (406 mm) high and less than 42 inches (1067 mm) wide.

System Controls (Section 503.2.4)

One temperature and humidity (when applicable) controller per zone



System Controls

Heat pump systems

- Heat pump thermostat required



Energy Recovery Ventilation Systems (Section 503.2.6)

- Applies to individual fan systems with
 - Design supply air capacity $\geq 5,000$ cfm
 - Minimum outside air supply of $\geq 70\%$ of design supply air quantity
- Exhaust air recovery efficiency must be $\geq 50\%$

Duct and Plenum Insulation and Sealing (Section 503.2.7)

Required for supply and return ducts and plenums

- Insulating ducts and plenums:
 - Located in unconditioned space - **R5**
 - Located outside the building - **R8**



Duct and Plenum Insulation and Sealing (Section 503.2.7)

- Duct Sealing for Low and Medium Pressure Duct Systems (< 3 in. w.g.)
- All joints, longitudinal and transverse seams and connections must be sealed
 - welds
 - gaskets
 - mastics
 - mastic-plus-embedded fabric systems
 - tapes
 - unlisted duct tape is not permitted as a sealant on any metal ducts



Duct Sealing

- Labeling for approved mastics and tapes

Sealant/ Duct Connection Type	UL Listing
Pressure Sensitive Tape	181A-P
Mastic	181A-M
Heat Sensitive Tape	181A-H
Flexible Air Ducts - Pressure Sensitive Tape	181B-FX
Flexible Air Ducts - Mastic	181B-M

High Pressure Duct System

- Ducts designed to operate at static pressures ≥ 3 in. wg to be leak tested in accordance with SMACNA HVAC Air Duct Leakage Test Manual
 - Air leakage rate < 6.0
- Must test $\geq 25\%$ of the duct area and meet the requirements

Piping Insulation (Section 503.2.8)

All piping serving heating or cooling system must be insulated in accordance with Table 503.2.8

TABLE 503.2.8
MINIMUM PIPE INSULATION^a
(thickness in inches)

FLUID	NOMINAL PIPE DIAMETER	
	≤1.5"	> 1.5"
Steam	1½	3
Hot water	1	2
Chilled water, brine or refrigerant	1	1½

For SI: 1 inch = 25.4 mm, British thermal unit per inch/h · ft² · °F = W per 25 mm/K · m²

a. Based on insulation having a conductivity (k) not exceeding 0.27 Btu per inch/h · ft² · °F.

Exceptions to Table 5.3.2.8

- Internal piping, factory installed and tested
- Piping for fluid in temperature range $55 < \text{temp} < 105$
- Piping for fluid not heated or cooled by electricity or fossil
- Runout piping $\leq 4'$ in length and 1" in diameter between the control valve and HVAC coil

Manuals

- Equipment Capacity and Required Maintenance
- Equipment O & M Manuals
- HVAC System Control Maintenance and Calibration Information
- Written Narrative of Each System Operation

Simple HVAC Systems and Equipment

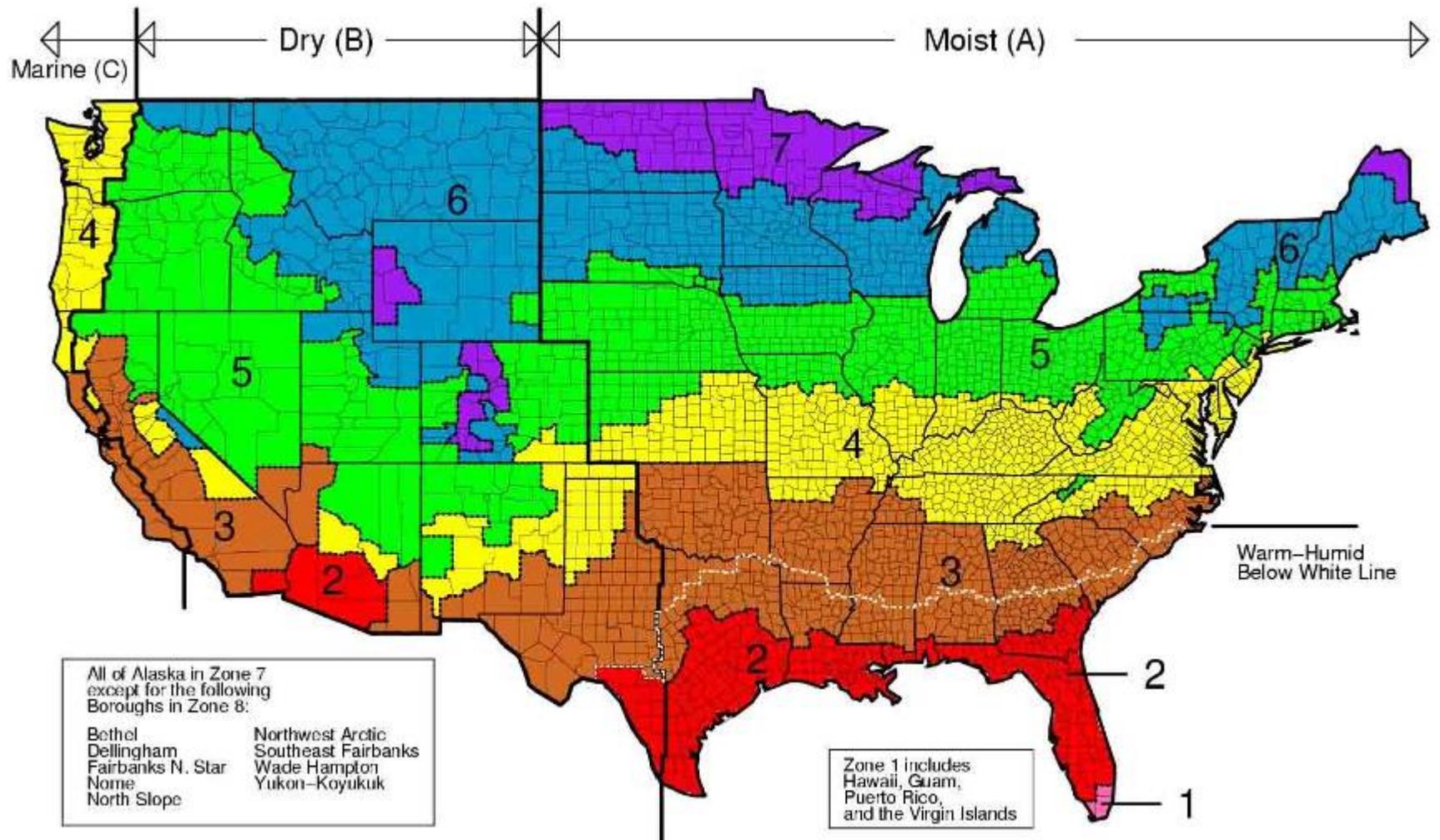
(Section 503.3)

Unitary or packaged, single zone controlled by a single thermostat in the zone served. Includes:

Simple Systems

- Unitary packaged cooling system
- Split system cooling
- Packaged terminal A/C
- Heat pump cooling
- Unitary packaged heating
- Split system heating
- Packaged terminal heat pump
- Fuel-fired furnace
- Electrical resistance heating
- Two-pipe heating systems w/o cooling

Climate Zones—2006 IECC



Economizers (Section 503.3.1)

TABLE 503.3.1(1)
ECONOMIZER REQUIREMENTS

CLIMATE ZONES	ECONOMIZER REQUIREMENT
1A, 1B, 2A, 3A, 4A, 7, 8	No requirement
2B, 3B, 3C, 4B, 4C, 5B, 5C, 6B	Economizers on all cooling systems $\geq 54,000$ Btu/h
5A, 6A	Economizers on all cooling systems $\geq 135,000$ Btu/h

For SI: 1 British thermal unit per hour = 0.293 W.

Economizers (*Section 503.3.1*)

- Trade-off high cooling efficiency for economizer

**TABLE 503.3.1(2)
EQUIPMENT EFFICIENCY PERFORMANCE
EXCEPTION FOR ECONOMIZERS**

CLIMATE ZONES	COOLING EQUIPMENT PERFORMANCE IMPROVEMENT (EER OR IPLV)
2B	10% Efficiency Improvement
3B	15% Efficiency Improvement
4B	20% Efficiency Improvement

Complex HVAC Systems and Equipment (Section 503.4)

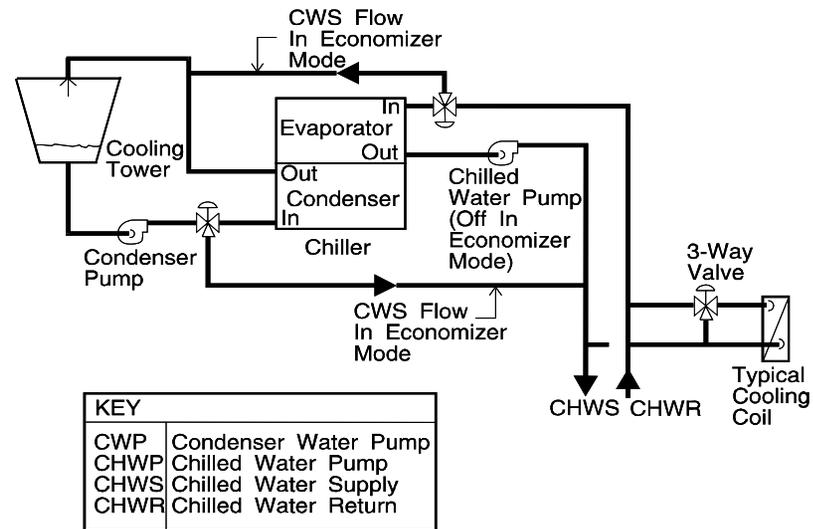
Complex Systems

- Packaged VAV reheat
- Built-up VAV reheat
- Built-up single-fan, dual-duct VAV
- Built-up or packaged dual-fan, dual-duct VAV
- Four-pipe fan coil system with central plant
- Hydronic heat pump with central plant
- Any other multiple-zone system
- Hydronic space heating system

This section applies to all HVAC equipment and systems not included in Section 503.3

Economizers (Section 503.4.1)

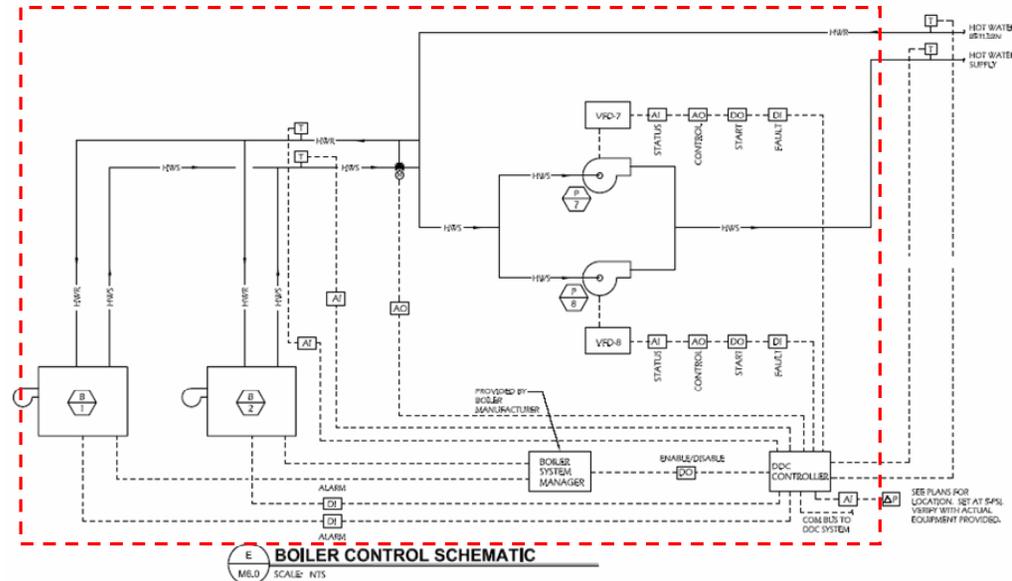
- Air side economizer requirements in Tables 503.3.1(1) and 503.3.1(2)
- Water side economizer requirements
 - Capable of providing 100% of the cooling system load at 50° F dry bulb/ 45° F wet bulb



Hydronic System Controls (Section 503.4.3)

Limit reheat/recool of fluids

- Multiple-packaged boiler systems designed to deliver conditioned water/steam into common distribution system
 - Automatic controls capable of sequencing operation of the boilers



Hydronic System Controls (Section 503.4.3)

Limit reheat/recool of fluids

- Single boilers $> 500,000$ Btu/h
 - Multi-staged or modulating burner required



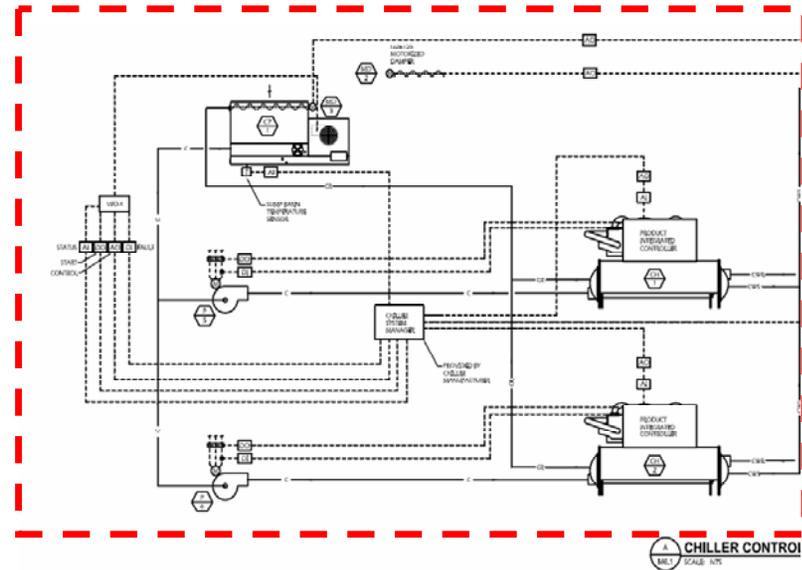
Part Load Control (*Section 503.4.3.4*)

System > 300,000 Btu/h

- Automatic Resets for Supply Water Temperature by 25% of Design Supply-to-Return Temperature Differences **or**
- Reduce System Pump Flow by 50% of Design Flow Using
 - Multiple Staged Pumps
 - Adjustable Speed Drives
 - Control Valves with Modulate or Step Down Capabilities

Pump Isolation (Section 503.4.3.5)

- Multiple chiller chilled water plants
 - Capability to reduce flow automatically when chiller is shut down
 - Chillers piped in series considered one chiller
- Multiple boiler plants
 - Capability to reduce flow automatically when boiler is shut down



Heat Rejection Equipment Fan Speed Control (*Section 503.4.4*)

Each fan powered by a motor ≥ 7.5 hp to have capability to operate that fan at 2/3 of full speed or less

- Have controls to automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device
- Exception
 - Factory-installed heat rejection devices within HVAC equipment tested and rated in accordance with Tables 503.3.2(1) through 503.3.2(11)

Multiple Zone System Requirements

(Section 503.4.5)

- VAV Systems must be designed and capable of being controlled to reduce the primary air supply to each zone before reheat, recool, or mixing take place
- Options
 - 30% of the maximum supply air to each zone
 - <300 cfm where the maximum flow rate is <10% of total fan system supply airflow rate
 - Minimum ventilation requirements from IMC

Variable Air Volume System or Zone Exceptions

- Zones with Special Pressurization or Cross-Contamination Requirements
- Where 75% of Reheat Energy Comes from Site-Recovered or Site-Solar Energy Source
- Zones with Special Humidity Requirements
- Zones with < 300 CFM Peak Supply and Flow Rate is $< 10\%$ of Total Fan System Supply Airflow Rate
- Zones Where Reheated, Recooled or Mixed Air Volume $<$ Minimum Ventilation Requirements
- Systems with Controls Capable of Preventing Reheating, Recooling, Mixing or Simultaneous Supply of Air Previously Heated or Cooled

Variable Air Volume Fan Control

(Section 503.4.2)

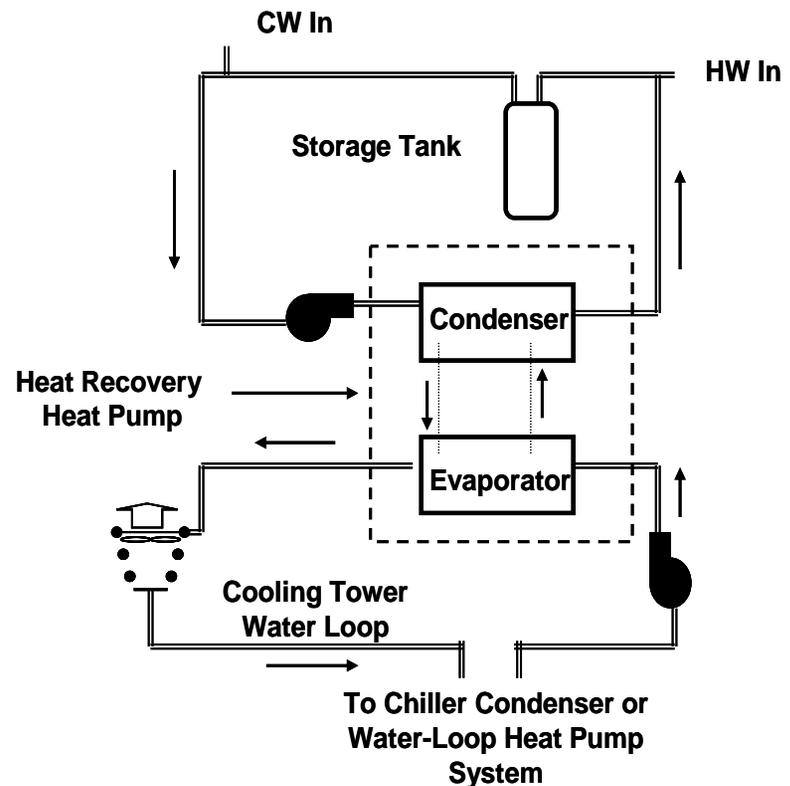
- Individual fans with motors ≥ 10 hp
- Driven by a mechanical or electrical variable speed drive

OR

- Have controls or devices to result in fan motor demand $\leq 30\%$ of their design wattage at 50% of design airflow when static pressure set point = $1/3$ of the total design static pressure

Heat Recovery for Service Hot Water Heating (*Section 503.4.6*)

- Most effective where water heater loads are large and well distributed throughout the day
- Typical applications
 - Hotels
 - Dormitories
 - Mixed-use retail/residential projects
 - Prisons
 - Hospitals
- Condenser heat recovery required for heating/reheating of SWH provided:
 - Facility operates 24 hours/day
 - Total installed heat capacity of water-cooled systems >6,000,000 Btu/hr of heat rejection
 - Design SWH load >1,000,000 Btu/h



Section 504 Service Water Heating

- Service water-heating equipment performance efficiency (Section 504.2)
- Table 504.2 Minimum Performance of Water-Heating Equipment
 - Water Heater Types Covered
 - Electric Storage
 - Gas and Oil Storage
 - Instantaneous Water Heaters – Gas and Oil
 - Hot water boilers – gas and oil
 - Pool heaters
 - Unfired storage tanks

Pipe Insulation (*Section 504.5*)

- Noncirculating system insulation requirements
 - First eight feet of outlet piping on systems with no integral heat traps
 - 1/2 inch of insulation required
- Circulating systems
 - 1 inch of insulation



Hot Water System Controls (Section 504.6)

- Ability to turn off circulating hot water pumps and heat trace tape when the system is not in operation
 - Automatically or manually



Pool Requirements

- Pool heaters (*Section 504.7.1*)
 - Readily accessible on-off switch
 - Gas fired pool heaters will not have continuously burning pilot lights
- Time switches (*Section 504.7.2*)
 - Automatic controls required to operate pool heaters and pumps on a preset schedule
 - Exceptions
 - Where public health standards require 24 hour operation
 - Where pumps are required to operate solar and waste heat recovery pool heating systems

Pool Covers (Section 504.7.3)

- Heated Pools Required to Have a Pool Cover
 - Pool cover must be vapor retardant
- Pools Heated to Over 90°F
 - Minimum R-12 insulation



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Vestibules: Understanding Requirements for Air Locks in Commercial Settings for the IECC

Designers of commercial buildings are required, by the 2003 IECC, to install vestibules on the primary entrance doors leading from spaces equal to or greater than 3,000 ft² in all buildings. By creating an air lock, vestibules reduce infiltration into a space that includes doors with high volume of pedestrian traffic.

This requirement typically applies to large “box” stores where the building entrance is directly into the resale area or other buildings with large lobbies, such as hotels and office buildings. The only specific requirement in the 2003 IECC for vestibule design and operation is that the vestibule be designed so that the interior and exterior doors do not open at the same time. Some doors may be exempt from the requirement, such as revolving doors, mechanical room doors, or doors that open from spaces less than 3,000 ft² (for a full list of exempt doors, see IECC 2003, Section 802.3.6).



Vestibules reduce infiltration and gain from stack and wind effects in buildings that experience a high volume of pedestrian traffic.

In reviewing commercial building plans,

1. Verify that doors separating conditioned space from the exterior leading to spaces 3,000 ft² or greater contain a vestibule.
2. Verify that doors separating conditioned space from the exterior that do not have vestibules are exempt from the requirement.
3. Verify that doors leaving into and out of the vestibule are designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time.
4. Verify that doors meet the requirement for means of egress doors as stated in 2003 IBC Section 1008.
5. Verify that building assemblies between the conditioned space and the vestibule meet the envelope requirements of Section 802 of the 2003 IECC.

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