HVAC Systems and Airside Economizers

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Engineers Newsletter Live
telecast

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CONTINUING EDUCATION AIA

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AIA continuing education
Learning Objectives

Participants will learn the following about airside economizers:

- **ASHRAE/IESNA Standard 90.1-2004 requirements**
- **How issues, such as building pressurization, affect economizer operation**
- **Ways to control airside economizer systems based on HVAC system type and location**

airside economizers
Today's Topics

- What an airside economizer is
- Reasons and exceptions for use
- Types of control
- Performance in constant- vs. variable-air-volume systems
- Implementation in different systems
- Application considerations

Today's Presenters

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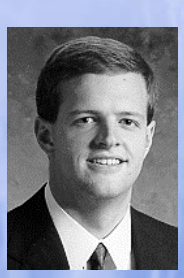
staff applications engineer

Brian Fiegen
manager, applications engineering



John Murphy
sr applications engineer

What Is an Airside Economizer?

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HVAC systems and airside economizers

definitions
Airside Economizer

*"**1.** Device that, on proper variable sensing, initiates control signals or actions to conserve energy …*

*"**2.** Control system that reduces the mechanical heating and cooling requirement … "*

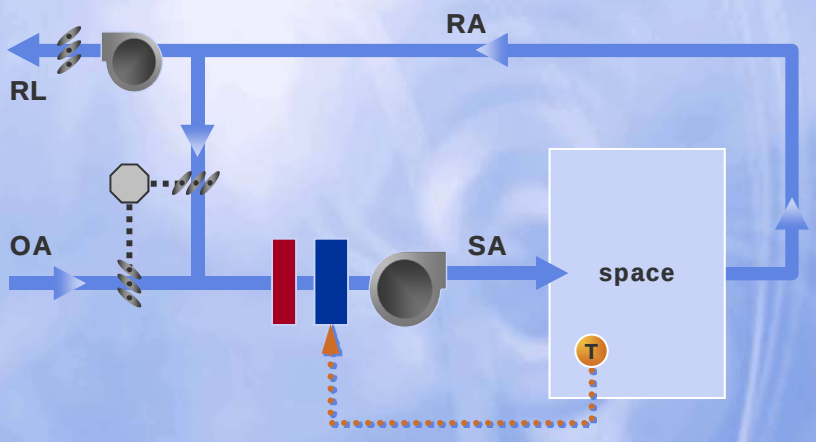
ASHRAE Terminology
of Heating, Ventilation,
Air Conditioning & Refrigeration

definitions
Airside Economizer

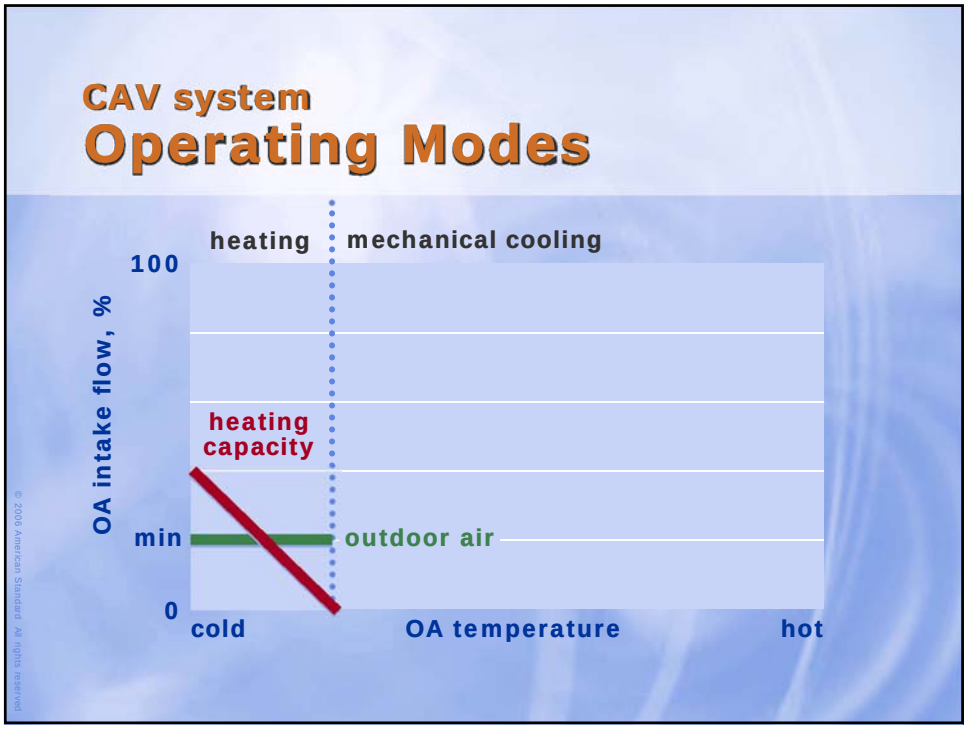
"A duct-and-damper arrangement and automatic control system that together allow a cooling system to supply outdoor air to reduce or eliminate the need for mechanical cooling during mild or cold weather"

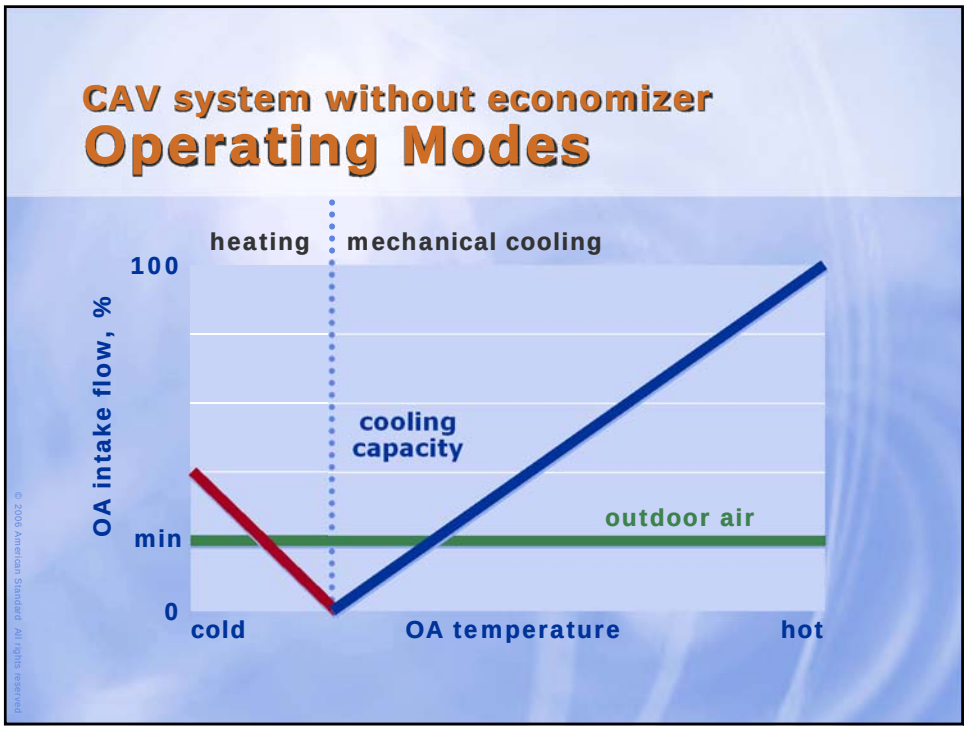
ASHRAE/IESNA
Standard 90.1-2004

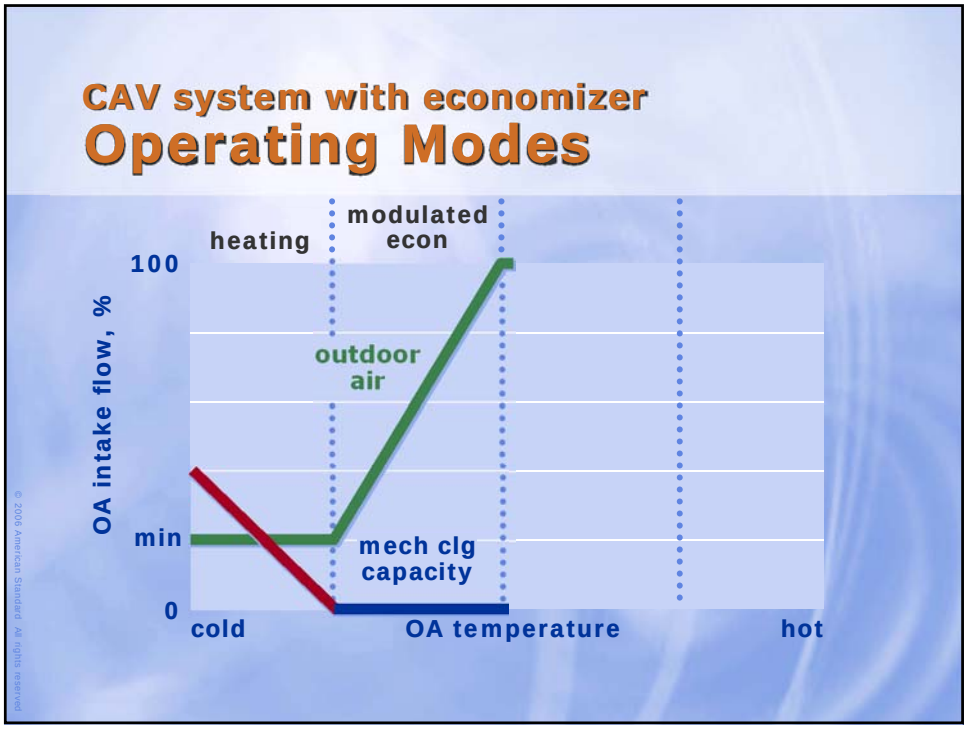
Single Zone, Constant Air Volume (CAV)

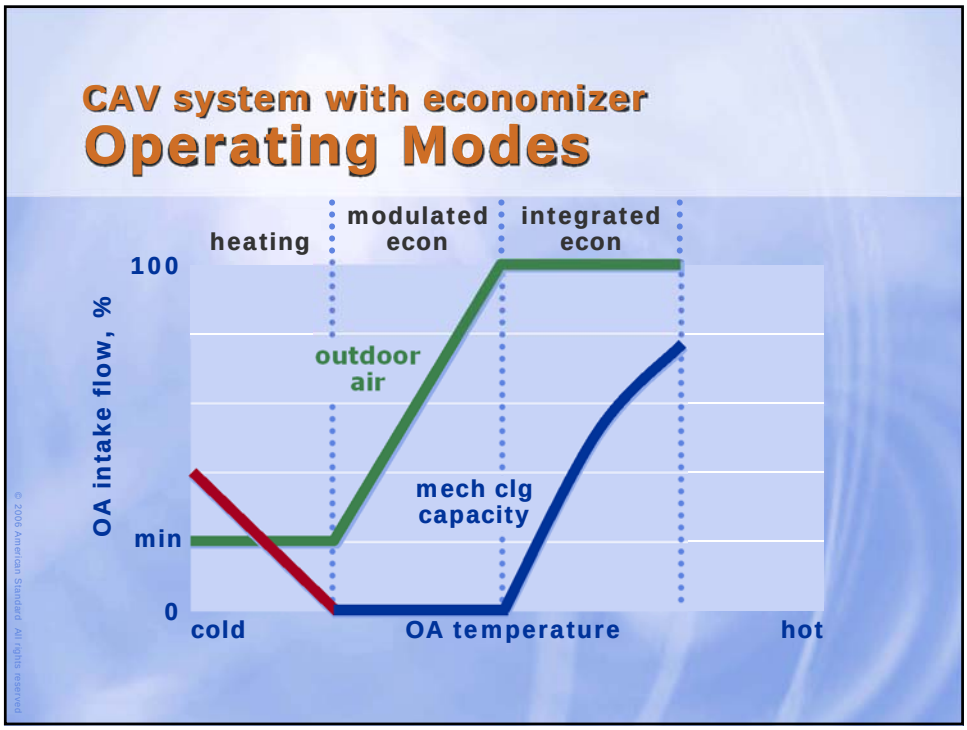


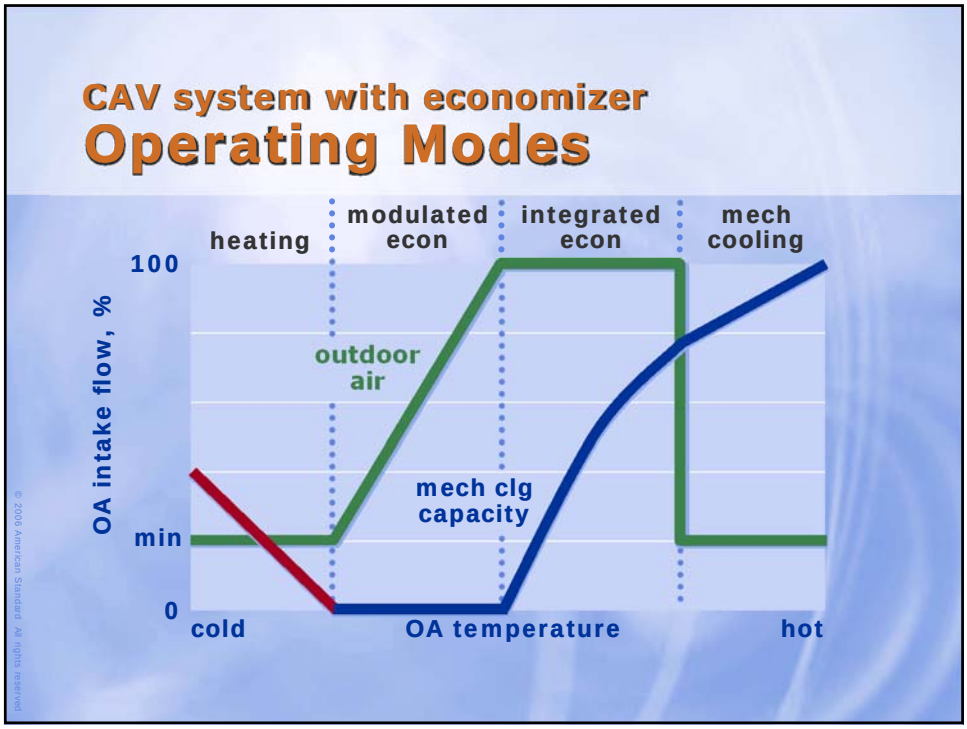
Supply-air temperature varies to match cooling load

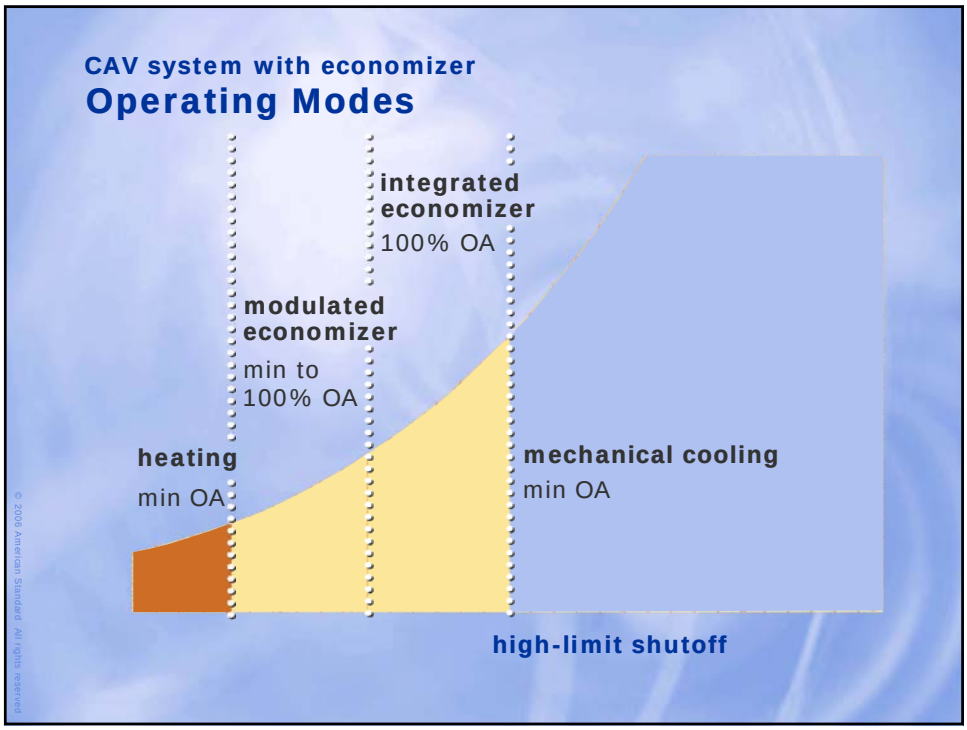












Why Use an Airside Economizer?

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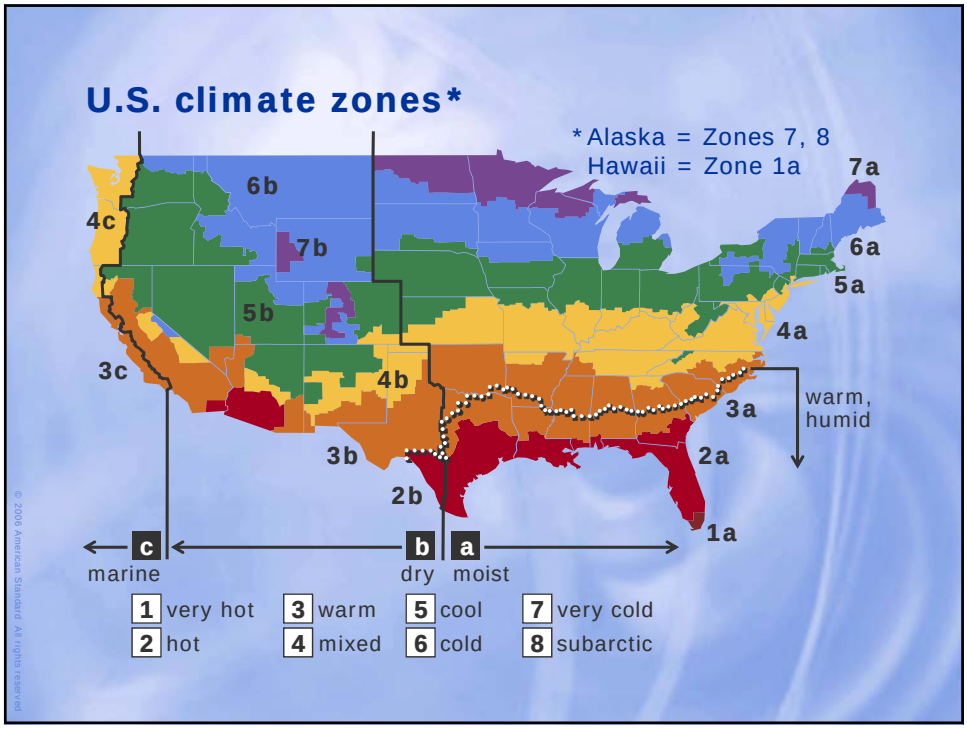
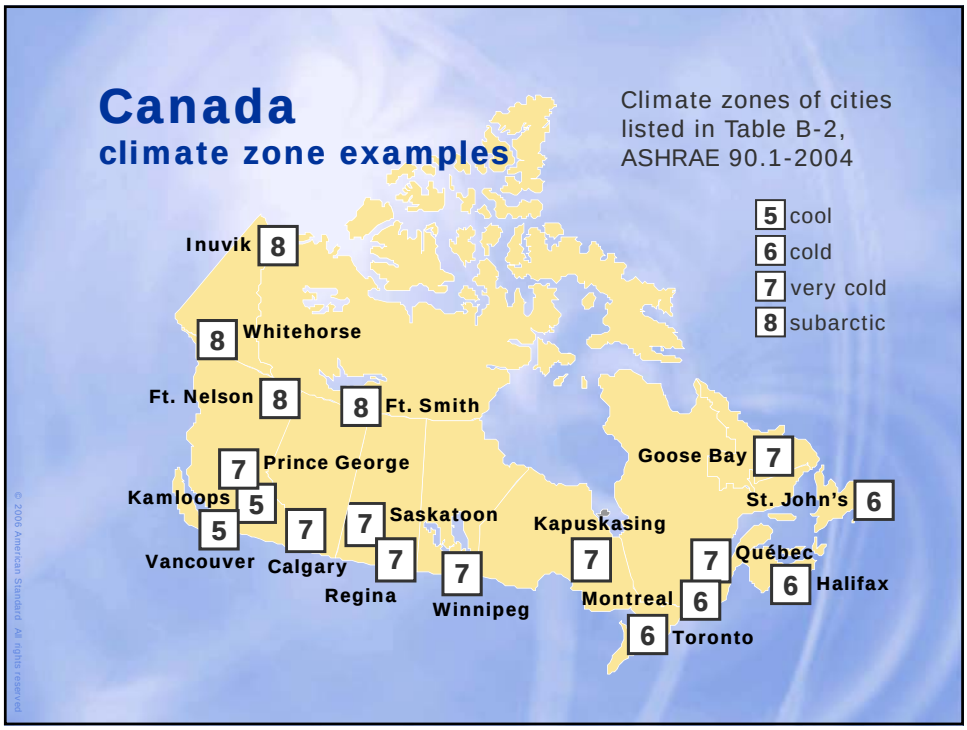
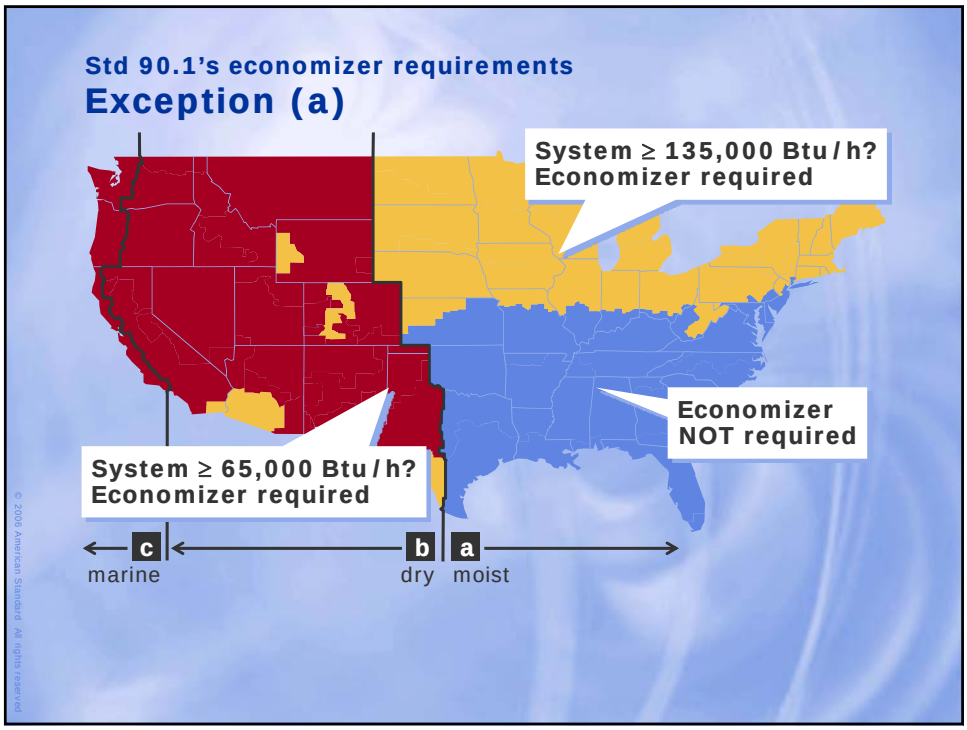
airside economizer Why Use It?

- **Comply with ASHRAE 90.1-2004, Section 6.5.1 … or local energy code**







airside economizer use
Std 90.1's Exceptions

(a) Individual fan-cooling units with less-than-minimum capacities installed in specific climate zones

(b) Systems with gas-phase outdoor air cleaning to meet ASHRAE Standard 62

(c) Systems with > 25% of supply air serving spaces humidified above 35°F DP for process needs

(d) Systems with condenser heat recovery

airside economizer use
Std 90.1's Exceptions

(f) Residential space systems with capacities < 5× limit in Exception (a)

(f) Space sensible cooling load ≤ transmission + infiltration load at 60°F

(g) Systems that operate < 20 hr/wk

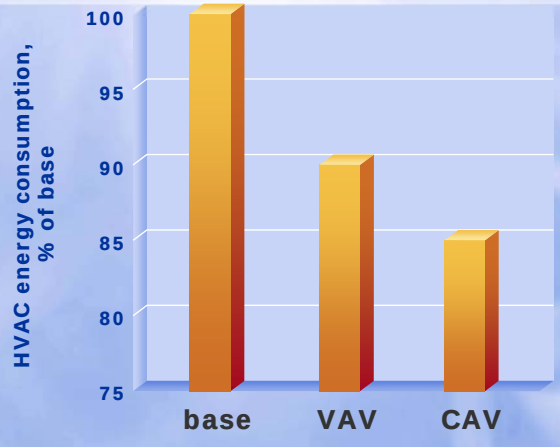
(h) Supermarket applications, where outdoor air for cooling affects open refrigerated cases

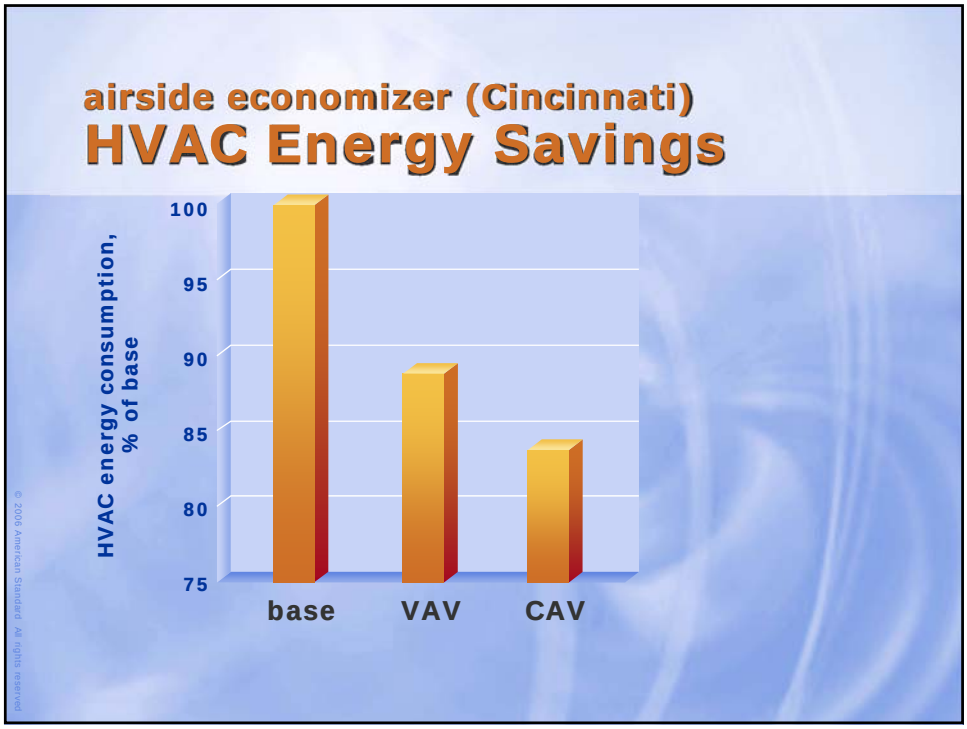
(i) Systems with high mechanical cooling efficiency (≥ Table 6.3.2 requirements)

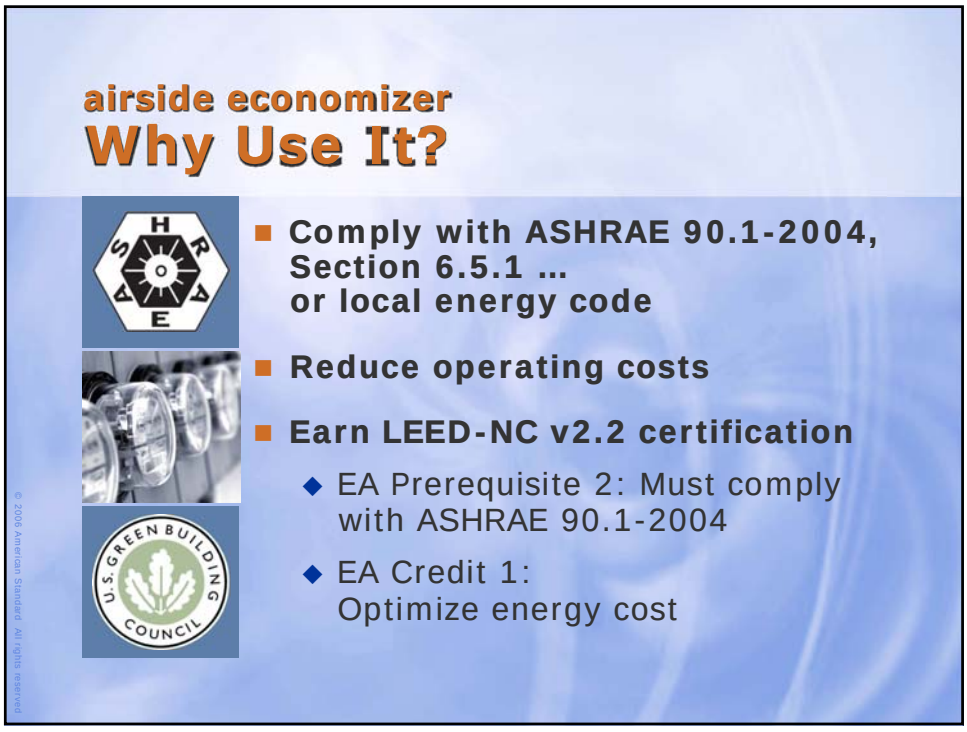
airside economizer
Why Use It?

- Comply with ASHRAE 90.1-2004, Section 6.5.1 … or local energy code
- Reduce operating costs

airside economizer (Columbus)
HVAC Energy Savings







Economizer Control Types

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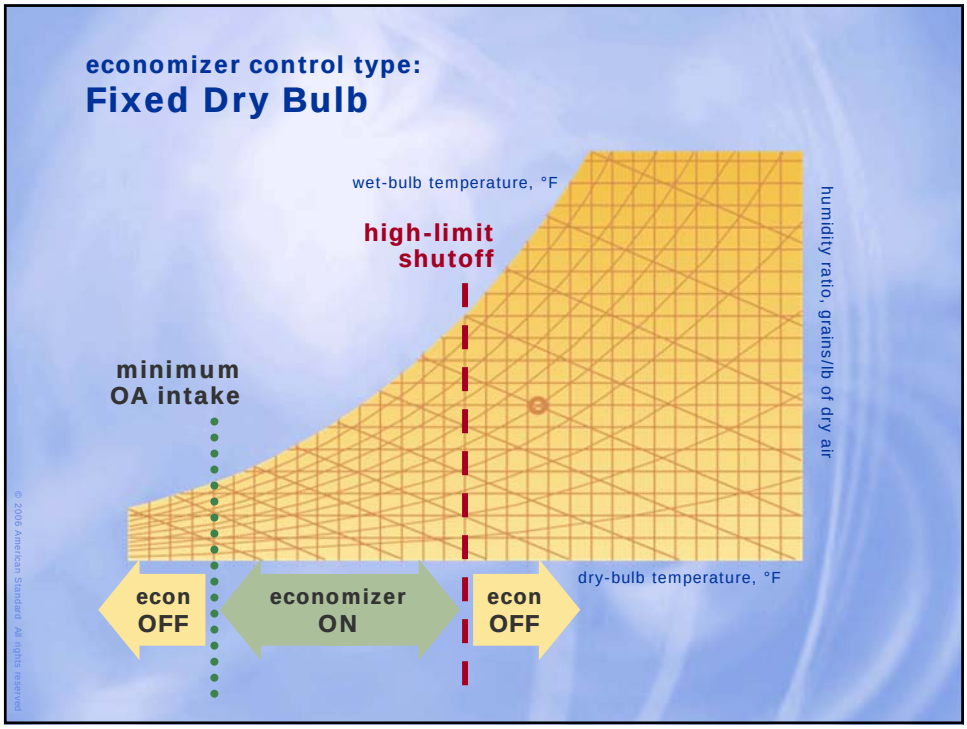
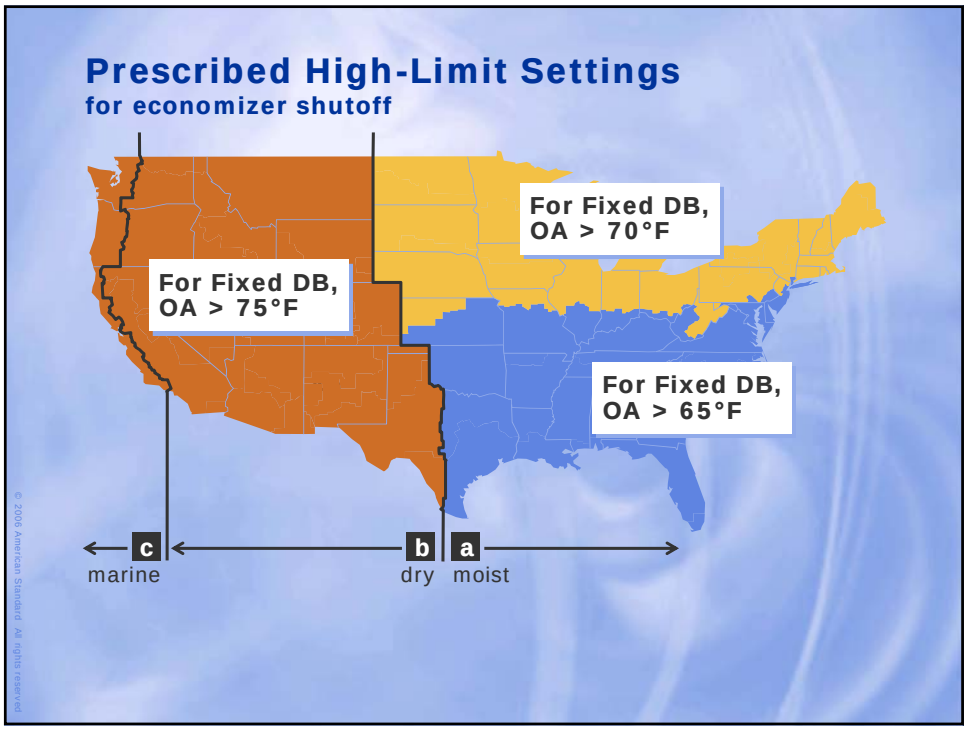
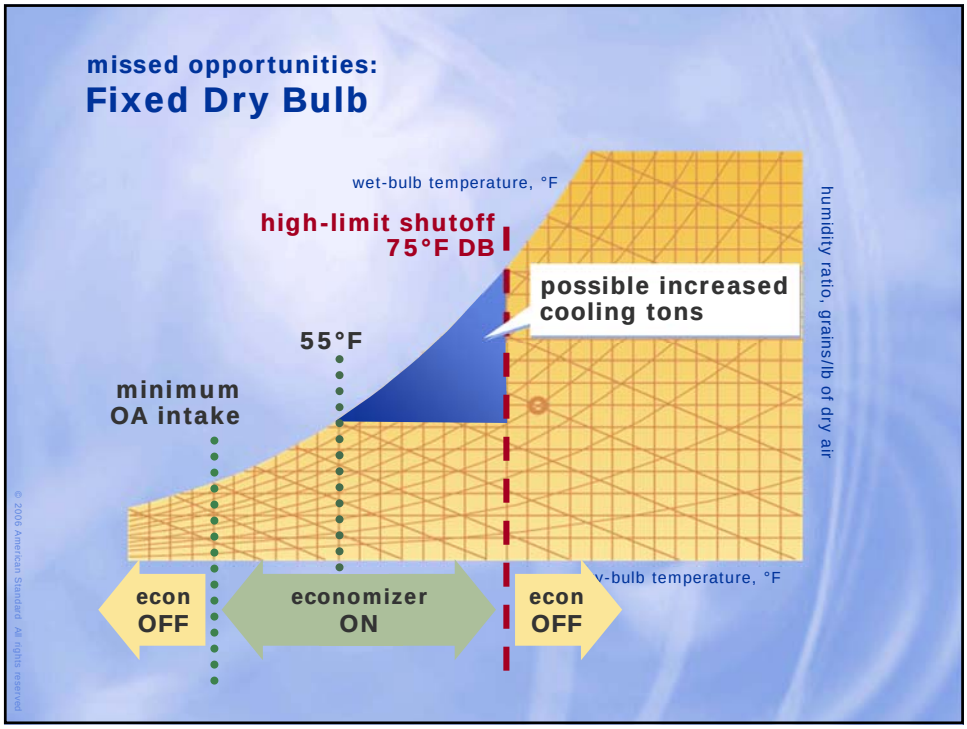
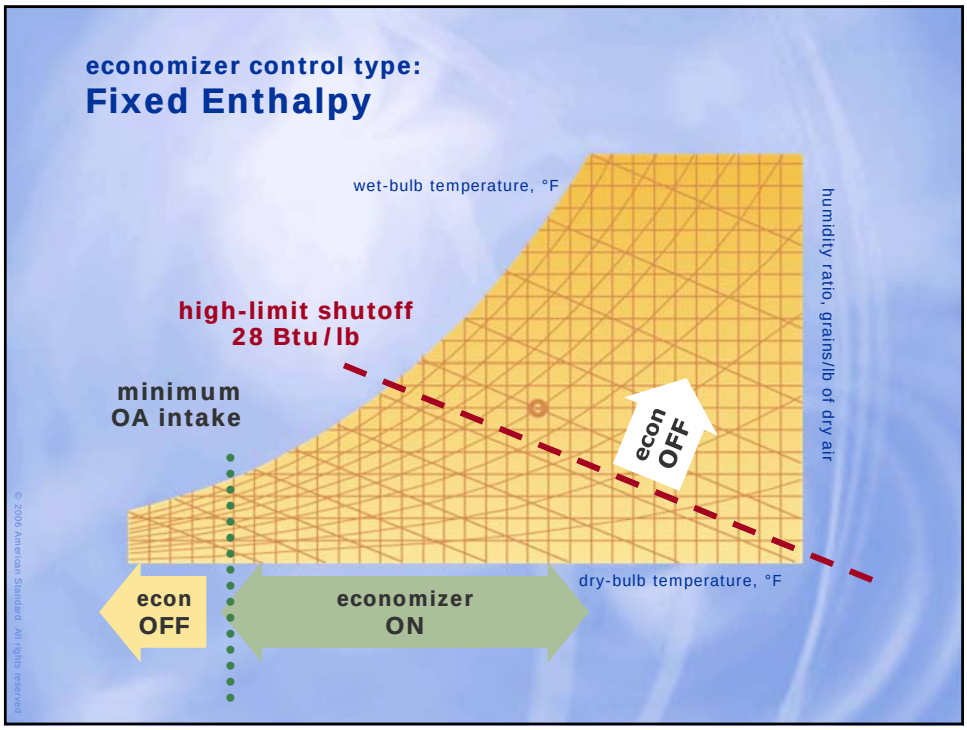
Allowed Types of Economizer Control

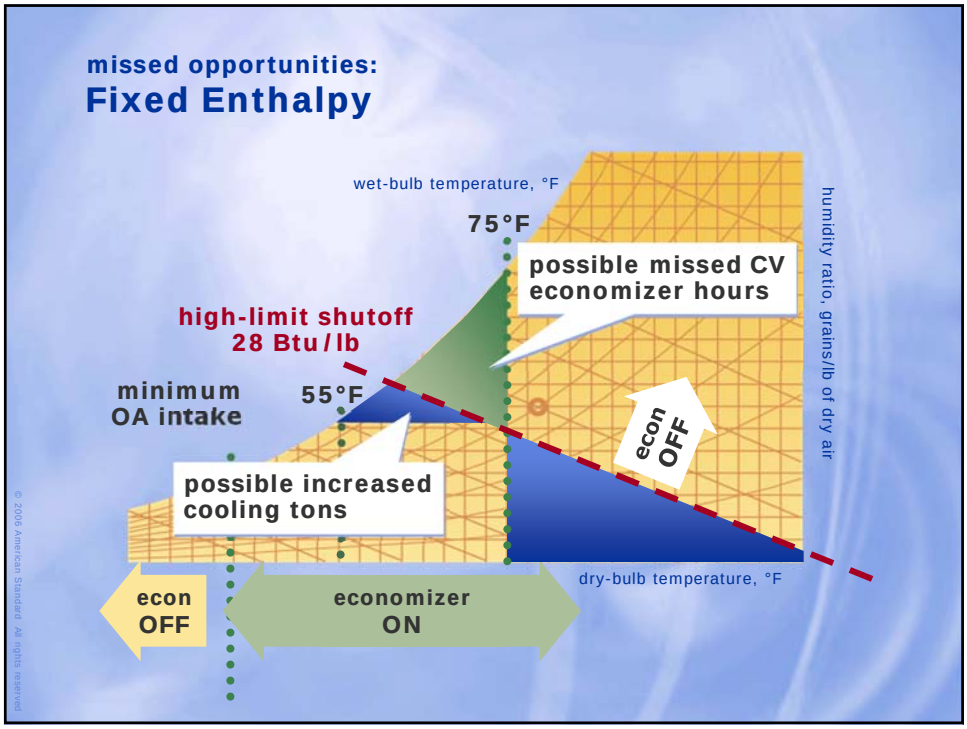
Control type	Disable econ (up to 100% OA) when OA is:	Enable econ (minimum OA) when OA is:
Fixed dry bulb	Warmer than fixed setting	Cooler than fixed setting
Differential dry bulb	Warmer than RA	Cooler than RA
Fixed enthalpy	Higher thermal energy than fixed setting	Lower thermal energy than fixed setting
Electronic enthalpy	Above fixed DB vs. DP curve	Below fixed DB vs. DP curve
Differential enthalpy (comparative enthalpy)	Higher thermal energy than RA	Lower thermal energy than RA
Dew point & dry bulb (fixed DB with DP lockout)	Warmer or wetter than fixed DB,DP settings	Cooler and drier than fixed DB,DP settings

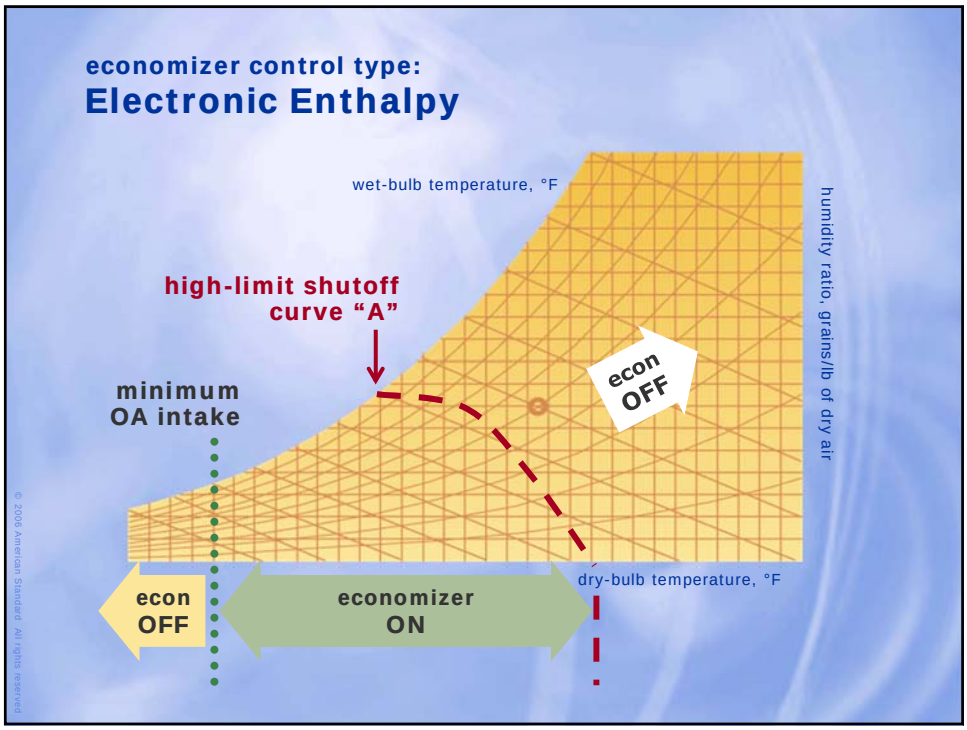


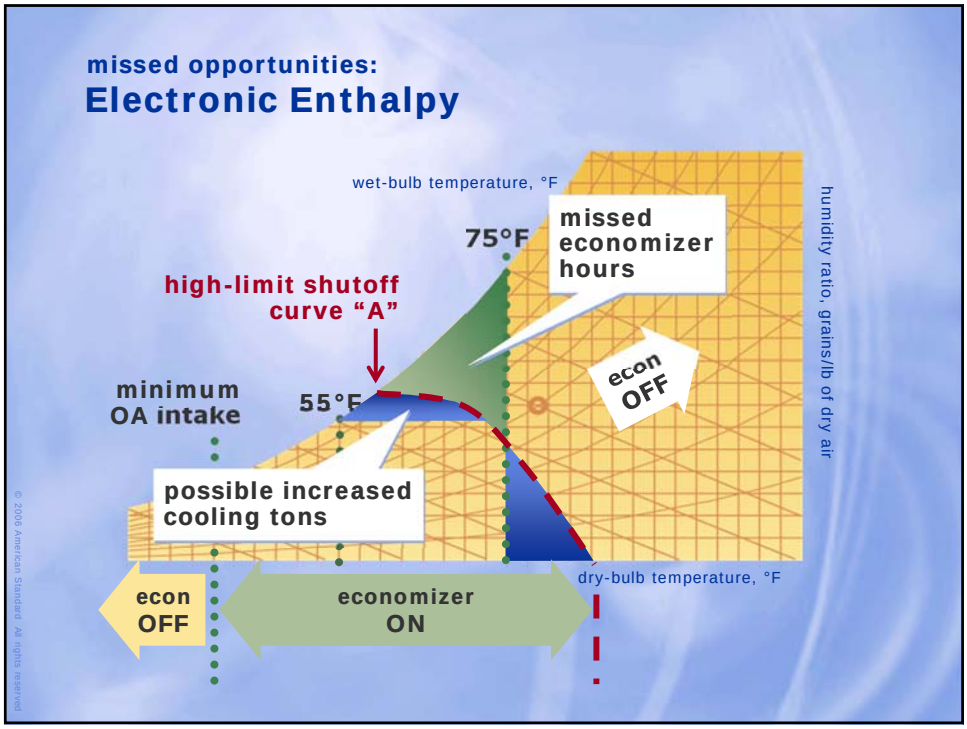


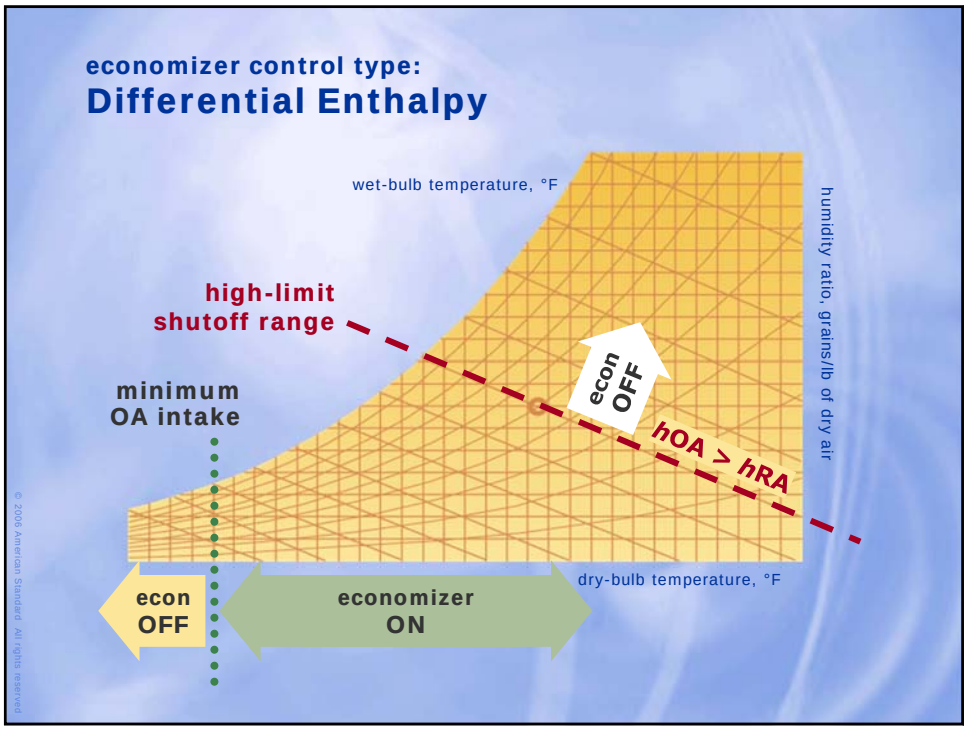


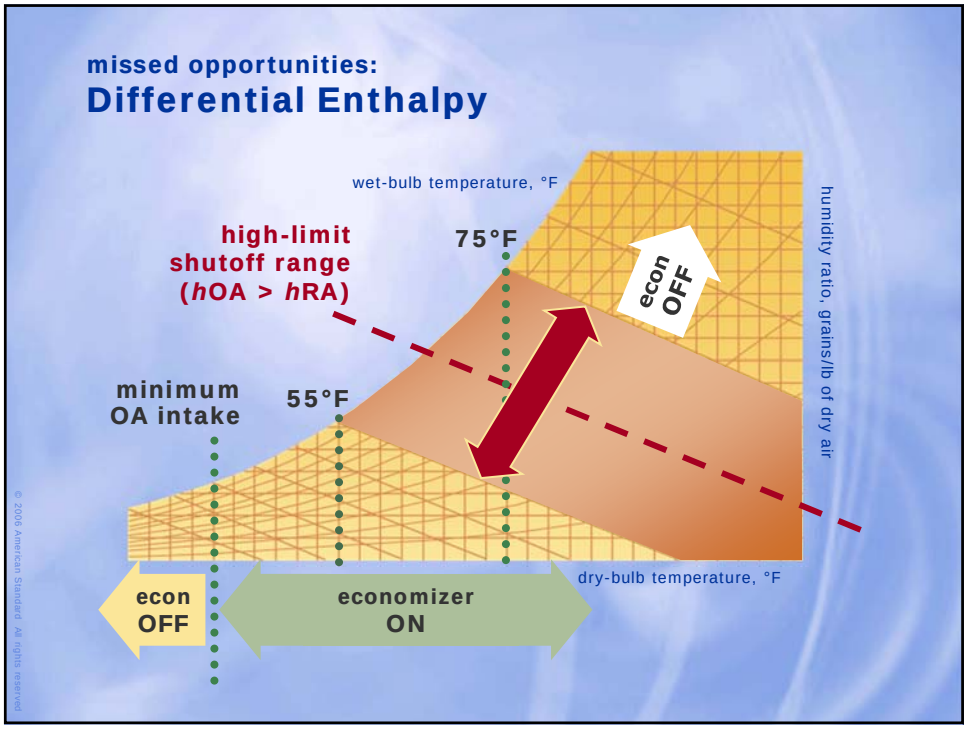


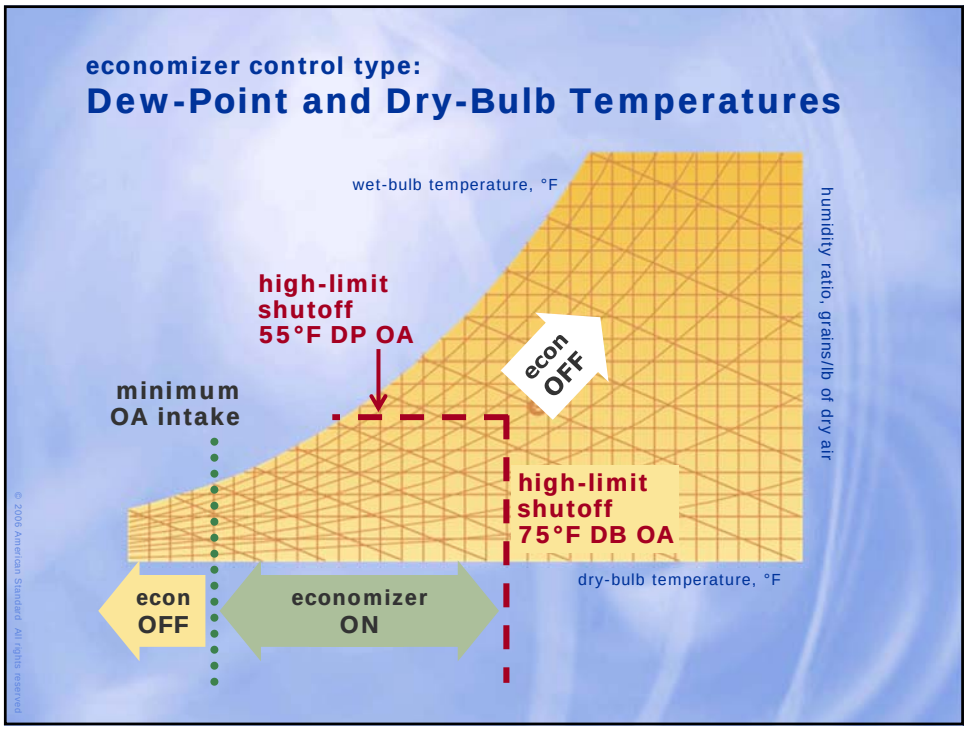


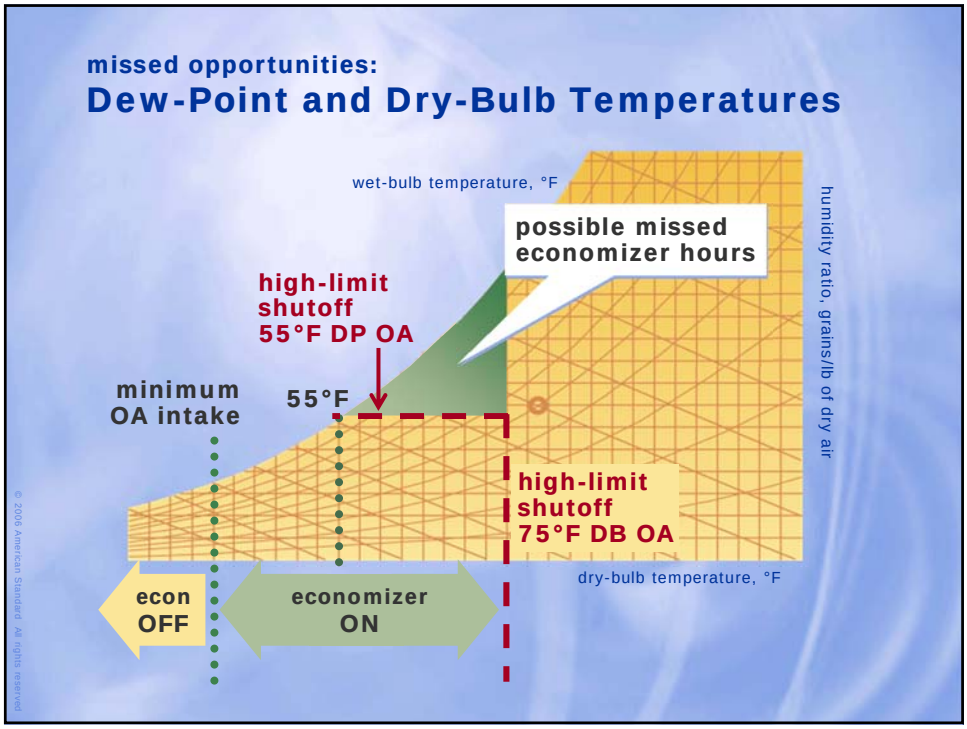


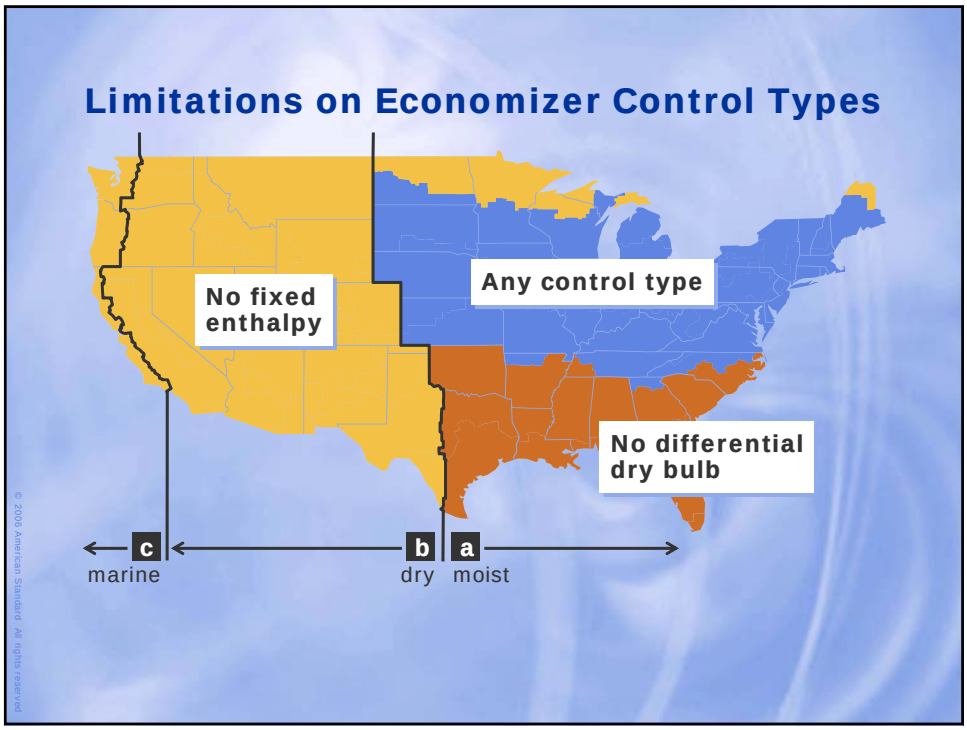












economizer control
High-Limit Shutoff

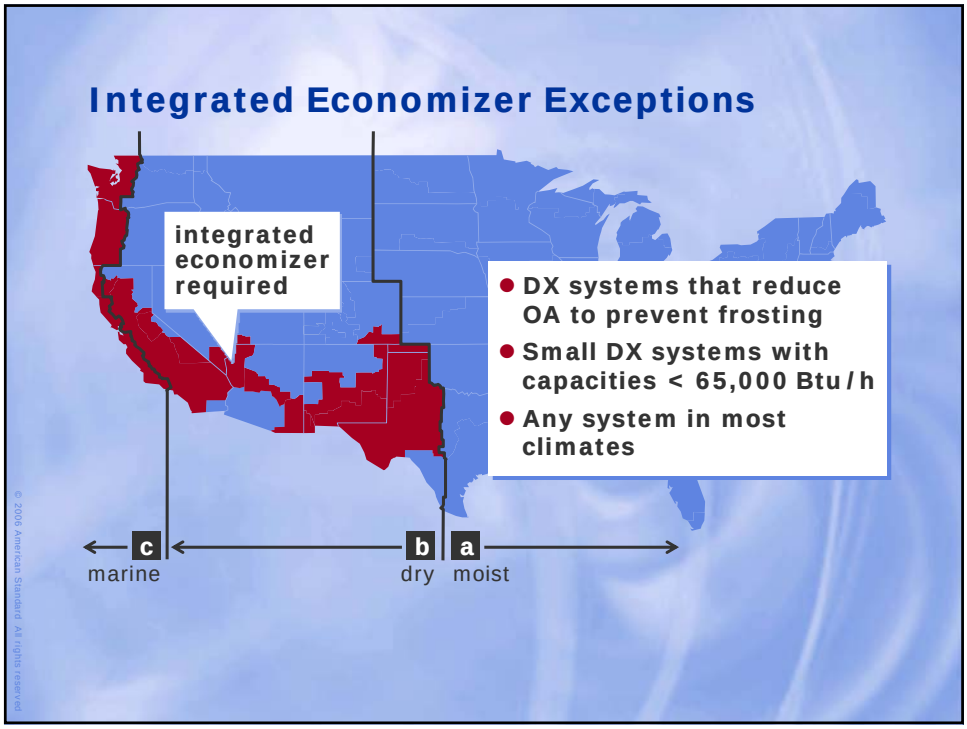
- **It's an enable/disable point, prescribed by control type and climate (see Table 6.5.1.1.3B)**
- **"Right" limit setting should yield largest energy-use reduction**
- **If analysis shows a "better" setting:**
  - Ask for a variance, or
  - Use Energy Cost Budget Method (Section 11)

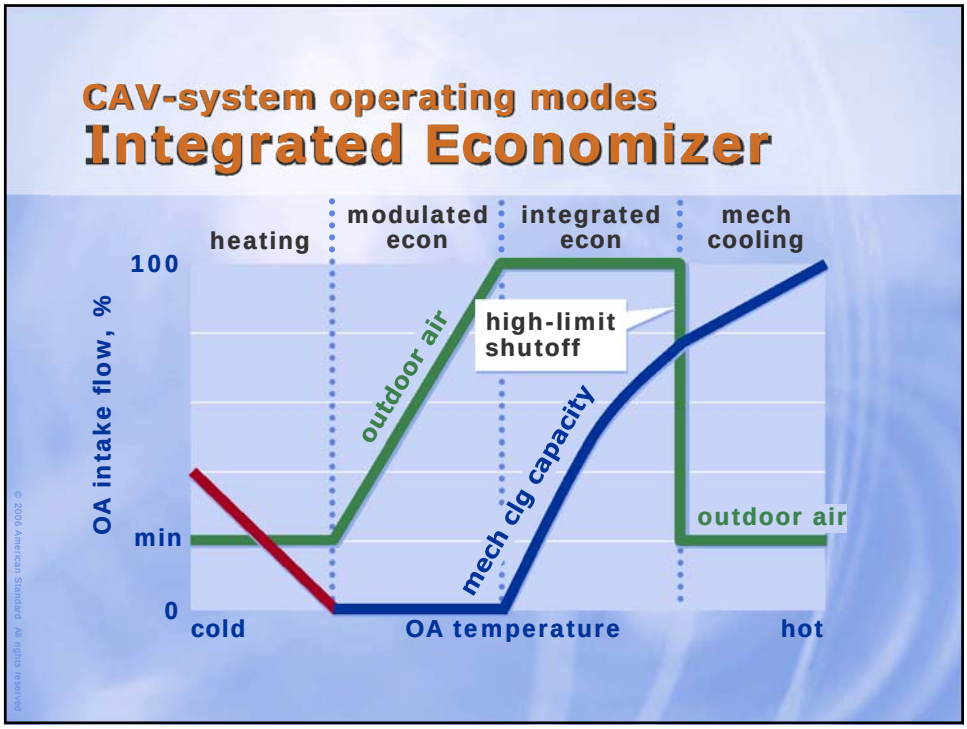
economizer control
Integrated Economizer

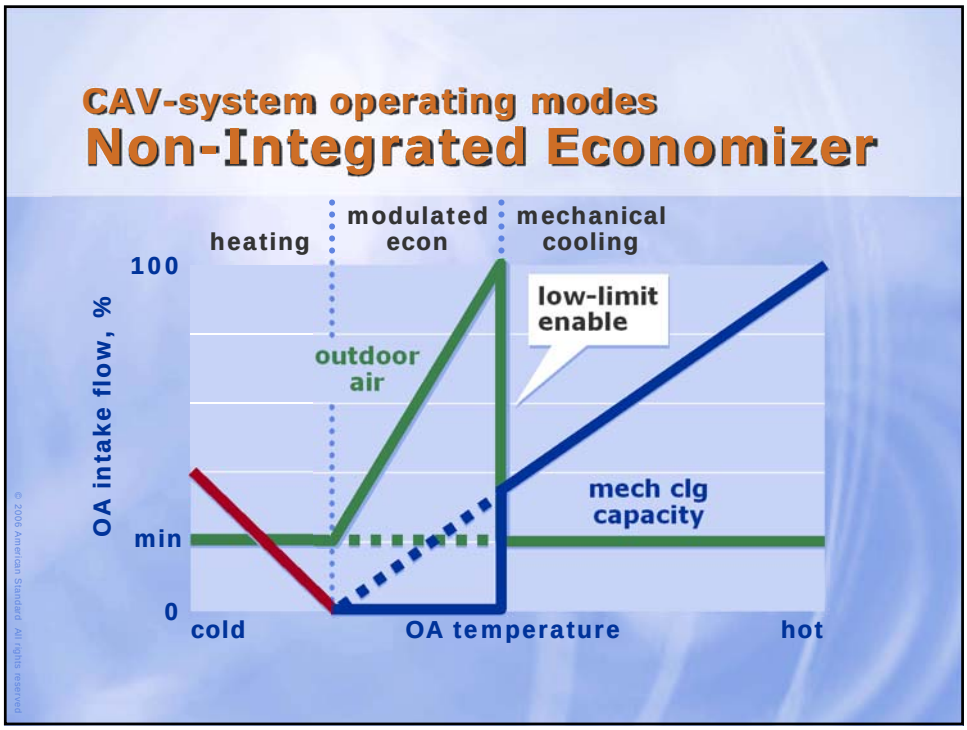
- **Extends economizer hours to save more cooling energy**
- **Must use everywhere—except almost anywhere**

"Economizer systems shall be integrated with the mechanical cooling system and be capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load"

ASHRAE/IESNA Std 90.1-2004, Section 6.5.1.3







Performance in a Constant-Volume System

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HVAC systems and airside economizers

Economizer Performance

- **Compare:**
  - Economizer control types
  - High-limit shutoff settings
- **Assess impact on:**
  - Energy use
  - Space humidity

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Building Analysis Tools

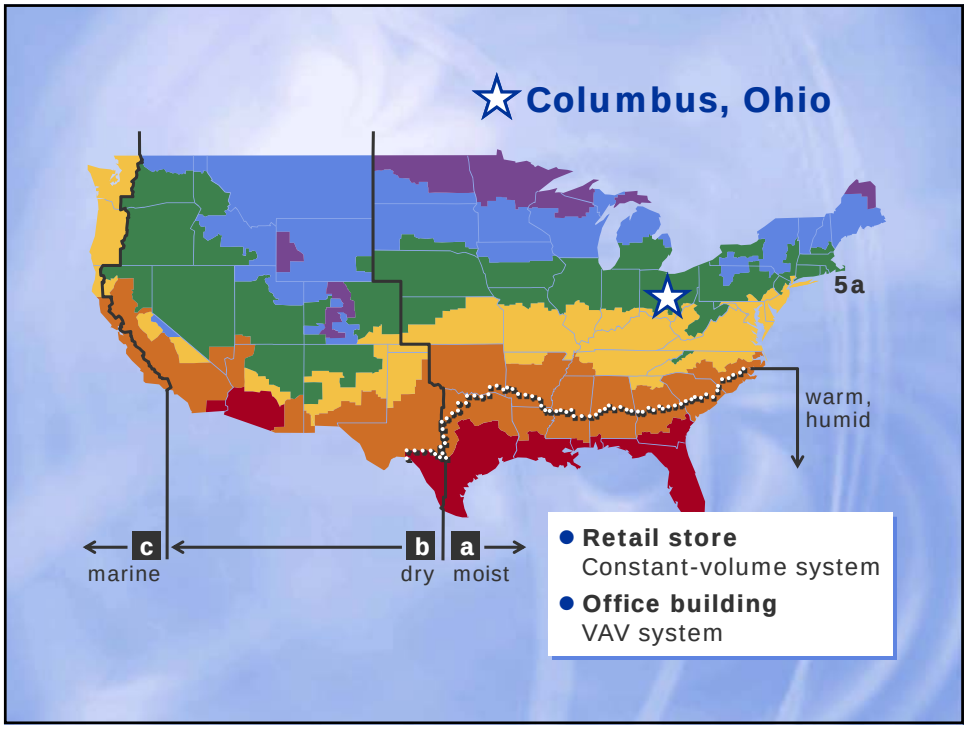
TRACE™ 700
HVAC load design and analysis software

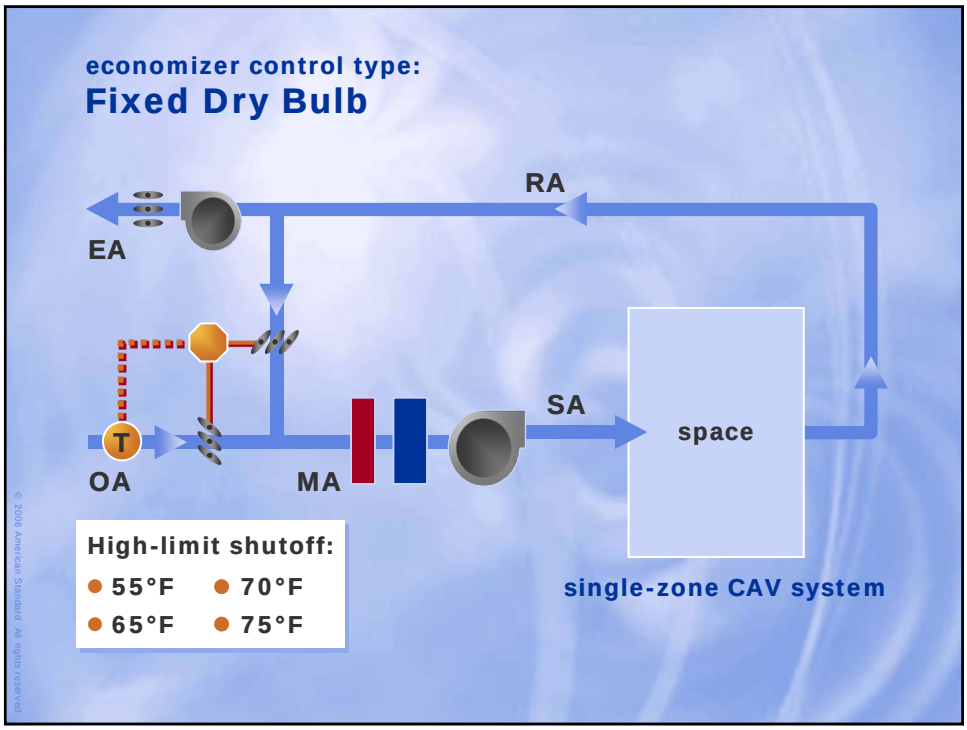
- Comprehensive energy and economic analysis for virtually any building
- Also tracks space humidity levels

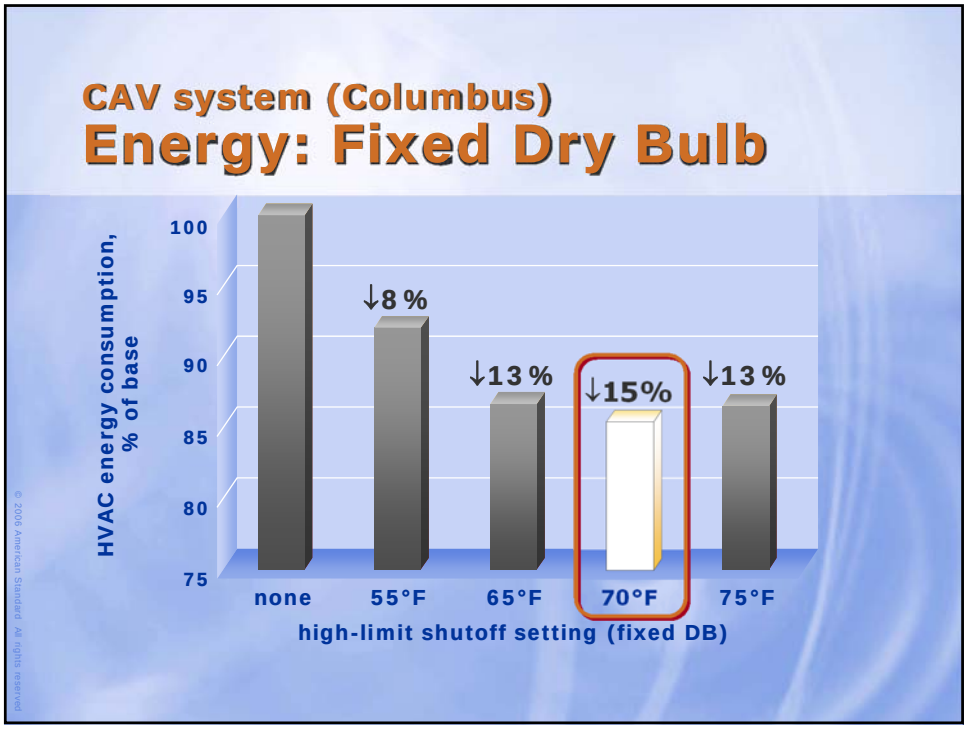
TRACE™ 700
Space Humidity Profile

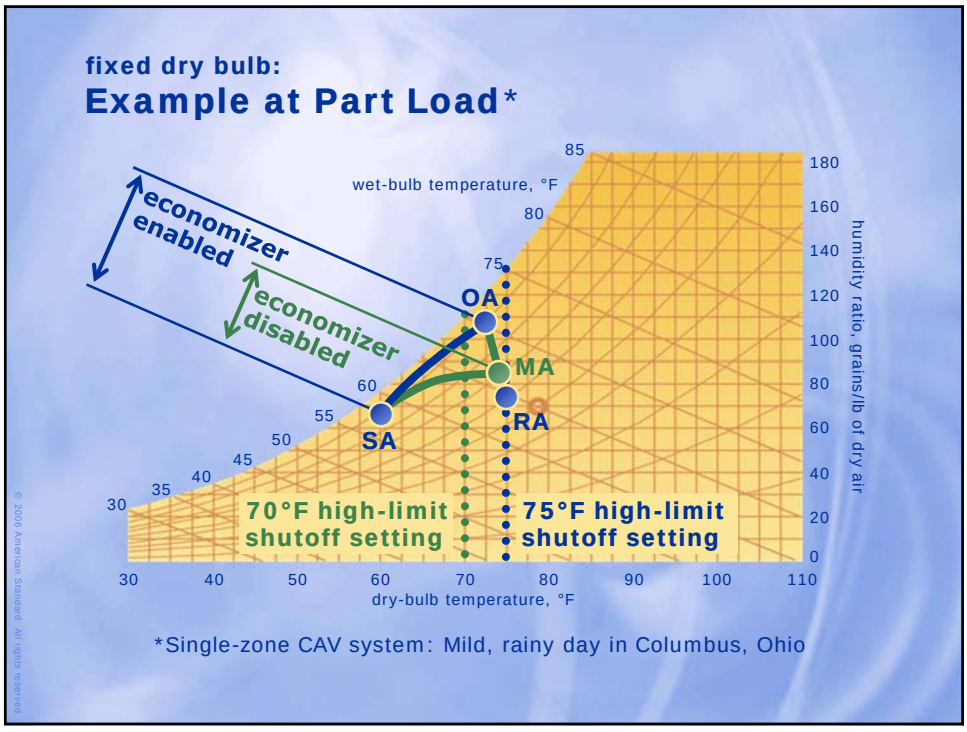
SYSTEM HUMIDITY PROFILES
By American Standard

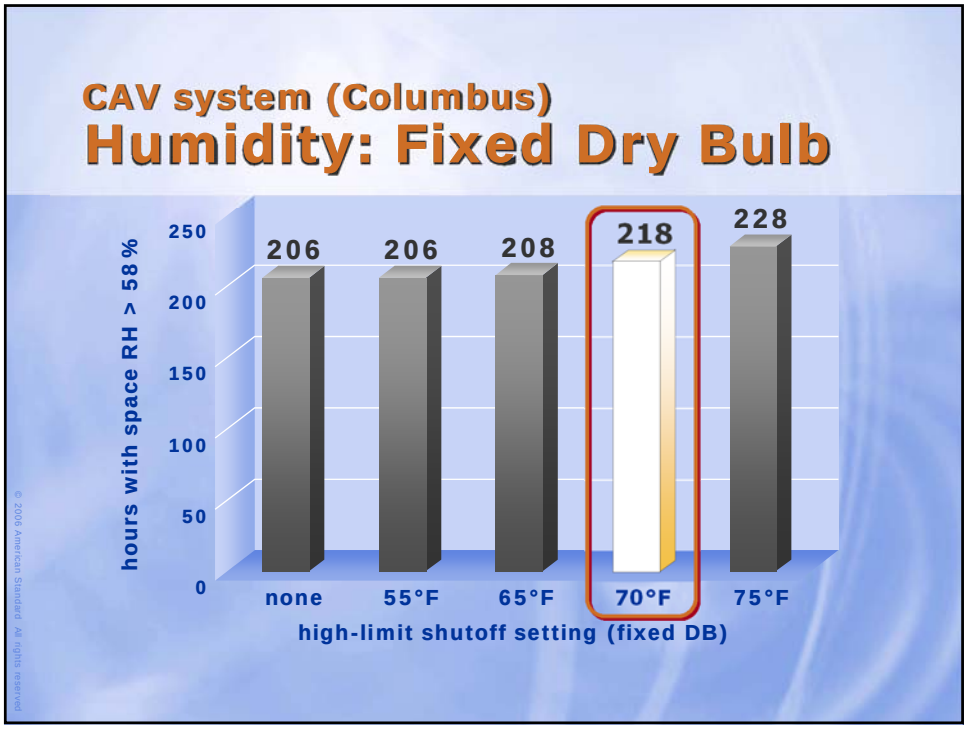
Room Description	---------- Number of Hours at each Percentage Range ----------											
	>70 %	70-66	66-62	62-58	58-54	54-50	50-46	46-42	42-38	38-34	34-30	<30 %
Kitchen	0	0	0	0	122	766	1,589	1,578	649	230	691	3,135
Dining Room	40	126	2,140	1,055	994	801	447	468	546	790	851	502

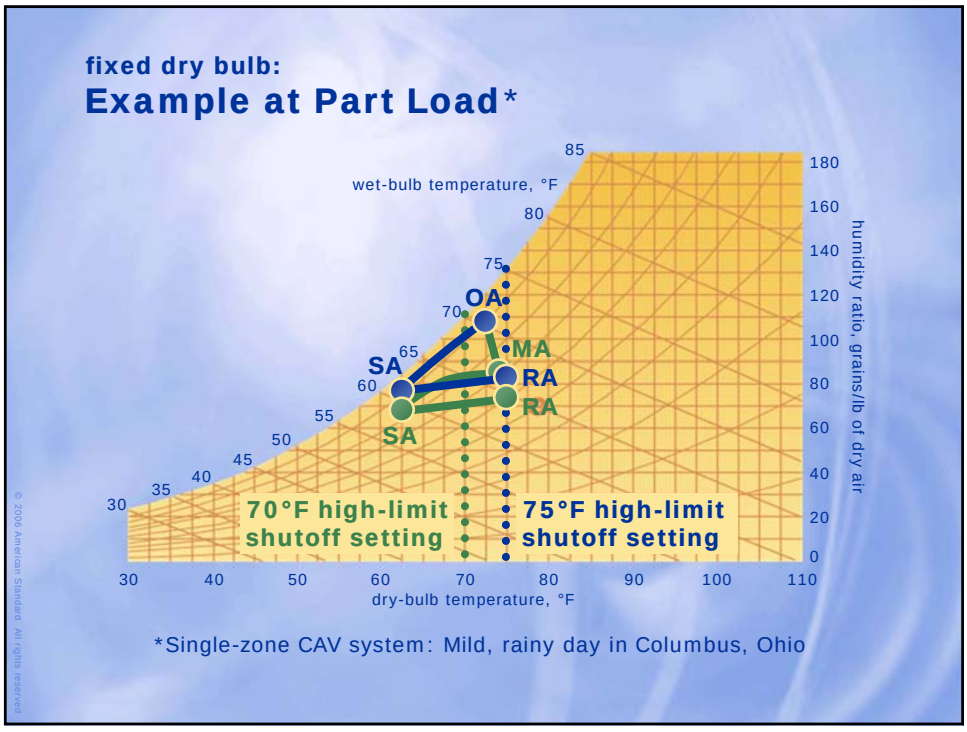


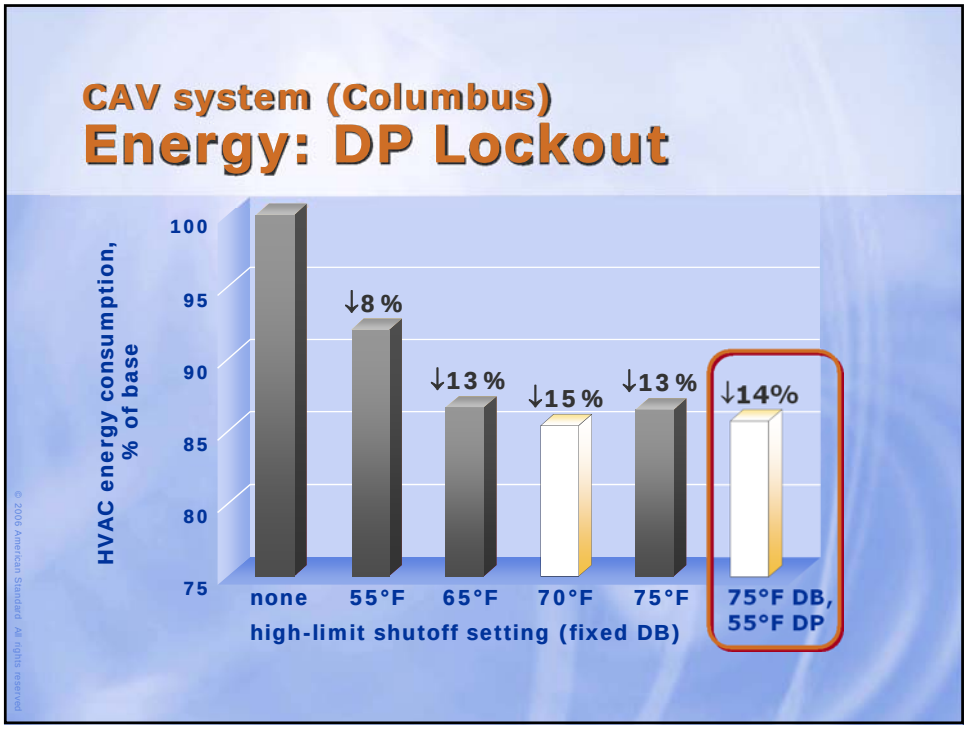


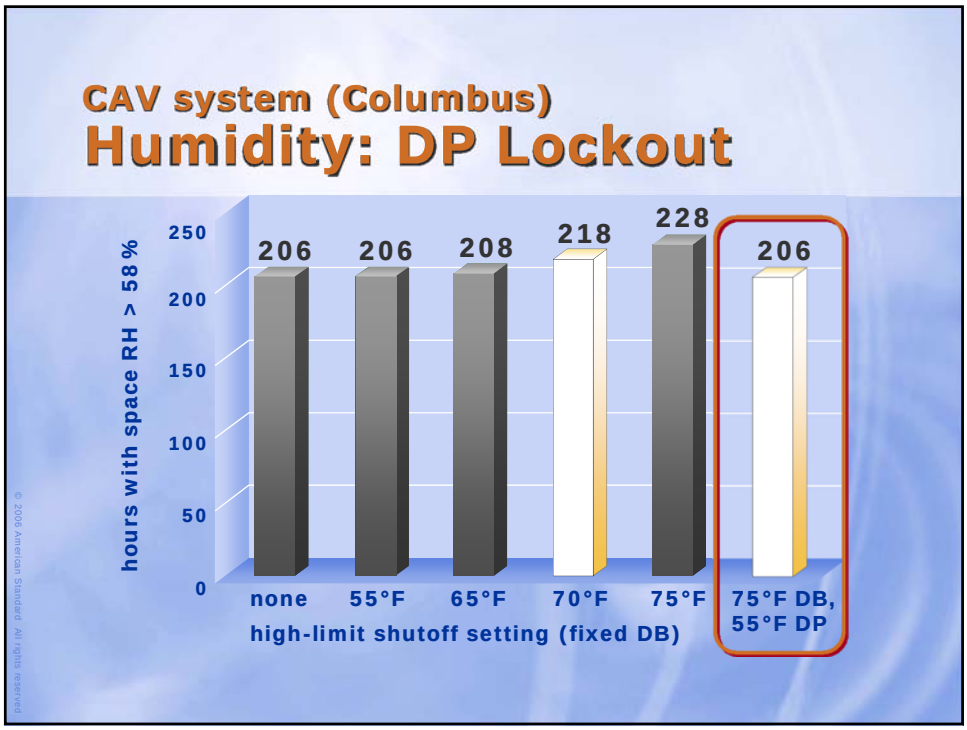


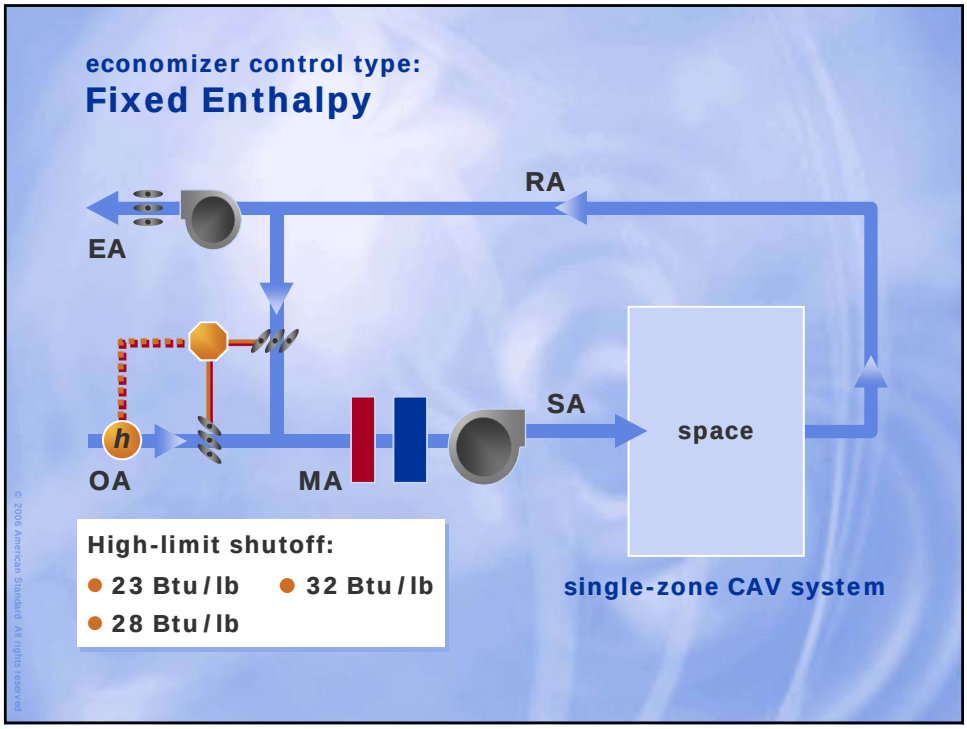


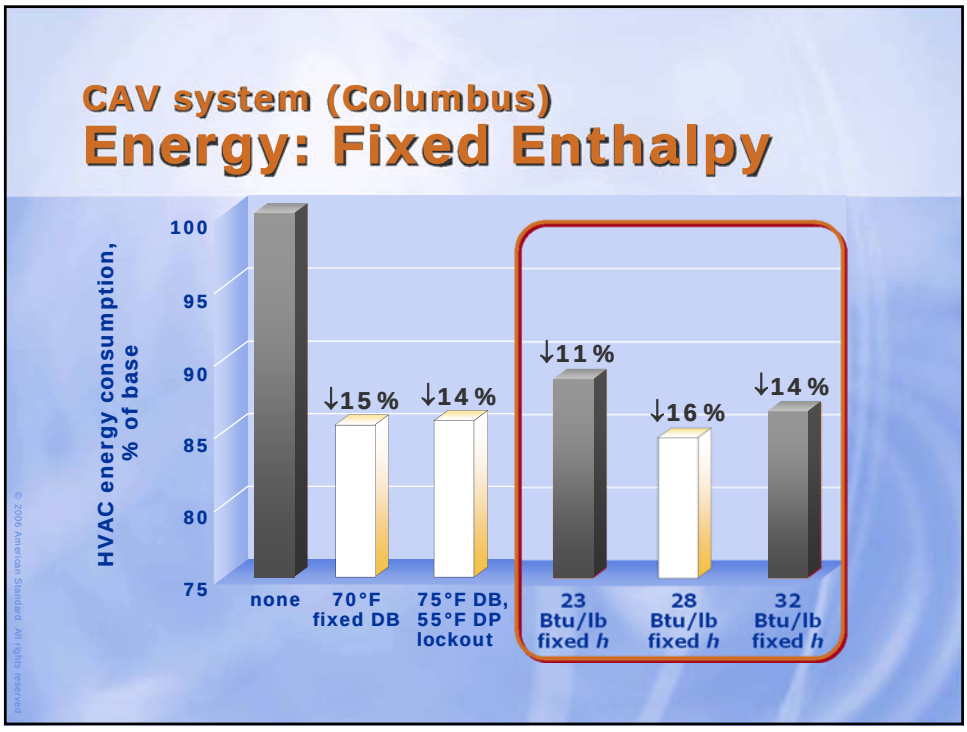


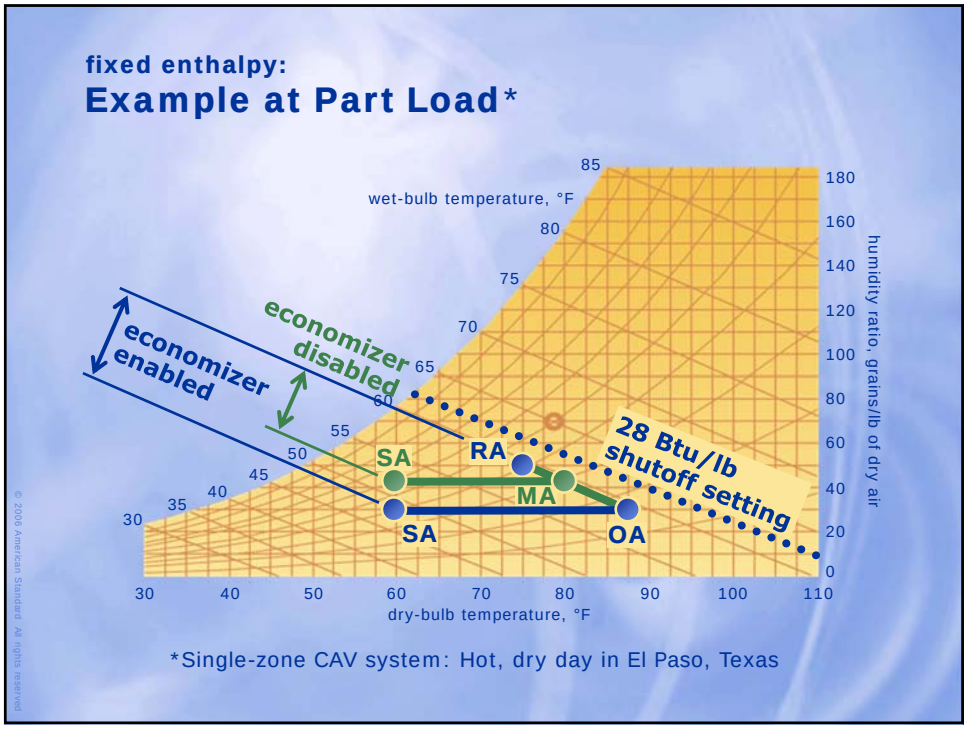


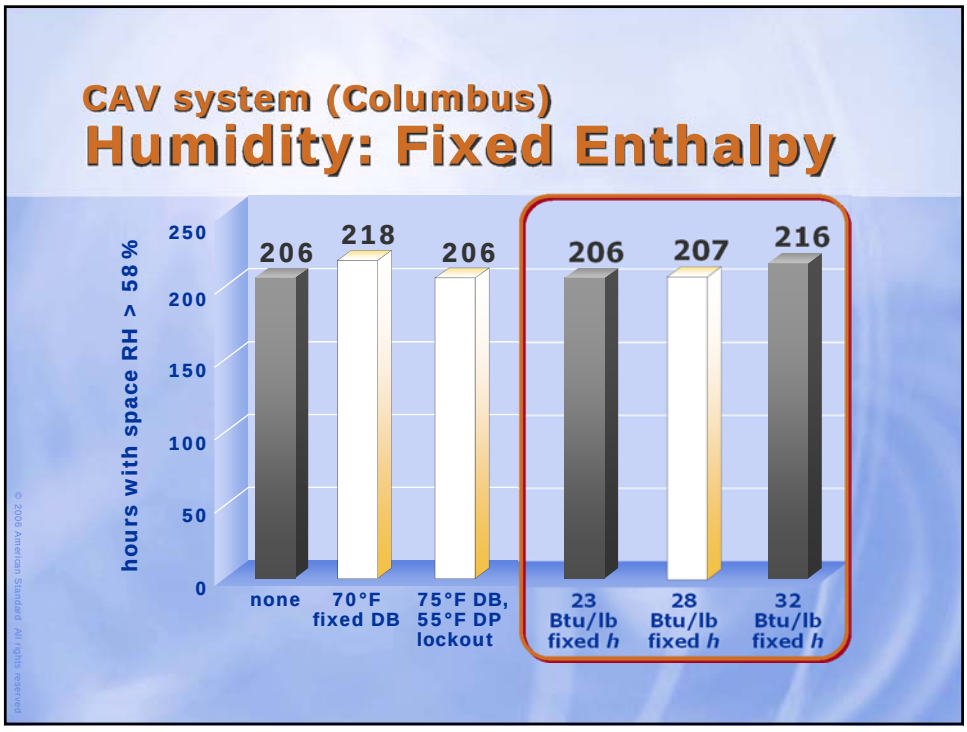


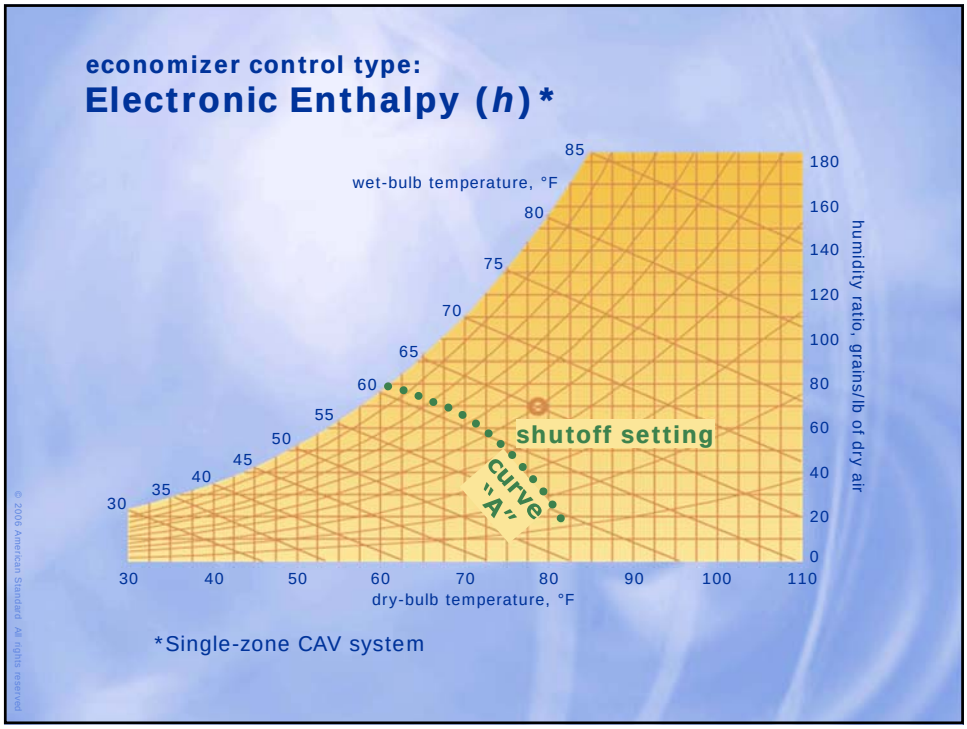


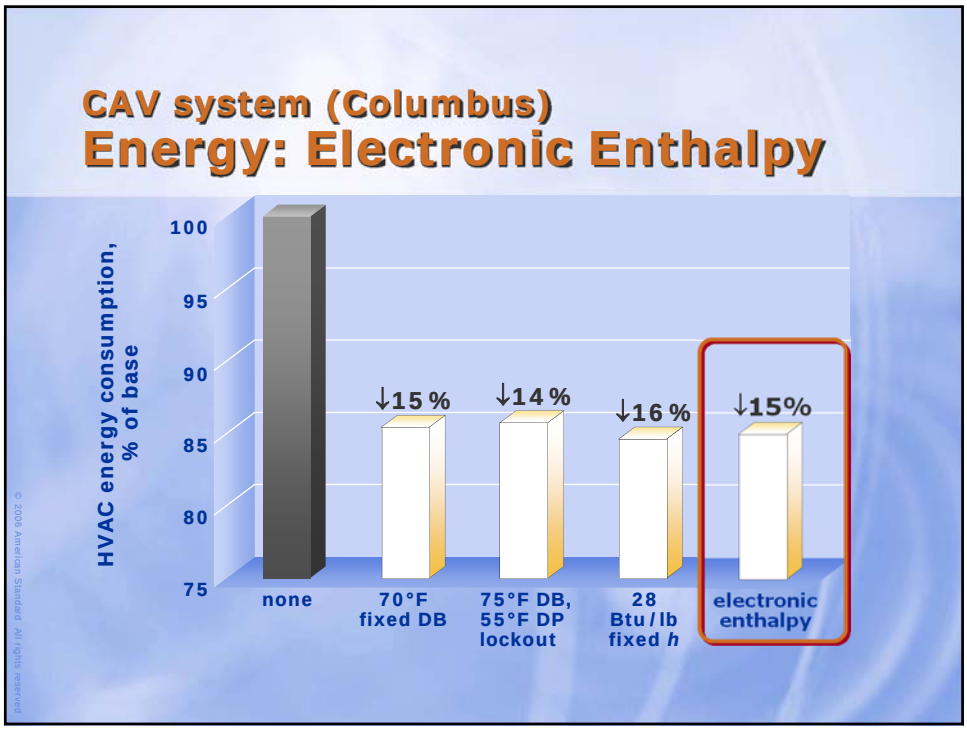












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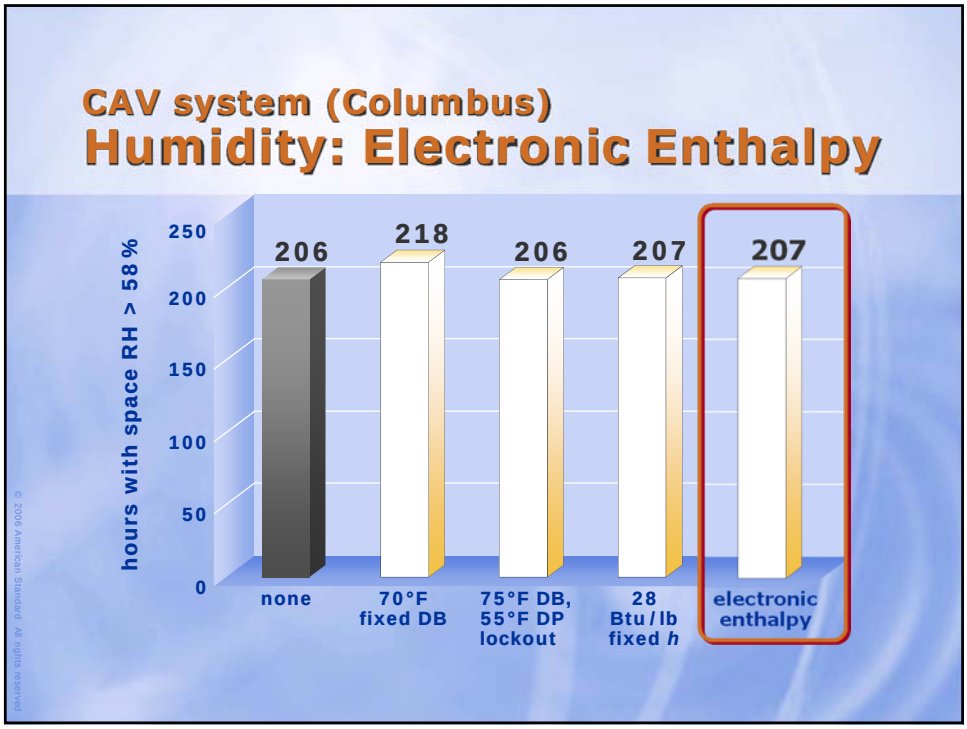
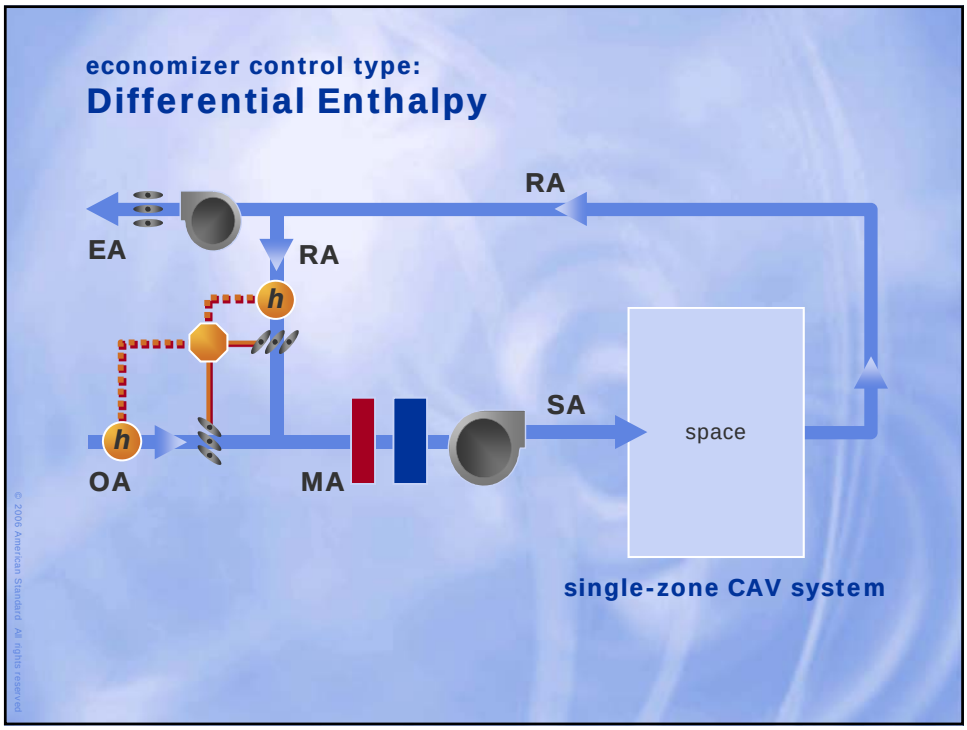
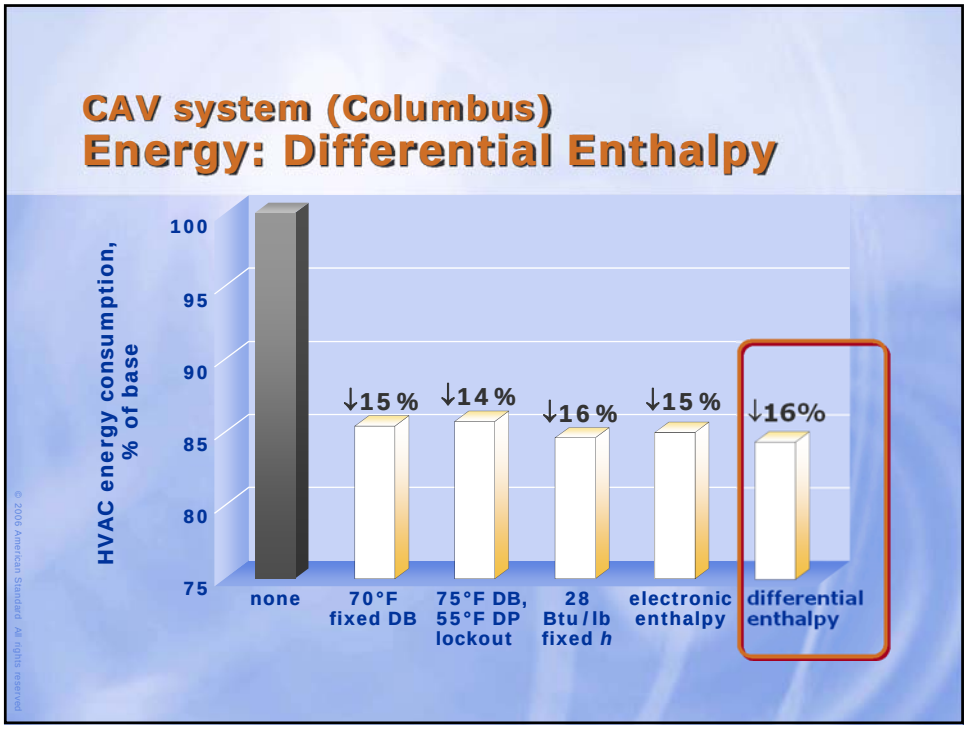
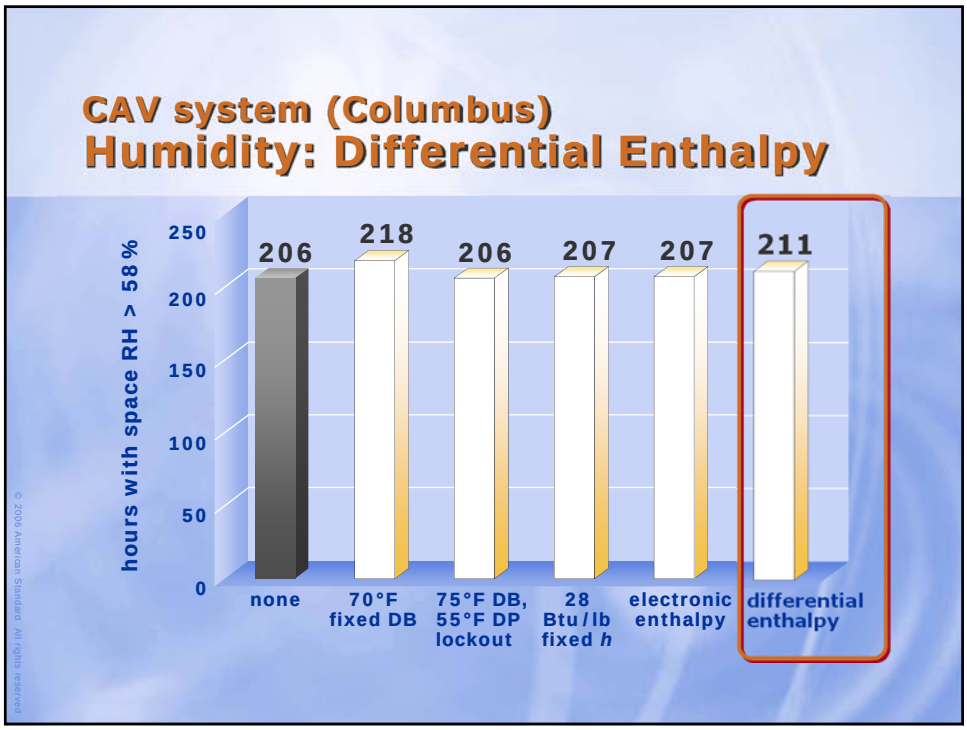


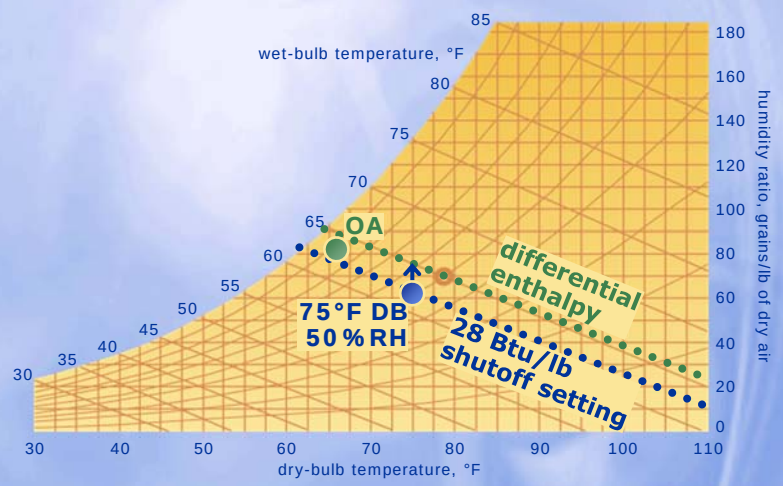






differential enthalpy:

Example at part load*



*Single-zone CAV system: Mild, rainy day in Columbus, Ohio

Performance in a Variable-Volume System

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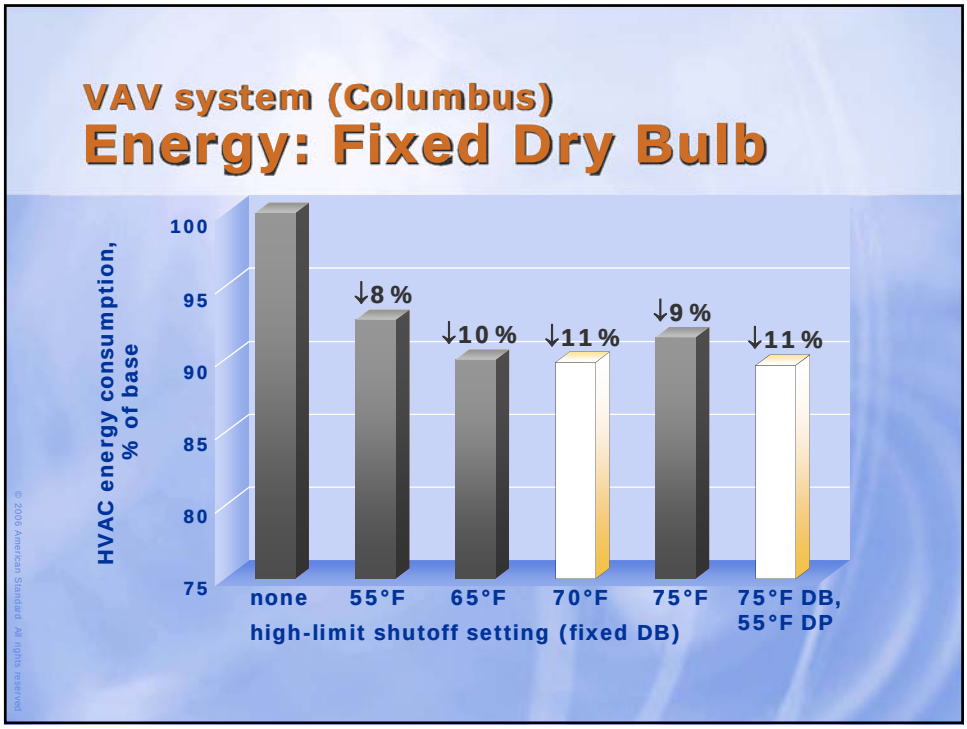

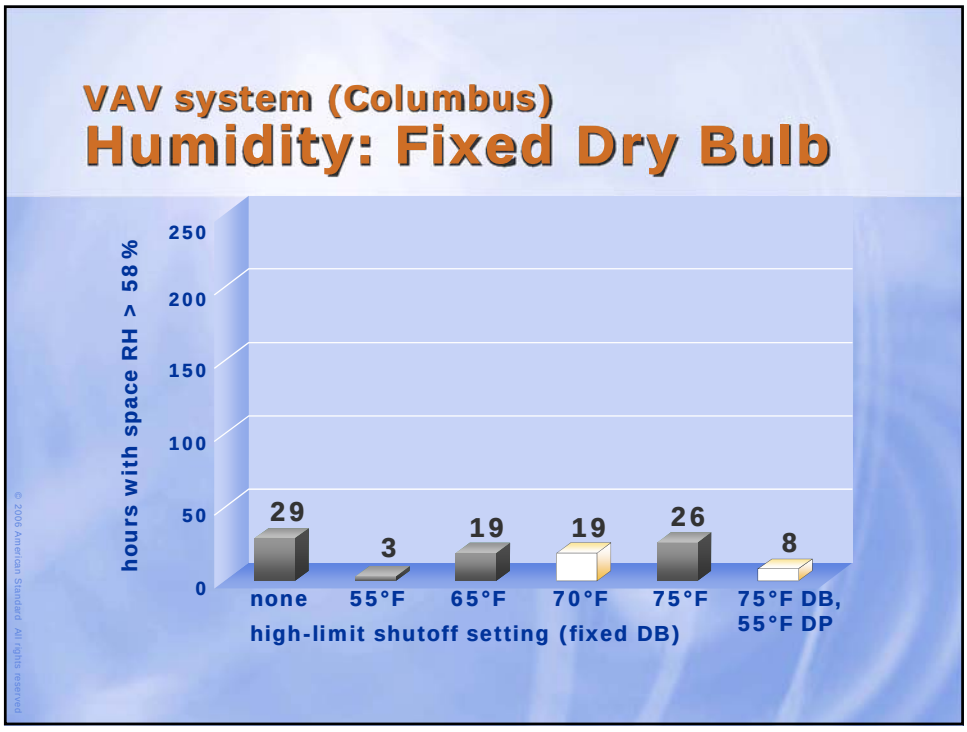

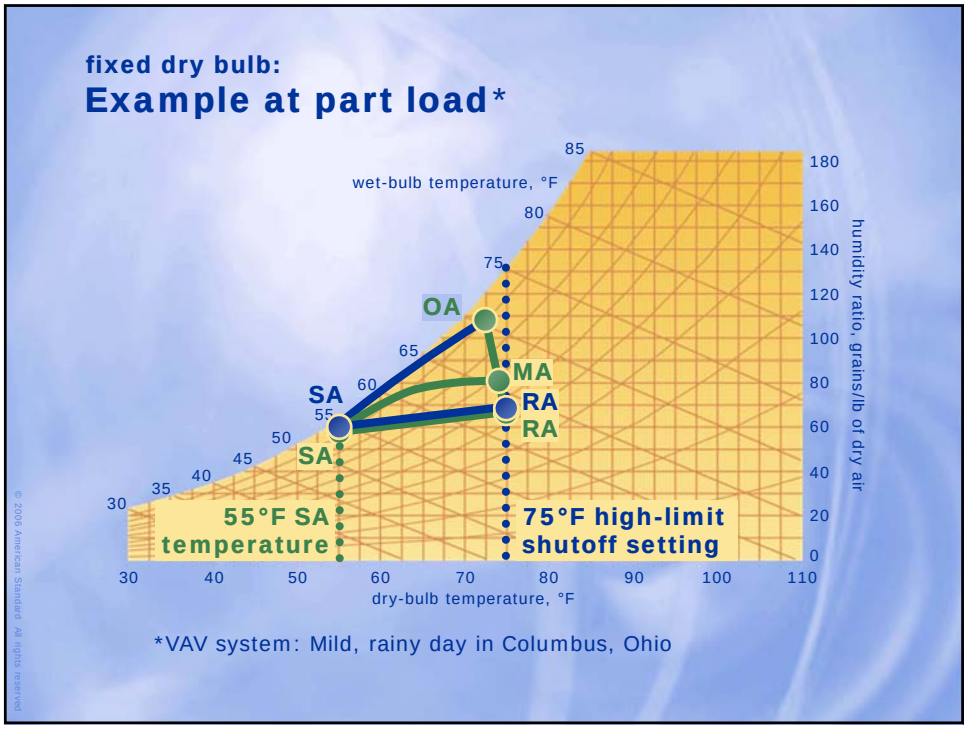

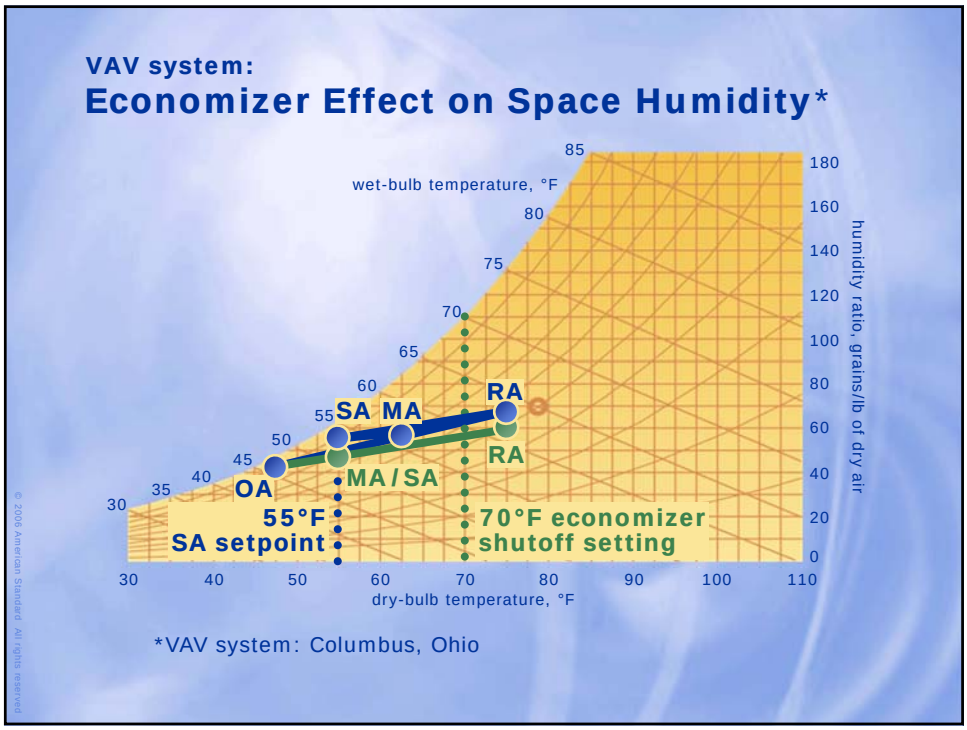

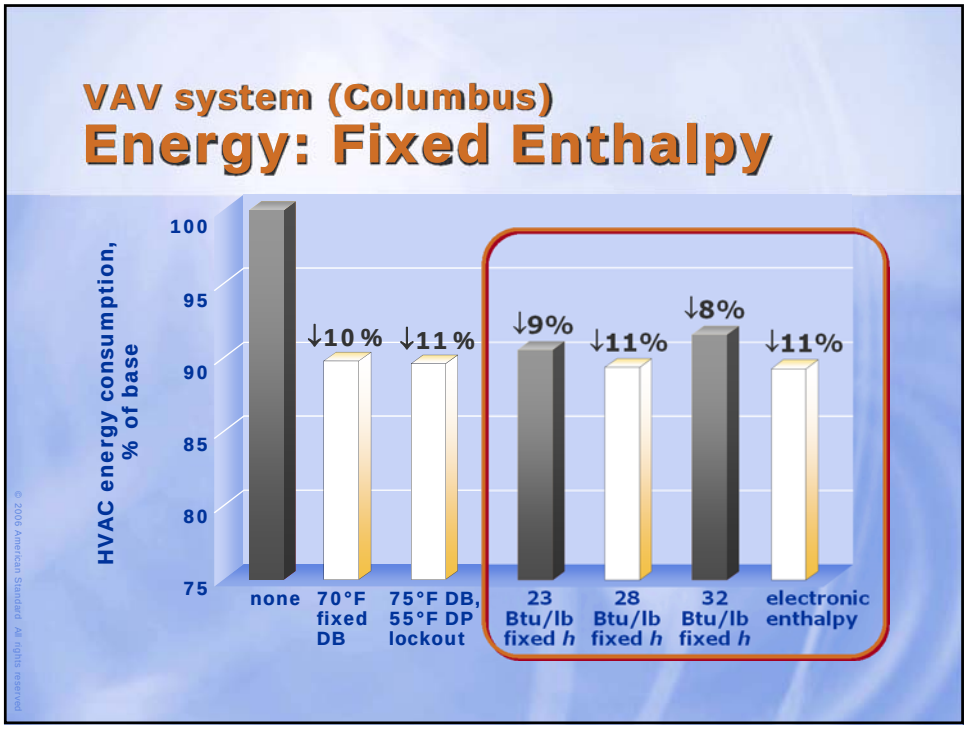

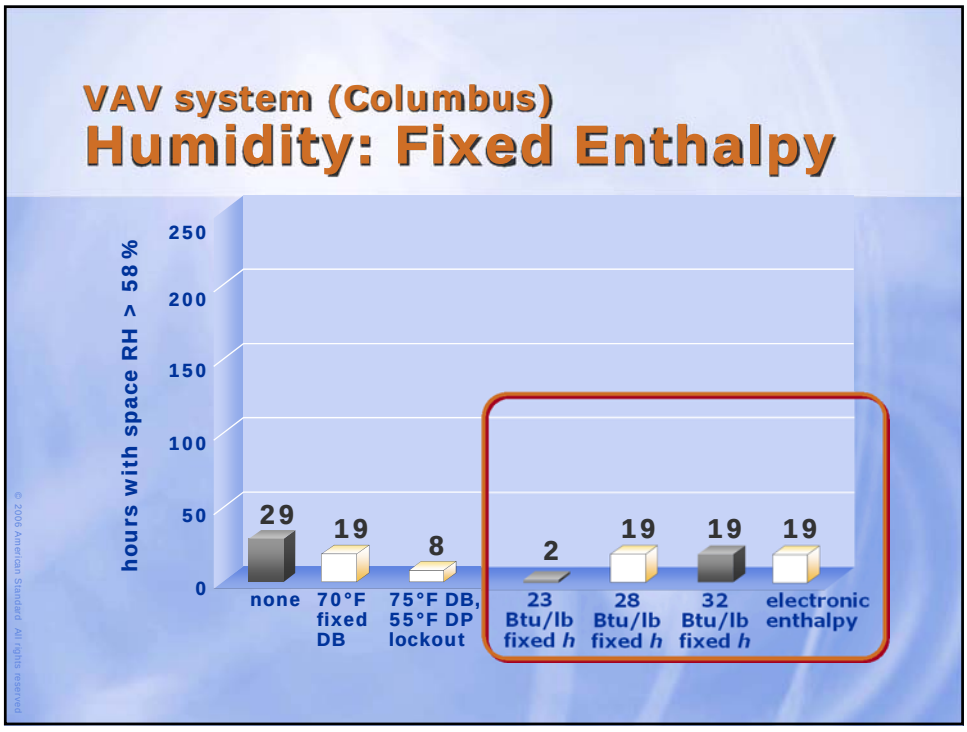

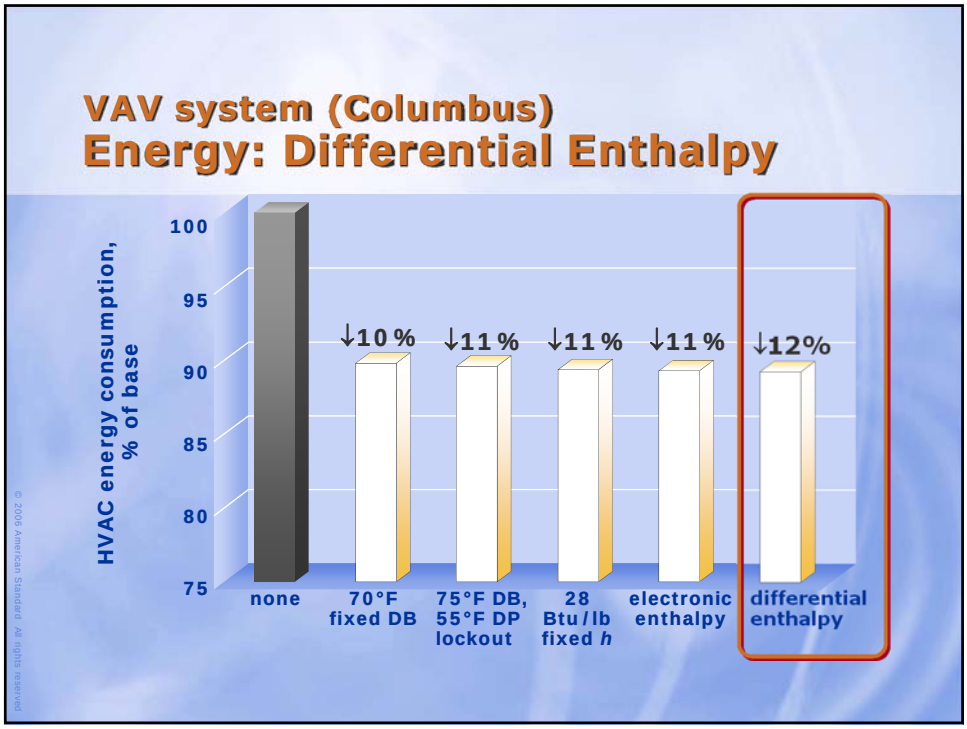

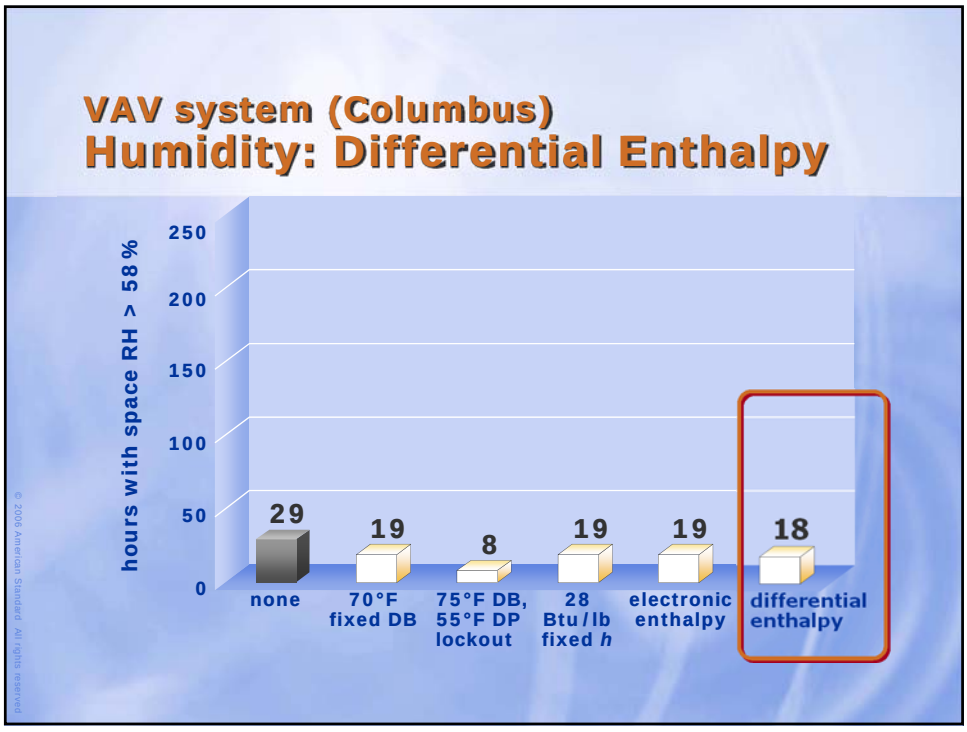

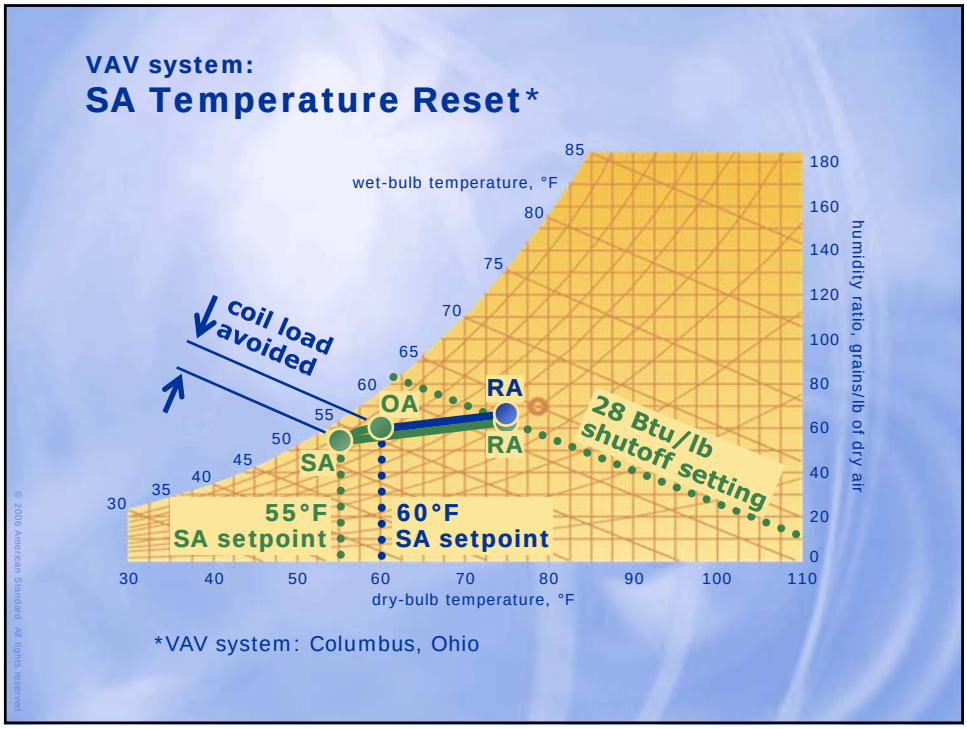

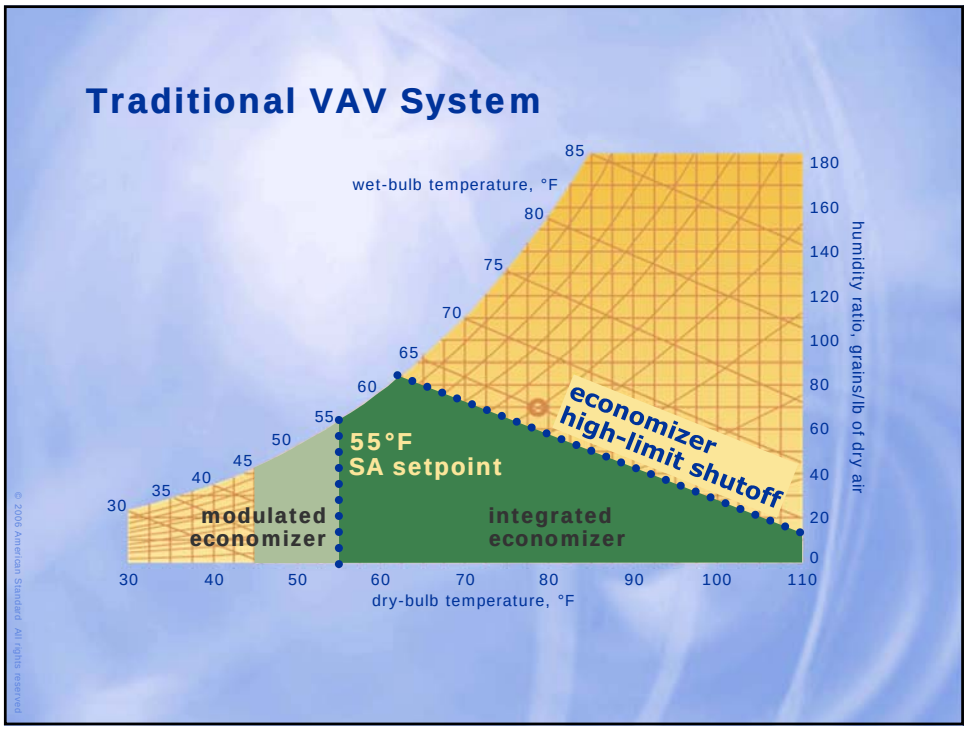

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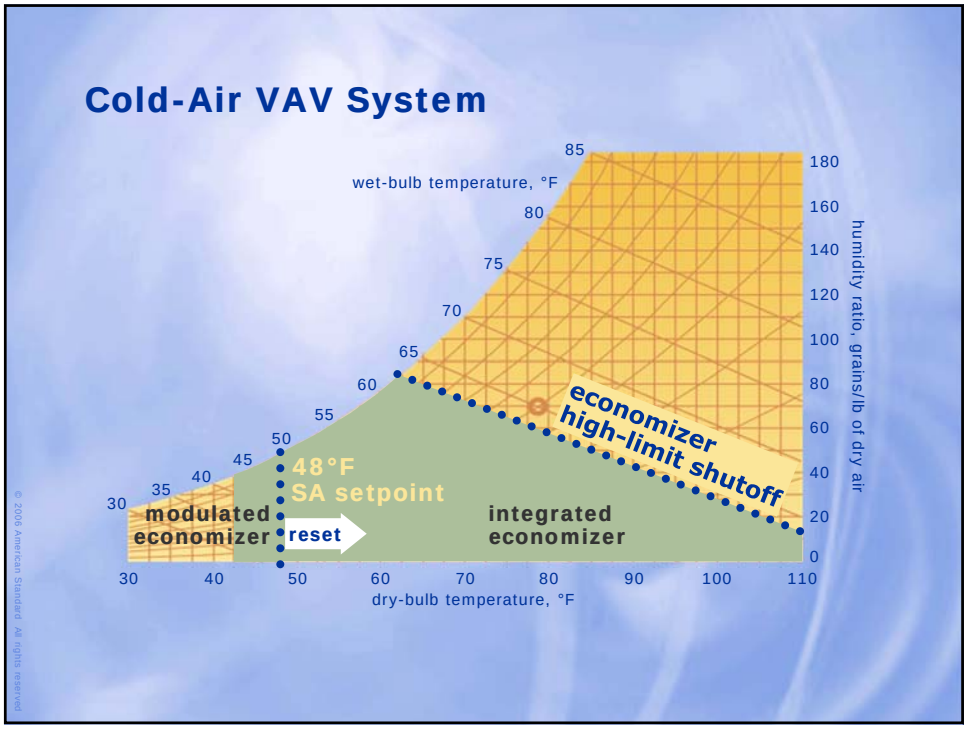

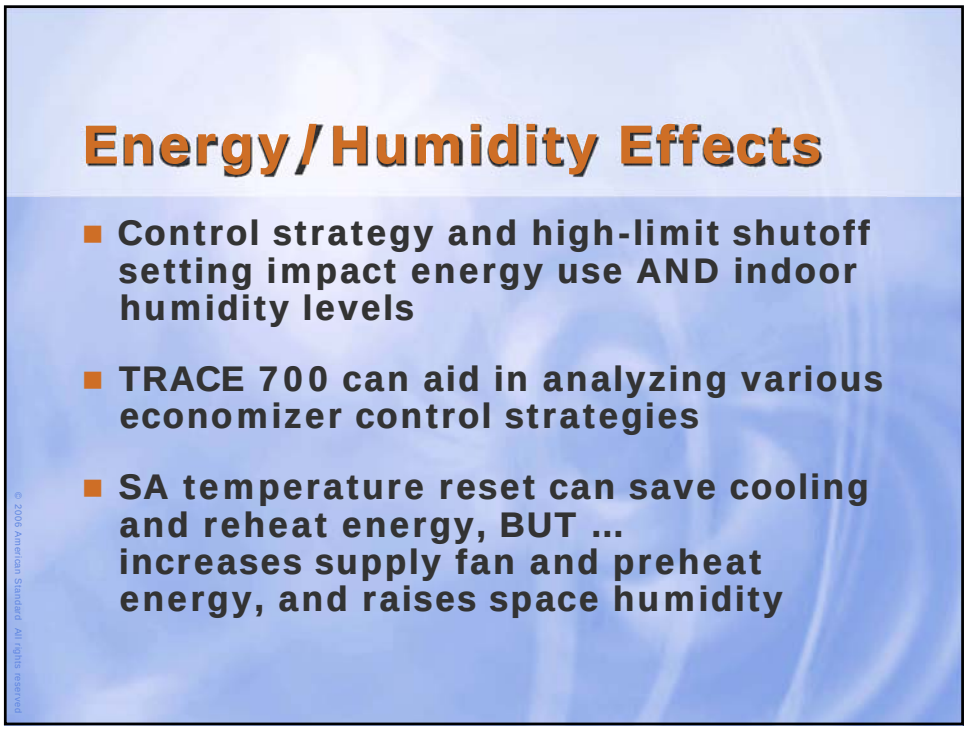

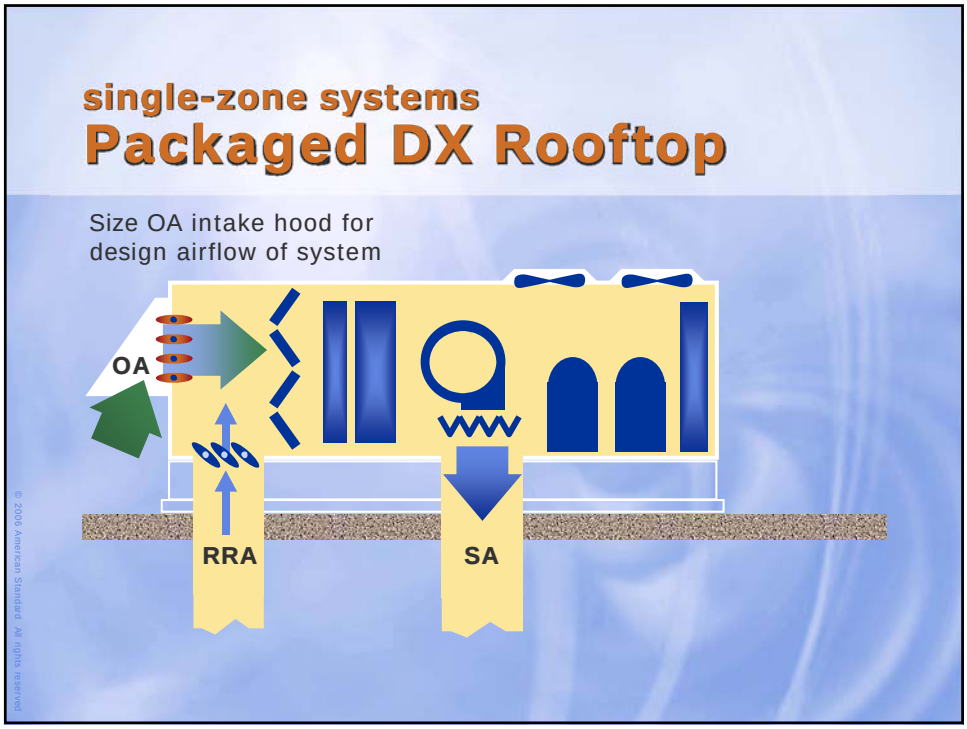

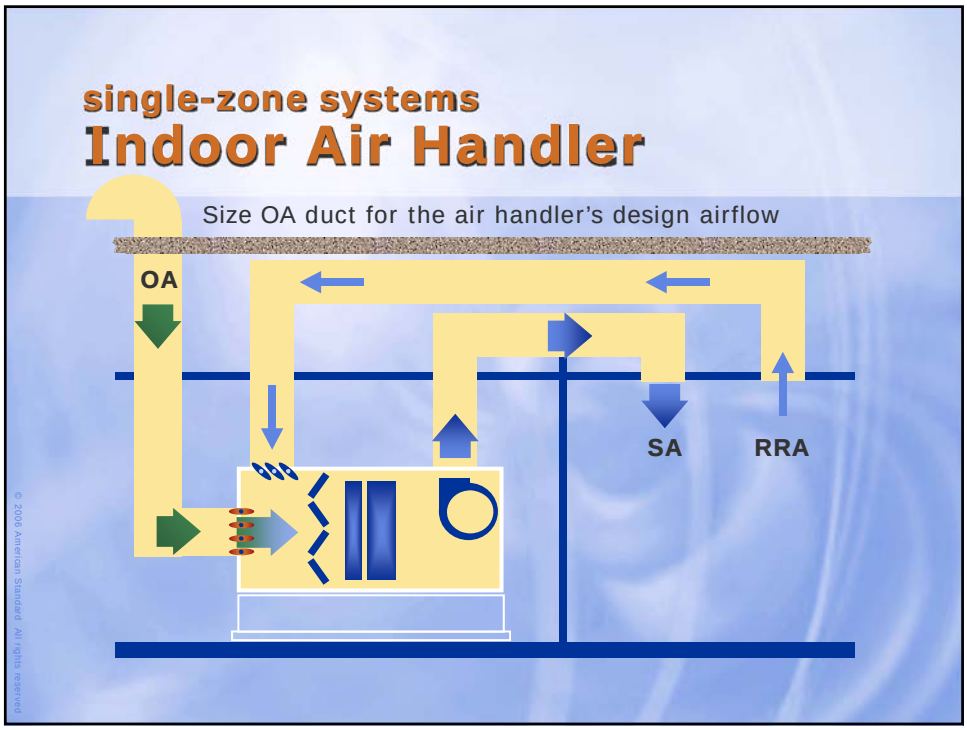

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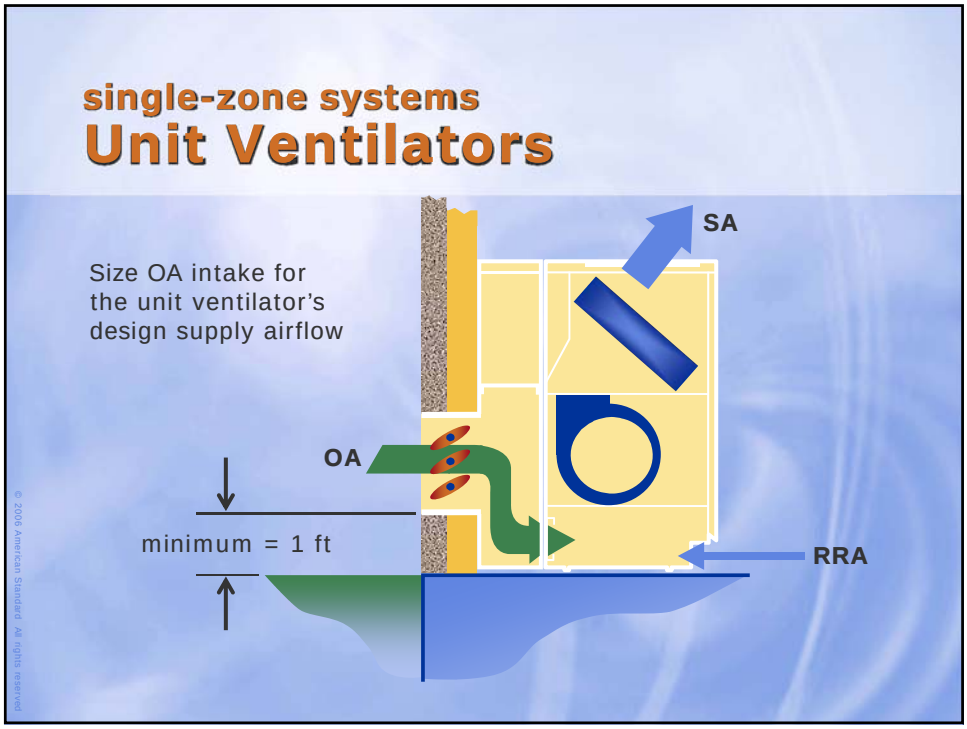

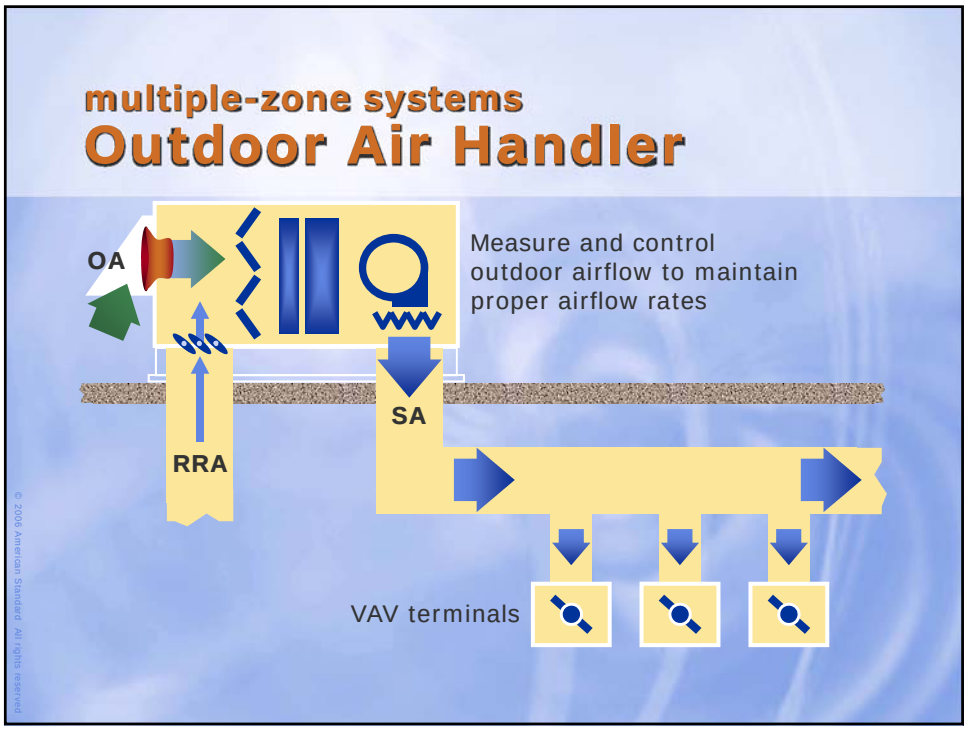

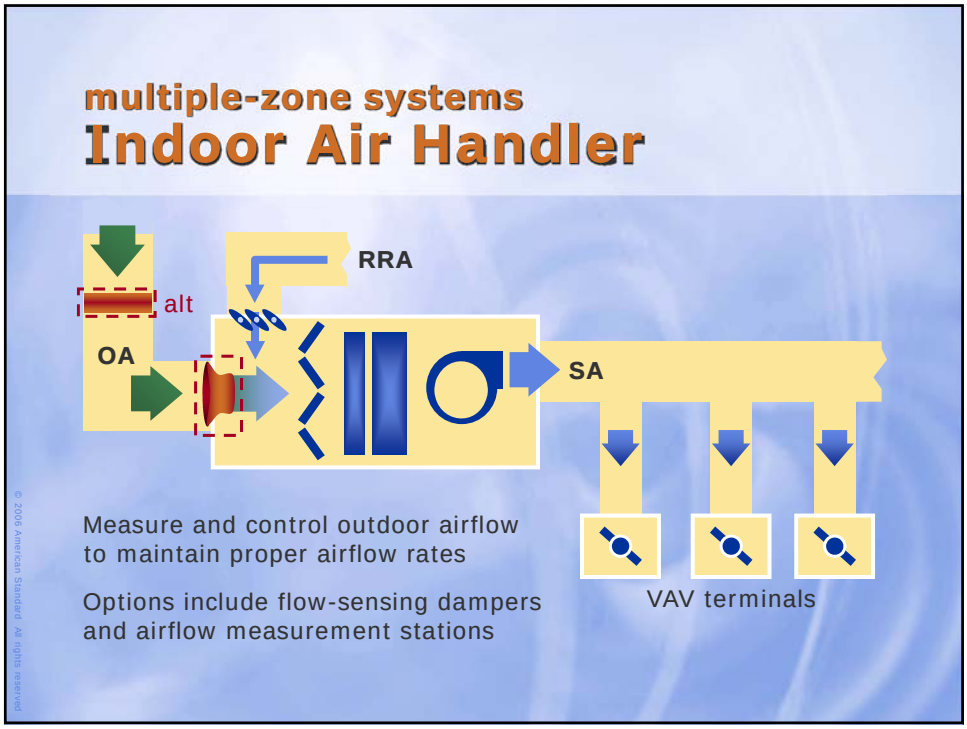

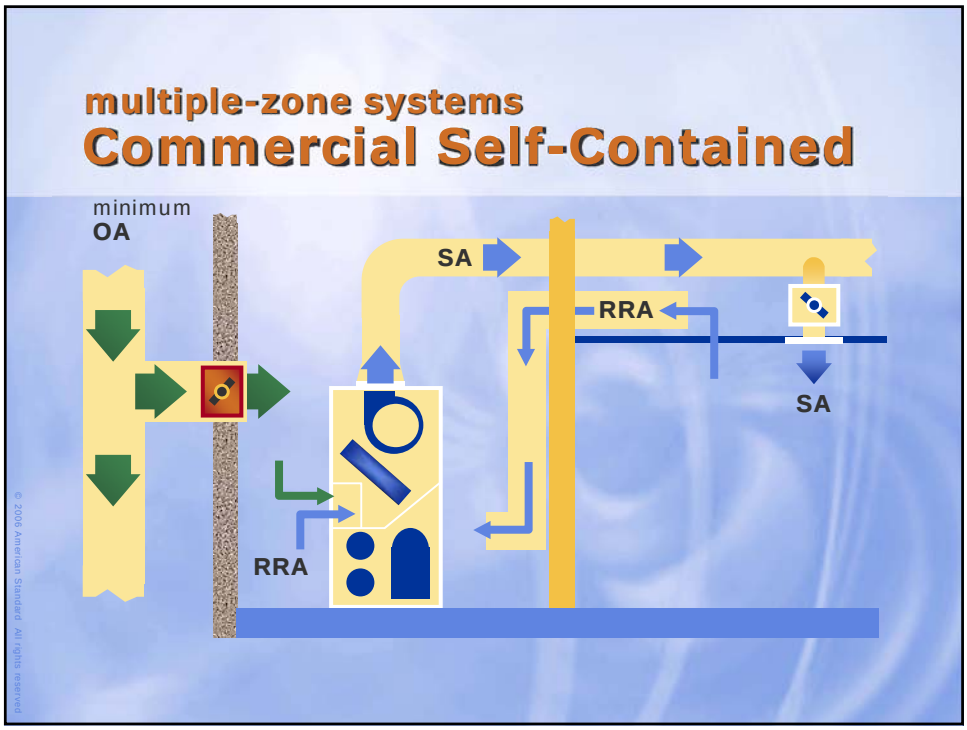

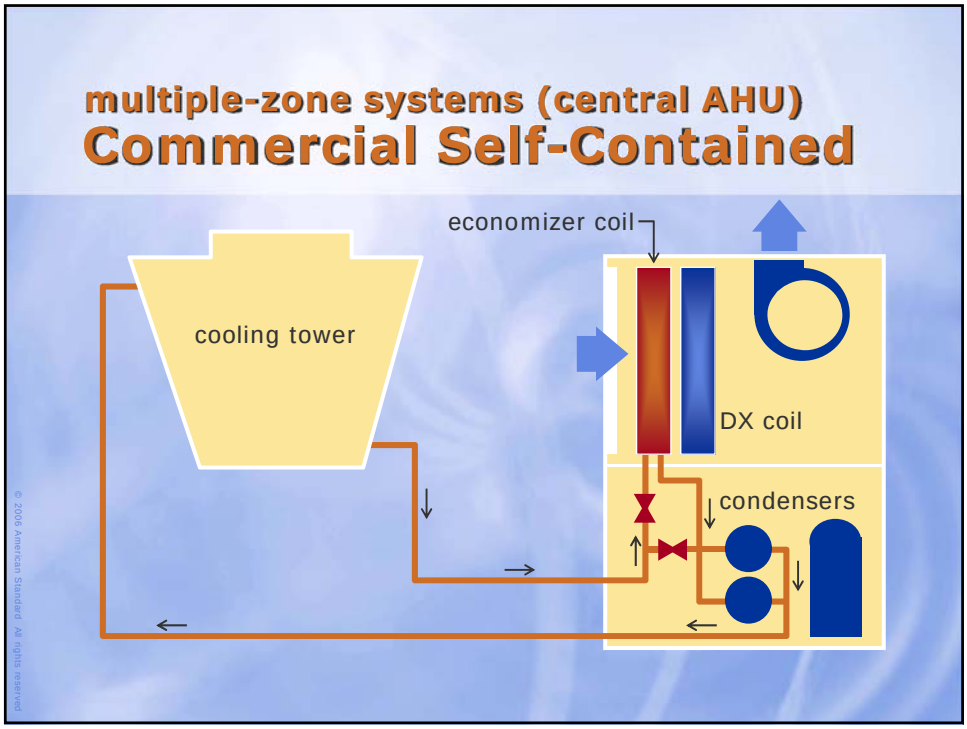

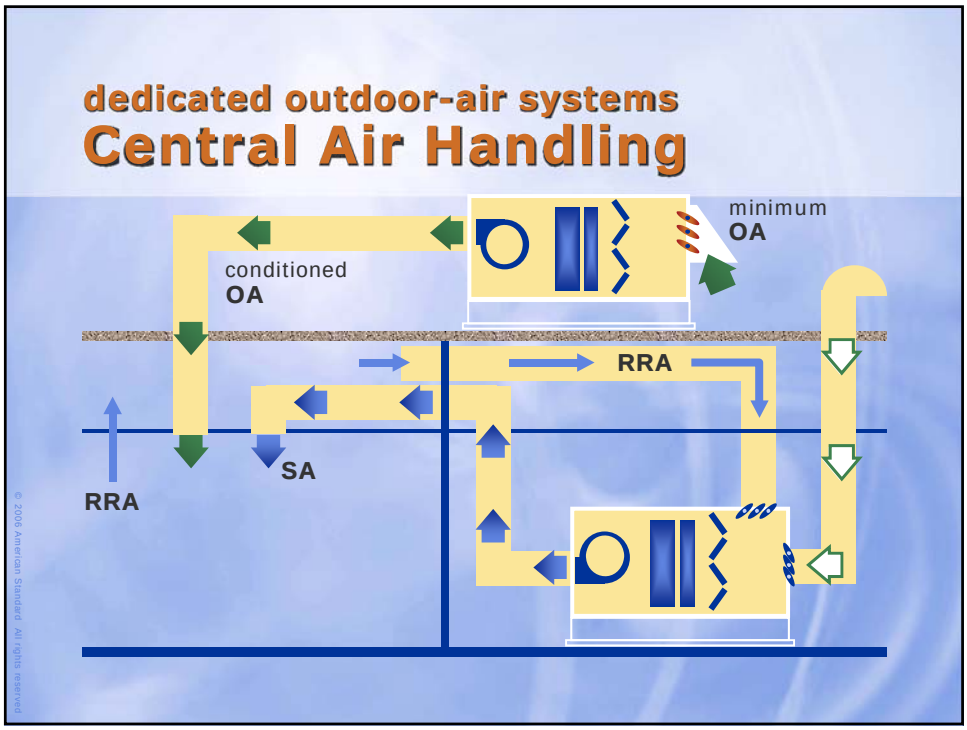

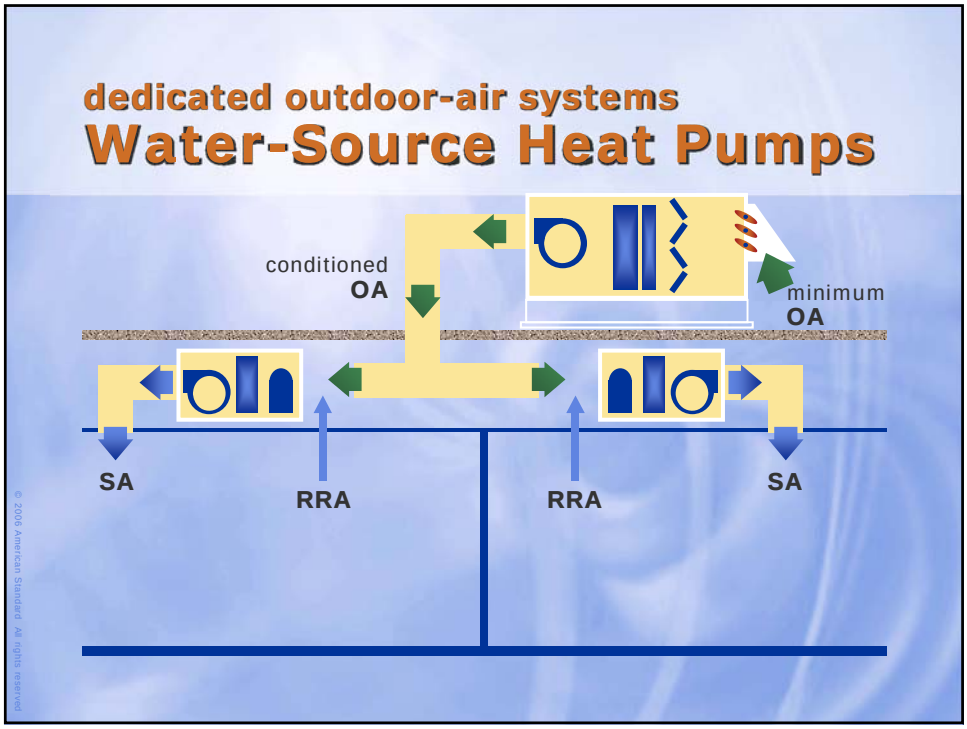

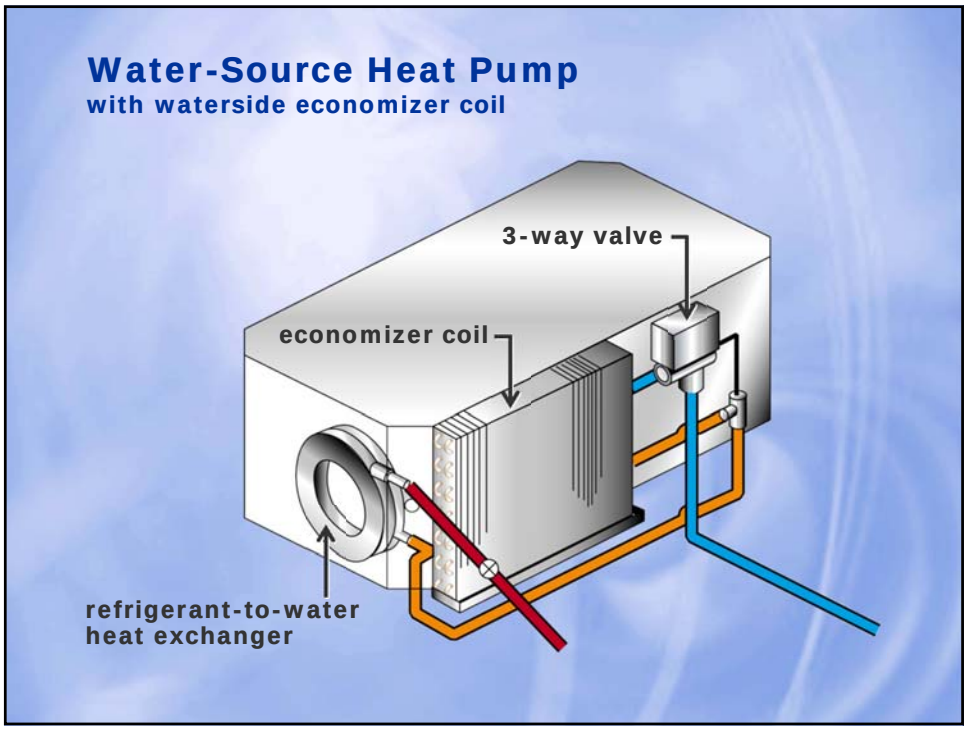

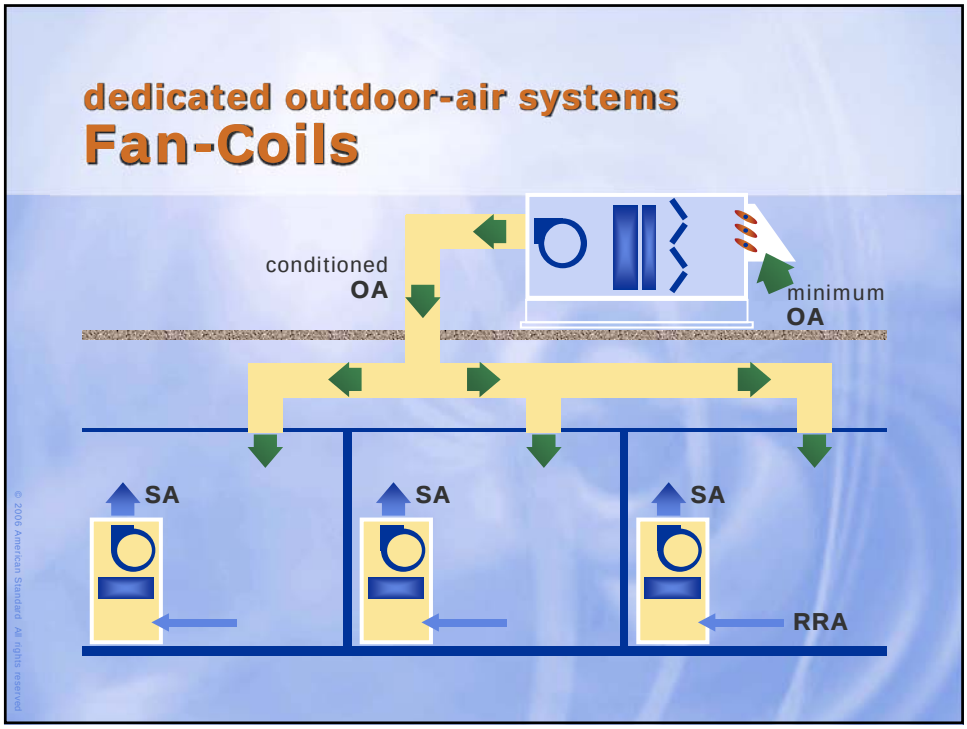

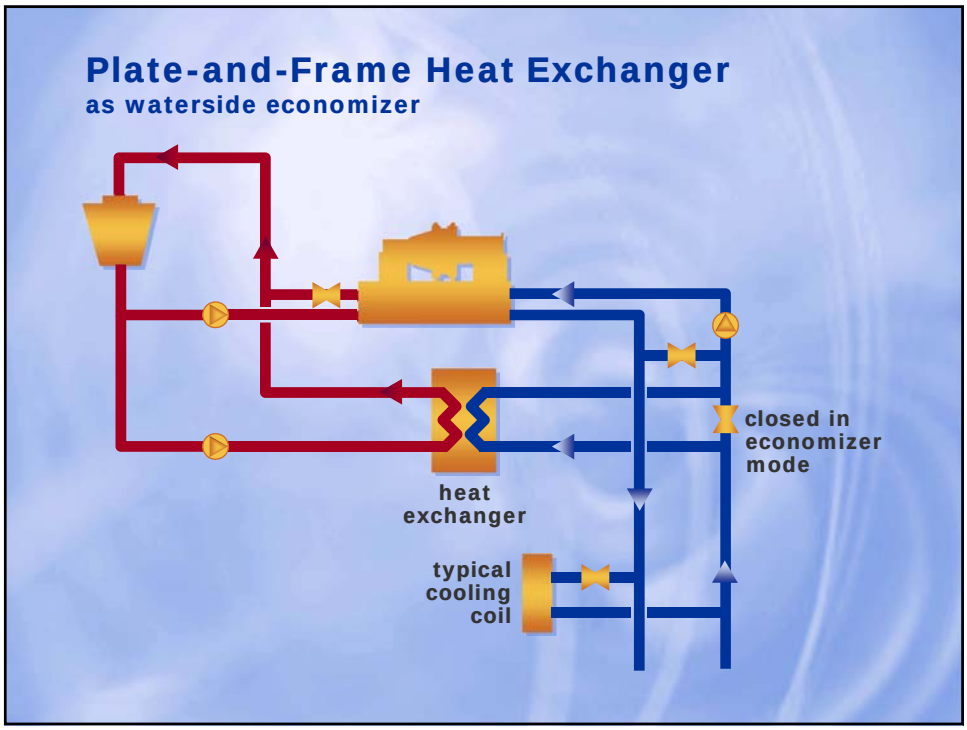

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application considerations

Building Pressure Control

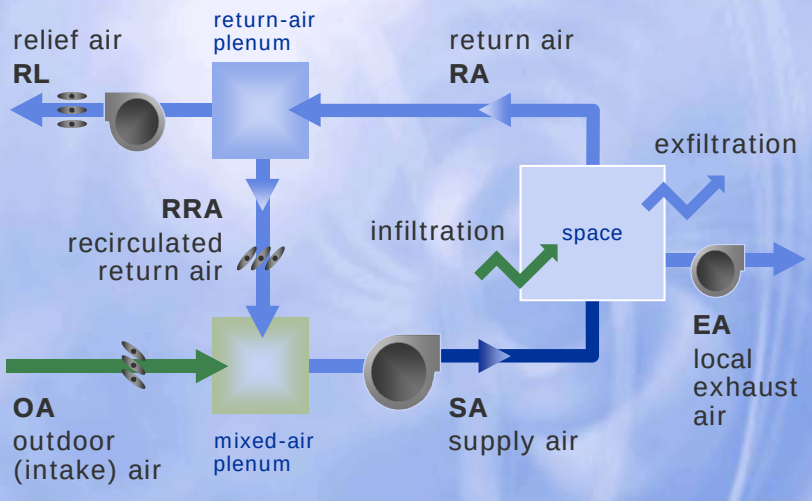
Standard 90.1 requires:

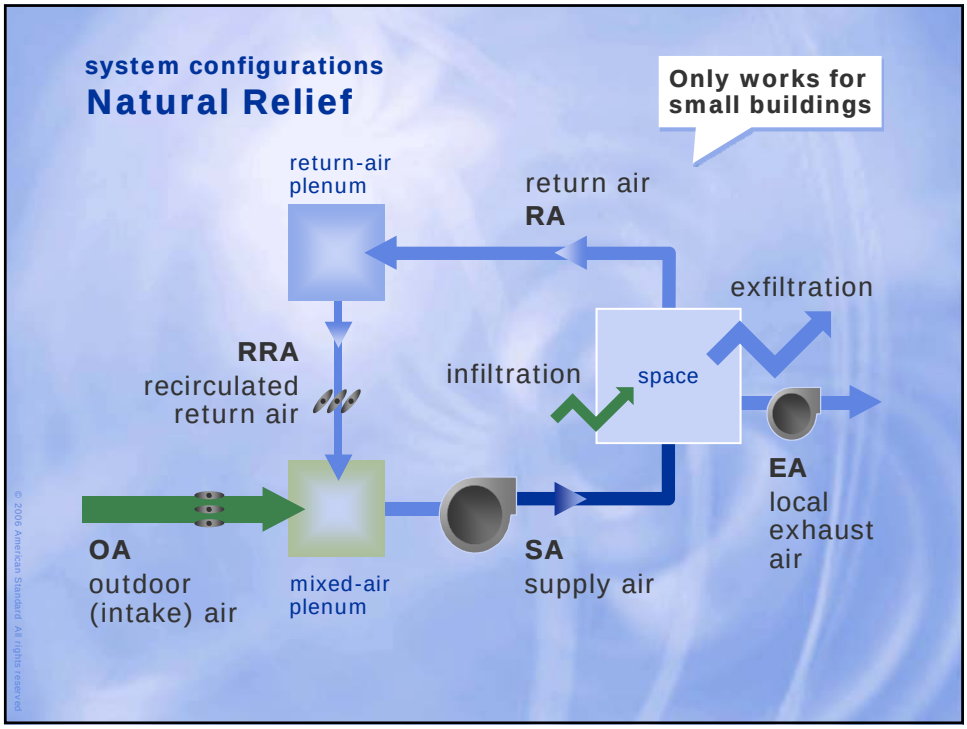
- Low-leak dampers
- Some method for controlling building pressure

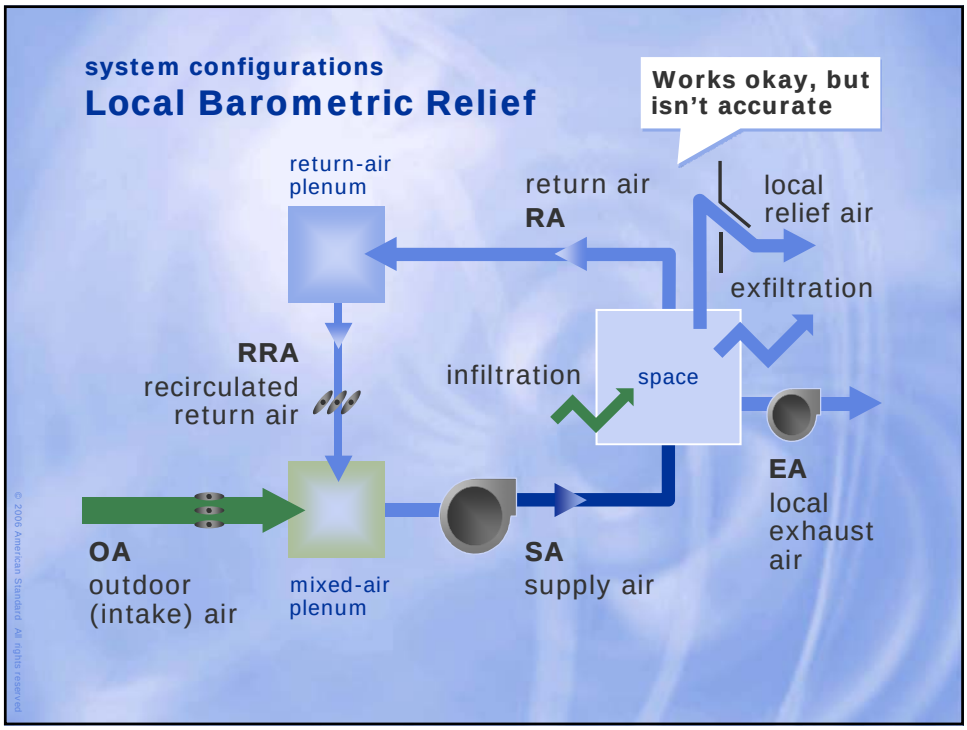
"Systems shall provide a means to relieve excess outdoor air during air economizer operation to prevent overpressurizing the building. The relief air outlet shall be located to avoid recirculation into the building"

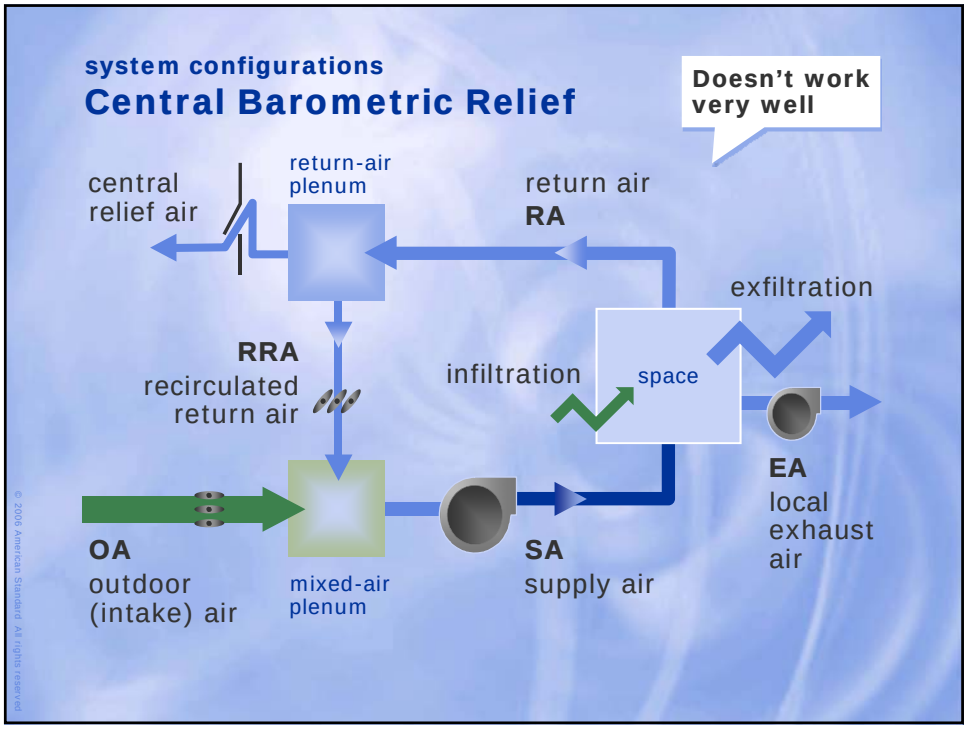
ASHRAE/IESNA Std 90.1-2004, Section 6.5.1.1.5

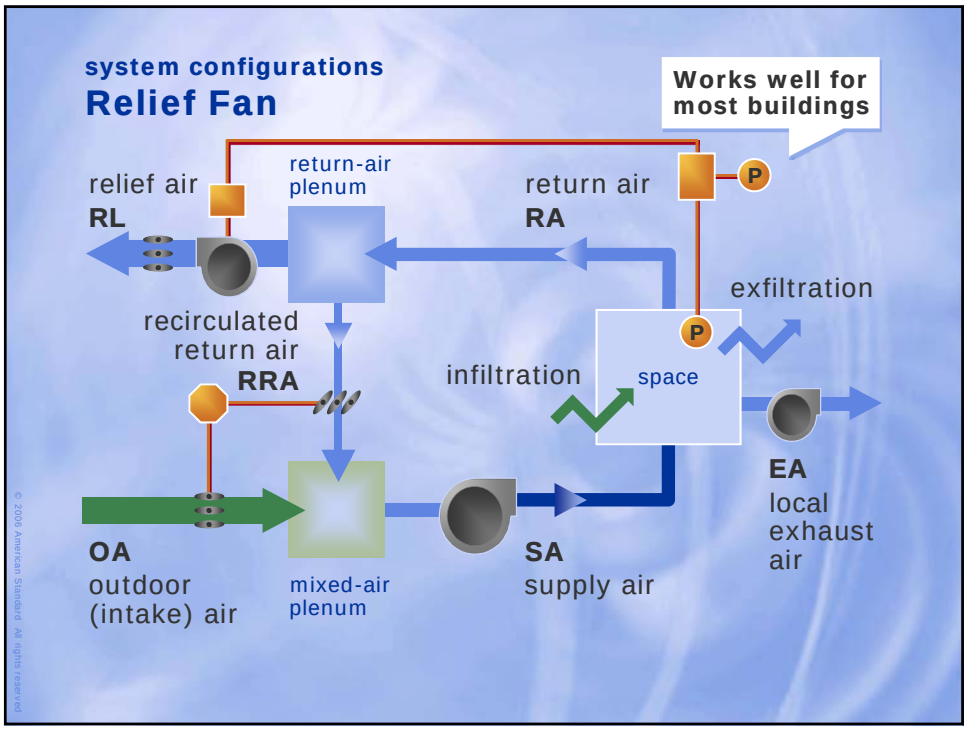
Building Pressure Terminology

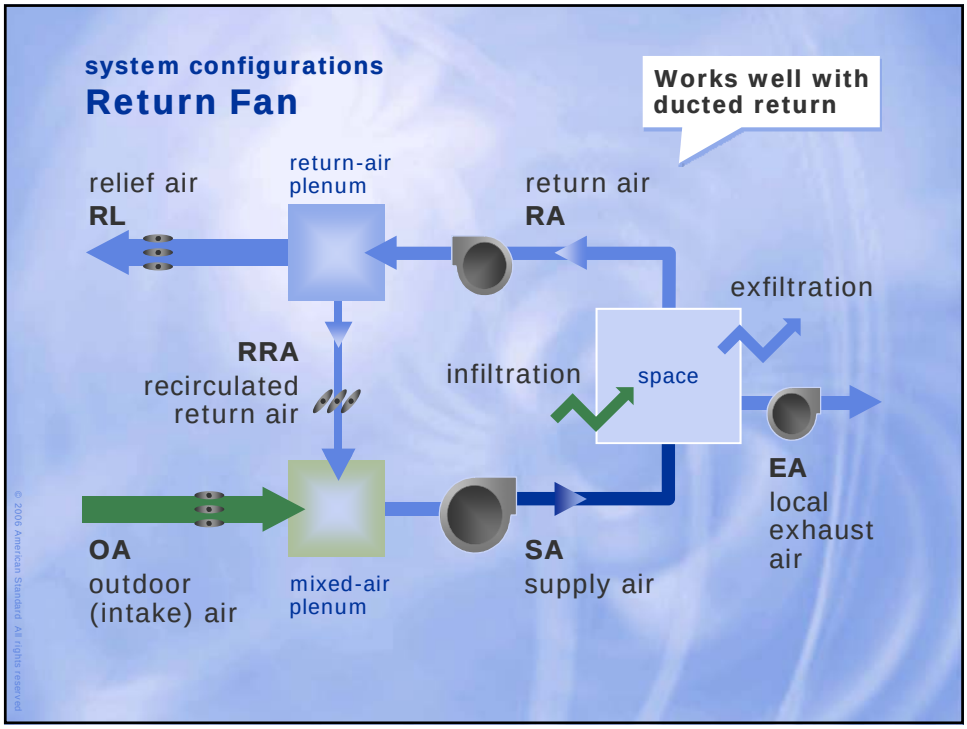


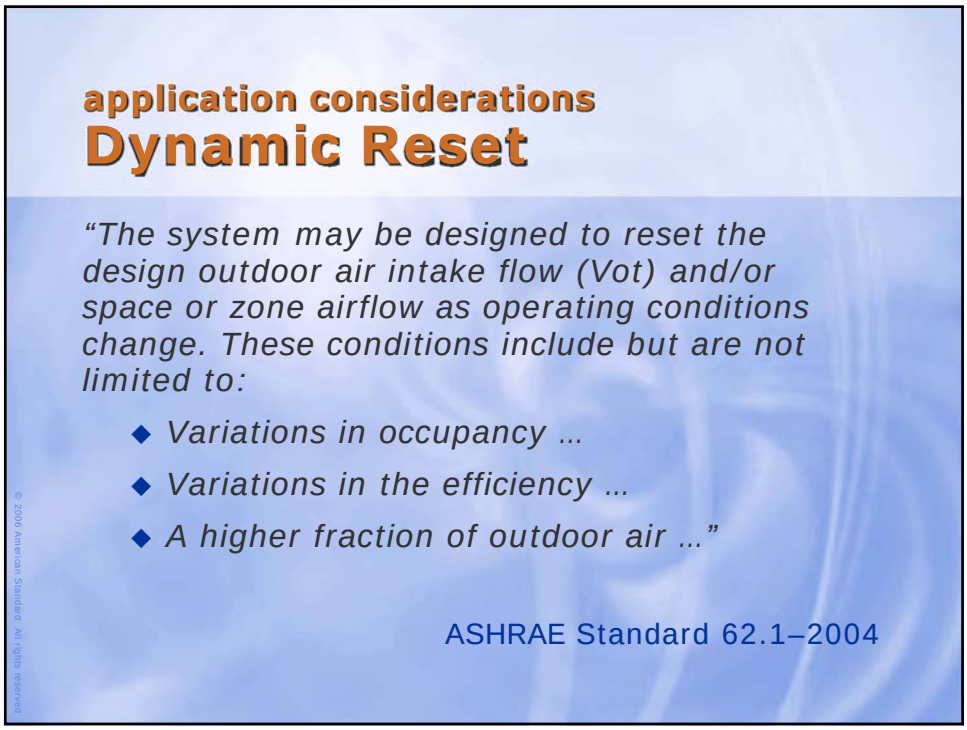












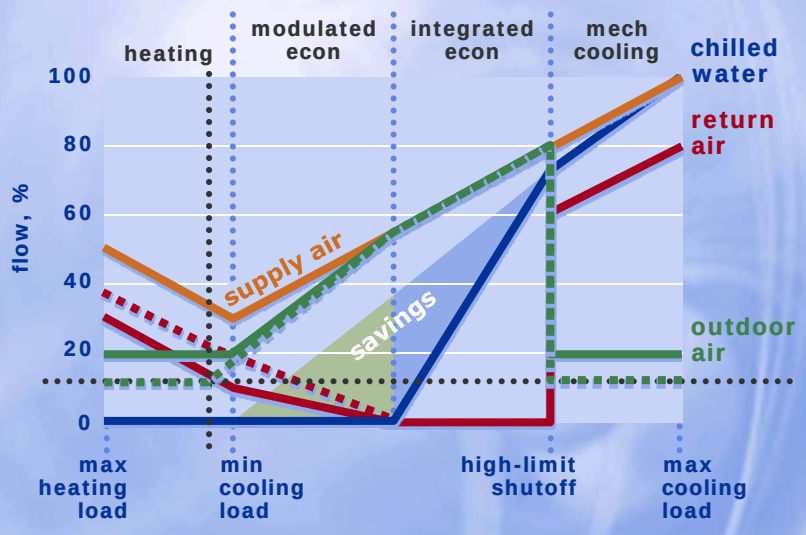
application considerations
Dynamic Reset Control

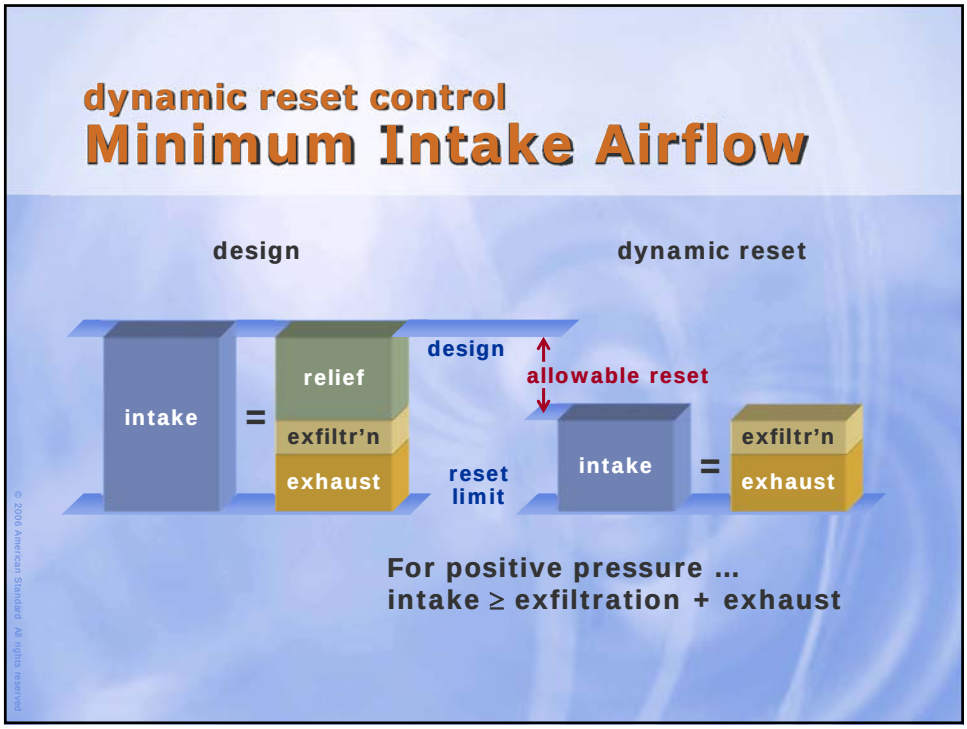
"These conditions include … Variations in occupancy or ventilation airflow in one or more individual zones for which ventilation airflow requirements will be reset.

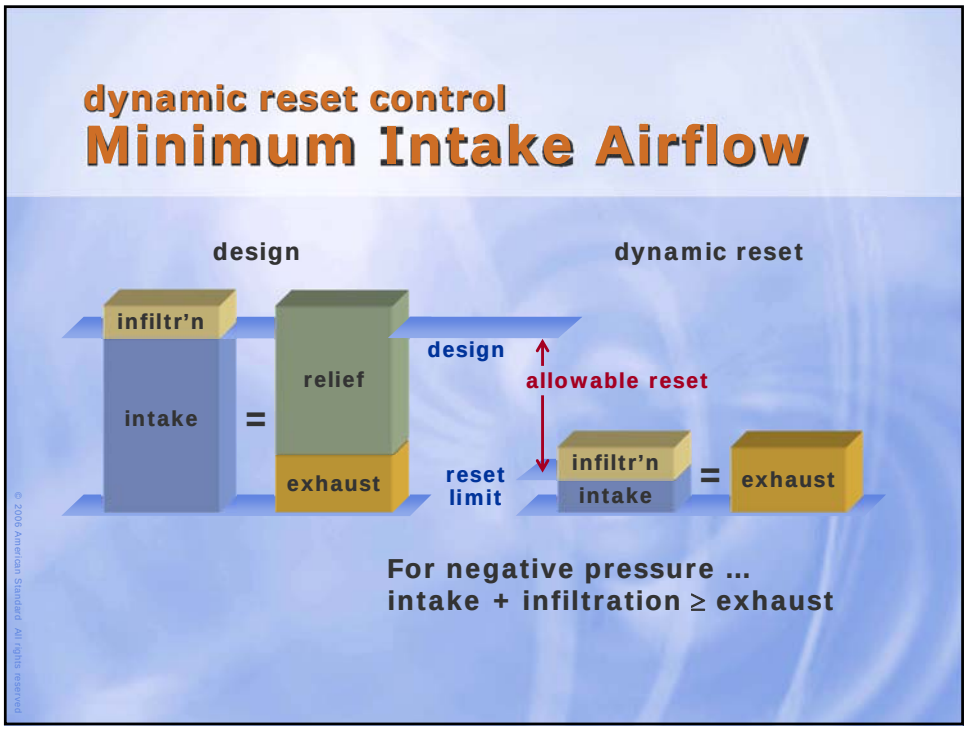
"Note: Examples of measures for estimating such variations include: occupancy scheduled by time-of-day, a direct count of occupants, or an estimate of occupancy or ventilation rate per person using occupancy sensors such as those based on indoor CO_2 concentrations."

ASHRAE Standard 62.1–2004

application considerations
Dynamic Reset







application considerations
Dynamic Reset

"These conditions include … :

- *Variations in occupancy …*
- *Variations in efficiency with which outdoor air is distributed to the occupants under different ventilation system airflows and temperatures*
- *A higher fraction of outdoor air in the air supply due to intake of additional outdoor air for free cooling or exhaust air makeup"*

ASHRAE Standard 62.1–2004

airside economizers
What We Covered

- **ASHRAE 90.1 requirements, exceptions** (location/size, controls, integration)
- **Energy costs and humidity levels** (constant- vs. variable-air-volume systems)
- **Economizer implementation in various system types**
- **Application considerations** (building pressurization)

Trane *Engineers Newsletter Live* satellite broadcast

Bibliography

03 May 2006

HVAC Systems and Airside Economizers

Industry Standards

American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE). *ANSI/ASHRAE IESNA Standard 90.1-2004: Energy Standard for Buildings Except Low-Rise Residential Buildings*. Available at http://xp20.ashrae.org/frame.asp?standards/std90.html

American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE). *Standard 90.1-2004 User's Manual*. Available at http://www.ashrae.org

American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE). *ANSI/ASHRAE Standard 62.1-2004: Ventilation for Acceptable Indoor Air Quality*. Available at <http://www.realread.com/prst/pageview/browse.cgi?book=1931862672>

American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE). *Standard 62.1-2004 User's Manual*. Available at http://www.ashrae.org

Articles

Brambley, M., Pratt, R., Katipamula, S. et al. 1998. "Diagnostics for Outdoor Air Ventilation and Economizers." *ASHRAE Journal* 40-10 (October), 49-55.

Taylor, S. 2000. "Comparing Economizer Relief Systems." *ASHRAE Journal* 42-9 (September), 33-40, 42.

Trane Publications

Stanke, D. "Keeping Cool with Outdoor Air: Airside Economizers." *Engineers Newsletter* 35-2 (2006). Available at <http://www.trane.com/commercial/navigation/files/pdf/6/admapn020en_0406.pdf>

Trane. 2002. *HVAC System Control* (Trane Air Conditioning Clinic TRG-TRC017-EN). La Crosse, WI: Inland Label and Marketing Services, LLC.

HVAC Systems and Airside Economizers

Brian Fiegen | manager, applications engineering & systems marketing | Trane

Brian has been with Trane for 23 years in a variety of product management and system development roles. Specifically, he has worked with Trane's air handling and VAV product lines, including unit controls for that equipment. He is presently responsible for Trane's applications engineering and systems marketing team, and is well-respected for his extensive knowledge in airside design and controls. Brian is a member of ASHRAE.

John Murphy | senior applications engineer | Trane

John has been with Trane since 1993. His primary responsibility as an applications engineer is to aid design engineers and Trane sales personnel in the proper design and application of HVAC systems. His main areas of expertise include dehumidification, air-to-air energy recovery, psychrometry, ventilation, and ASHRAE Standards 15, 62.1, and 90.1.

John is the author of numerous Trane application manuals and *Engineers Newsletters*, and is a frequent presenter on Trane's *Engineers Newsletter Live* series of satellite broadcasts. He also is a member of ASHRAE, has authored articles for the *ASHRAE Journal*, and is a member of ASHRAE's "Moisture Management in Buildings" and "Mechanical Dehumidifiers" technical committees.

Dennis Stanke | staff applications engineer | Trane

Dennis, a mechanical engineer from the University of Wisconsin, has been with Trane since 1973 and is a specialist in airside systems and controls, ventilation, indoor air quality, and dehumidification. He's authored numerous publications on these subjects, has appeared in several *Engineers Newsletter Live* broadcasts, and holds three U.S. patents related to VAV system control. An active ASHRAE member, Dennis currently serves as chair for SSPC62.1, the committee responsible for ASHRAE Standard 62, *Ventilation for Acceptable Indoor Air Quality*, and is a member of the editorial board for the ASHRAE publication, *IAQ Applications*. He combines his knowledge of ventilation system design and control with knowledge of IAQ-related issues and solutions to help designers meet IAQ, ventilation, and energy challenges in commercial, institutional, and high-rise residential buildings.

In addition to his Trane responsibilities as staff applications engineer, Dennis also serves on research advisory boards at UC–Berkeley (Centers for the Built Environment) and Penn State University (Indoor Environment Center), and is an active member of the USGBC LEED® Technical Advisory Group for Indoor Environmental Quality (EQ TAG).