Credit(s) earned on completion of this course will be reported to American Institute of Architects (AIA) Continuing Education Session (CES) for AIA members.

Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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Course Description

Maintenance & Operations of Building Systems APPAU201909B
This session will present an overview of the basic principles in maintaining and operating the various systems in higher education facilities. The discussion will identify building systems and their components, operating characteristics, and general maintenance practices. This course is intended to provide a basic overview as a foundation for electives that will address more detailed, technical information related to specific facility systems.

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Learning Objectives

1. Learn to ensure effective implementation and control of operation activities
2. Learn to ensure efficient, safe, and reliable process operations
3. Learn to be cognizant of status of all equipment
4. Learn to ensure that operator knowledge and performance will support safe and reliable facilities operation

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APPA Facilities Management Institute

Goal

To provide background on maintenance and operating issues of building systems so that facilities management personnel can understand the advantages and limitations of these systems and their operating practices.

APPA Facilities Management Institute

Course Outline

- Introduction
- Building System Identification
- Building System Requirements
- Major Building Systems
- Operation and Maintenance Issues

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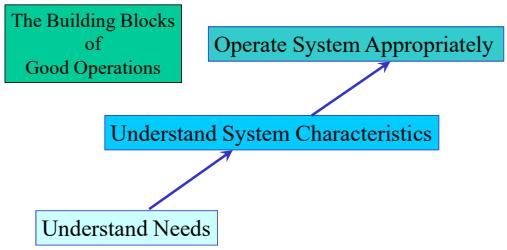

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Why are there systems in buildings?

- People_____
- Animals_____
- Research_____
- Equipment_____
- The building itself_____

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Building System List

- Mechanical:_____
- Electrical:_____
- Architectural:_____

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Mechanical System-Heating, Cooling, Ventilating

- Human Thermal Comfort
- Indoor Air Quality Control

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Six Variables of Human Thermal Comfort

1._____
2._____
3._____
4._____
5._____
6._____
7._____

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Human Thermal Comfort Relationships

Variable	Range	Relationship
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

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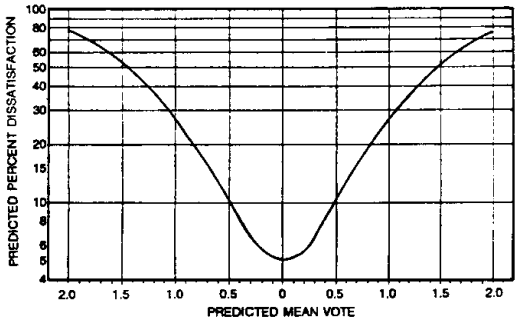

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ANSI/ASHRAE 55

ASHRAE
STANDARD

Thermal Environmental Conditions for Human Occupancy

The American Society of Heating, Refrigerating, and Air-conditioning Engineers, Inc.

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Typical Relative Humidity Levels

- Museums - 40% to 50%
- Libraries - 40% to 50%
- High Tech - 20% to 70%
- Laboratories - 30% to 70%
- Office - 30% to 40%

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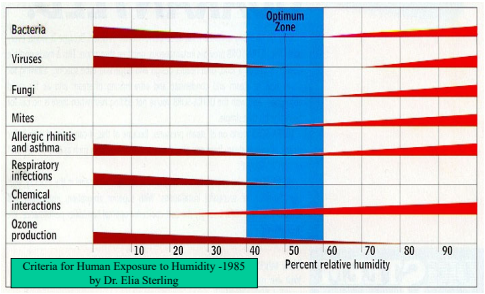

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INDOOR AIR QUALITY

Sick Building Syndrome (SBS)
Building Related Illness (BRI)

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Causes of SBS and BRI

- Toxic Gases
- Volatile Organic Compounds
- Biologicals
- Particulates
- Long-term Hazards
  - Asbestos
  - Radon

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Three Methods to Control Indoor Air Quality

1. _____

2. _____

3. _____

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Odor Threshold for Common Pollutants (mg/m^3)

- Ammonia - 33
- Carbon Dioxide - Infinite
- Carbon Monoxide - Infinite
- Formaldehyde - 1.2
- Hydrogen Sulfide - 0.007
- Ozone - 0.2
- Propane - 1800
- Sulfur Dioxide - 1.2

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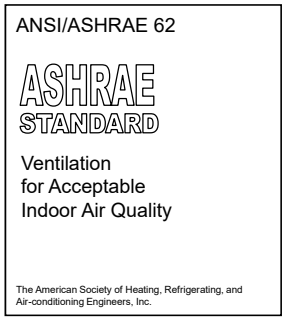

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Space Type	Ventilation Rate	
	CFM/SQFT	CFM/Per
• Offices	0.06	5
• Classrooms	0.06	7.5
• Conference	0.06	5
• Computer Lab	0.12	10
• Lobbies	0.06	7.5
• Bedroom	0.06	5
• Restaurant/Dining	0.18	7.5

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Heating, Cooling, Ventilating Design Issues

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

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Three Fundamental Types of Systems

1. _____
2. _____
3. _____

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Types of Control
- Two Position
- Floating
- Proportional
- Integral
- Derivative

Types of Control Power
- Electric
- Electronic
- Pneumatic
- Fluidic
- Hydraulic
- Microprocessor

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Energy Conservation Strategies
- Off-hour Setback
- Reset (Master/submaster)
  - Mixed Air Control
  - Drybulb Economizer
- True Economizer
- PID Control
- Adaptive Control

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Building Codes

- AIA - American Insurance Association
- ICBO – International Conference of Build. Officials
- BOCA - Building Officials and Code Administrators
- SBC - Standard Building Code

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Fire Codes

- NFPA - National Fire Protection Association
- UFC - Uniform Fire Code
- BOCA - Basic Fire Prevention Code
- Southern Standard Fire Prevention Code
- Fire Prevention Code by AIA

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Fire protection based on:

1. Building Classification
   - Non-combustible
   - Combustible
   - Building Elements
     - Exterior Wall
     - Primary Structural Frame
     - Floor Construction

AND…

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2. Occupancy Classification (NFPA 101)

Example Criteria

- Assembly - automatic sprinkler system
- Labs (Research) - automatic extinguishing
- Business - no specific requirements
- Residence Halls - no specific requirements

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NFPA 101

- ✓ Classrooms under 50 people - Business
- ✓ Classrooms over 50 people - Assembly
- ✓ Labs, instructional - Business
- ✓ Labs, research - Industrial

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Fire Detection Methods

1. _____
2. _____
3. _____
4. _____
5. _____

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Fire Extinguishing Systems

Automatic Sprinklers

- Wet Pipe
- Dry Pipe
- Deluge
- Fire Cycle

Chemical Systems

- HALON
- CO_2

Standpipe Systems - Dry & Wet

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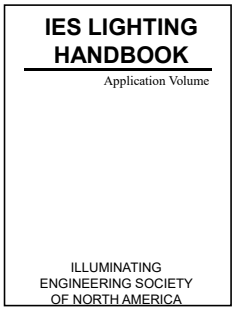

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Space Type	Footcandles
Office Space	20 - 50
Classrooms	50 - 100
Conference Rooms	20 - 50
Laboratories	50 - 100
Libraries	20 - 50
Lobbies	10 - 20
Dining Rooms	5 - 10
Outdoors	1 - 3

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Lamp Coloring

- Color of lamps is determined by temperature and is expressed in degrees kelvin, i.e. 3000^{o}K, 3500^{o}K, etc.
- An index has been created called the Color Rendering Index (CRI). It is arbitrarily based on an incandescent lamp having a CRI of 100.
- Typical office and classroom values are 3500^{o}K and a CRI of 70 to 75.

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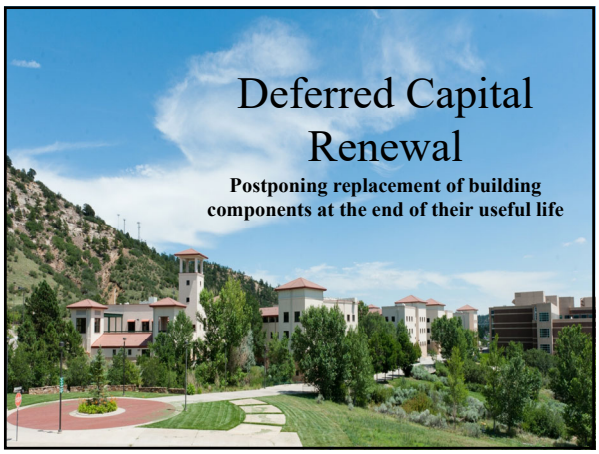
LAMP	Lumens/Watt	CRI	Life (hrs)
Incandescent	17-22	100	800
Mercury Vapor	42-57	Blue/White	4,000
Fluorescent	65-80	70	6,000
Metal Halide	75-85	65	15,000
HPS	85-125	21	25,000
LPS	125-140	0	25,000
Induction	130-190	85	100,000
LED	60	Varies	100,000


Deferred Maintenance
Routine maintenance and major repairs that are not done due to insufficient resources

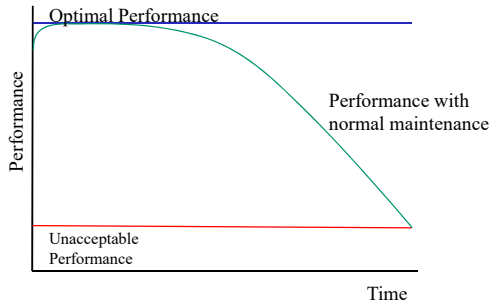

Capital Renewal
Funds that are provided to replace building components at the end of their useful life


Deferred Capital Renewal
Postponing replacement of building components at the end of their useful life

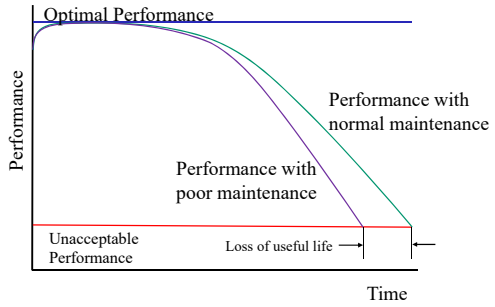
Capital Improvement

A change to a building component not driven by end of life or deferred maintenance

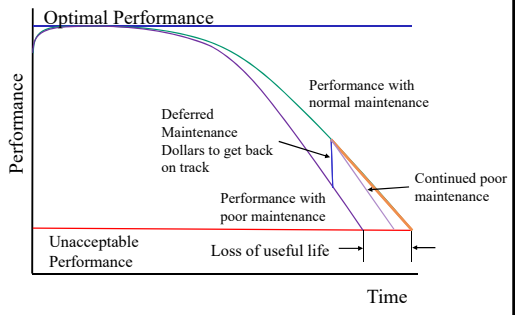
Building Performance - Normal



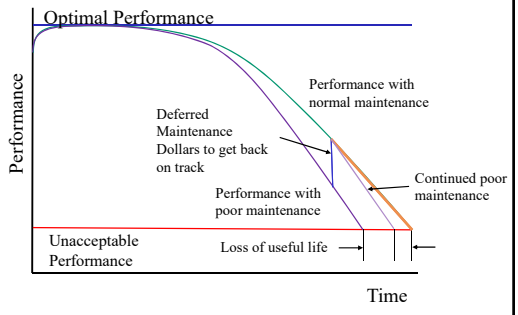
Building Performance – Poor Maintenance



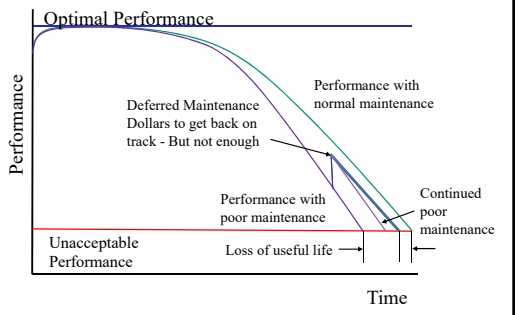
Building Performance – Deferred Maintenance



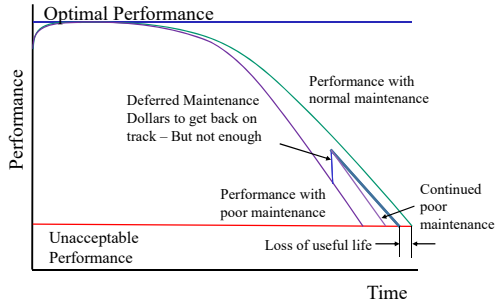
Building Performance – Deferred Maintenance



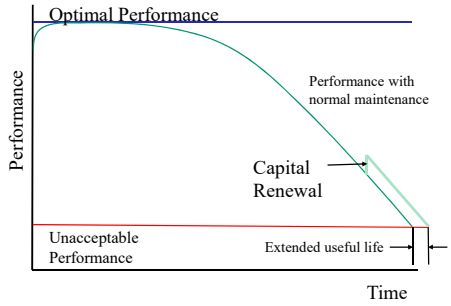
Building Performance – Some Deferred Maintenance



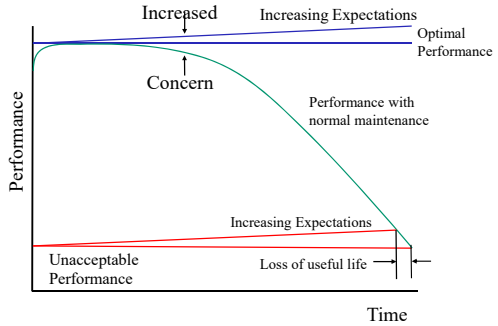
Building Performance – Some Deferred Maintenance



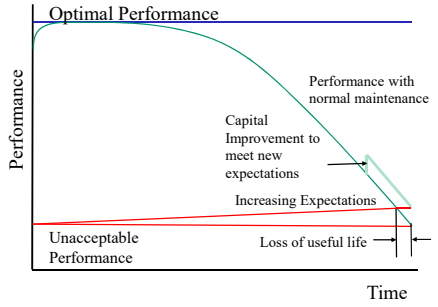
Building Performance – Capital Renewal



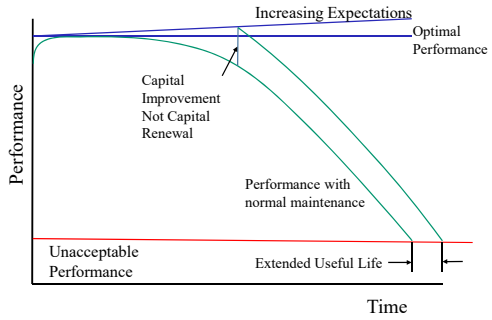
Building Performance – Changing Expectations



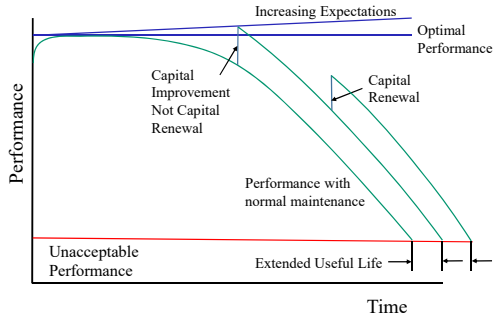
Building Performance – Capital Improvement



Building Performance – Capital Renewal & Improvements



Building Performance – Capital Improvement & Renewal



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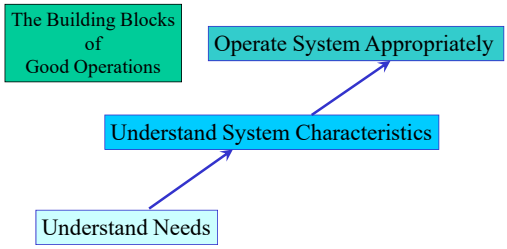

Takeaways

- _____
- _____
- _____
- _____
- _____
- _____
- _____

This concludes The American Institute of Architects Continuing Education Systems Course

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Thank you!

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