

## **Building Operations and Maintenance Training Program**

Learning Objectives and Content Outline

Cooling Season Training (Cooling Systems) – 2.5 Hours

### **Training Program Overview**

- Training Program Overview and Goals
  - Improve building operation and reduce environmental impacts
  - Provide new solutions, and the tools needed to perform O&M tasks better/more efficiently
  - Explain the function of various HVAC systems and set performance expectations

### **Training Module: Cooling Systems**

Upon completion of this training module, participants will be able to:

- Describe various types of cooling systems and their typical components
  - Cooling system types
    - Basic cooling system operation
    - Package units
    - Split systems
    - VRF/Mini-Split
    - Chillers
  - Central chiller plants
    - Air cooled chillers
    - Water cooled chillers
    - Electric chillers
    - Absorption chillers
    - Sequence of operation
  - Chiller components and settings
    - Safety devices
    - Major component overview
    - Water temperatures and setpoints
- Inspect general condition of the unit
  - Check for any unusual noise or vibration
  - Check for damage or signs of wear
- Inspect chilled water and condenser pumps for proper operation
  - Types of pumps and components
  - Record suction and discharge pressures
  - Check VFD for signs of proper operation
- Recognize signs of surging
  - What causes surging
  - How to correct surging
- Perform routine maintenance activities



- Check refrigerant pressures and temperatures
- Check for presence of non-condensables
- Check compressor oil level
- Inspect and clean pump strainers
- Check and replace seals on the chambers if needed
- Check for evidence of fouling on heat exchanger surfaces
  - Evaluate pump pressure readings
- Eddie current testing
- Tube cleaning
- Determine when O&M work can be performed or when outside help is needed

### **Training Module: Cooling Towers**

Upon completion of this training module, participants will be able to:

- Describe the operation of a cooling tower and its typical components
  - Cooling tower function
  - Component overview
  - Sequence of operation
- Overview of Local Law 77
  - Requirements of the law
  - Inspection cleaning and disinfection
- Inspect general condition of the unit
  - Check for any unusual noise or vibration
  - Check for damage or signs of wear
- Perform chemical testing of system water
  - Using a biological process control indicator (dip slide)
  - Interpreting Heterotrophic plate count (HPC) count results
  - Check for foaming
  - Reporting and recordkeeping
- Identify signs of build-up or fouling on heat exchanger surfaces
  - Inspect for even water flow over the fill and clean nozzles if needed
  - Check for dirt/debris in basin
  - Drain, clean, and flush the basin as needed
  - Clean strainers
  - Blowdown the basin as needed
  - Inspect the float valve for proper operation
  - Check basin heater for proper operation
  - Inspect for leaks
- Inspect cooling tower fans for proper operation
  - Check fan blades and fan housing
  - Inspect air inlet louvers
  - Check fan belt tension, signs of belt wear



- Check sheaves for signs of misalignment or evidence of wear
- Check VFD for signs of proper operation
  - Record min speed for fans with gear boxes
- Inspect cooling tower pumps for proper operation
  - Recognize signs of cavitation
    - Record net positive suction pressure
    - Ensure proper water level at basin
  - Check VFD for signs of proper operation
    - Check triple duty valve position

### **Training Module: Air Distribution Systems**

Upon completion of this training module, participants will be able to:

- Describe the operation of common air handling units and their typical components
  - Air handler function
  - Component overview
  - Sequence of operation
- Inspect general condition of the unit
  - Check for any unusual noise or vibration
  - Check for damage or signs of wear
    - Torn flex connectors, doors closing fully
- Inspect coils and drain pan
  - Inspect and clean coils if needed, straighten fins
  - Check for signs of leaks
  - Check pan signs of standing water, proper pitch
  - Inspect and clean P-trap and condensate drain
- Inspect fans for proper operation
  - Replace air filters
  - Inspect and clean fan blades and fan housing
  - Check fan belt tension, signs of belt wear
  - Check sheaves for signs of misalignment or evidence of wear
  - Check VFD for signs of proper operation
- Inspect dampers for proper operation
  - Identify stuck or leaky dampers
- VAV Boxes
  - Troubleshoot VAV box for proper operation
    - Damper, actuator function
  - Replace/repair VAV box if needed

## **Building Operations and Maintenance Training Program**

Learning Objectives and Content Outline

Heating Season Training (Hydronic) – 4 Hours

### **Training Program Overview**

- Training Program Overview and Goals
  - Improve building operation and reduce environmental impacts
  - Provide new solutions, and the tools needed to perform O&M tasks better/more efficiently
  - Explain the function of various HVAC systems and set performance expectations

### **Training Module: Hydronic Boilers (2 Hours)**

Upon completion of this training module, participants will be able to:

- Describe various types of hydronic boilers and their typical components
  - Boiler types and construction
    - Atmospheric, induced draft, sealed combustion
  - Near boiler piping and components
    - Safety components
    - Temperature/pressure gauge
    - Feedwater system
    - Expansion capacity
    - Air/Dirt elimination
    - Piping configurations
- Explain burner modulation function and determine proper control setpoints
  - Types of Burners
    - On/Off
    - Multi-Stage
    - Modulating
  - Controls
    - Aquastat operation and function
    - Outdoor reset control
    - Determining the appropriate reset range
  - Verifying Sequence of operation
- Perform routine maintenance activities
  - Daily, weekly, monthly, and annual maintenance activities (cleaning, lubricating, monitoring, etc.)
  - Determine when O&M work can be performed or when outside help is needed

### **Training Module: Circulation in Hydronic Systems (2 Hours)**

Upon completion of this training module, participants will be able to:

- Describe various types of hydronic circulators and their typical components
  - Types of Circulators
    - In-line, end-suction
    - Single speed, variable speed (VFD)
    - Installation considerations
  - Circulator function
    - Pressure, flow relationship
    - Static vs. dynamic pressure
    - Determining flowrate
- Recognize proper circulator operation
  - Pump sequencing
  - Cavitation
    - Causes and solutions
  - Over-Pumping
    - Triple duty valve settings
    - VFD operation
    - Differential pressure bypass
- Identify types of hydronic heating terminal units and their components
  - Package Terminal Air Conditioners (PTAC)
  - Baseboard Convectors
  - Air Handlers
  - Need for Proper Airflow
- Understand the control components of terminal units
  - Control valves
  - Thermostats and temperature sensors
  - Outside air dampers
- Recognize failed terminal units
  - Troubleshooting procedures
- Perform routine maintenance activities
  - Daily, weekly, monthly, and annual maintenance activities (cleaning, lubricating, monitoring, etc.)
  - Determine when O&M work can be performed or when outside help is needed

## **Building Operations and Maintenance Training Program**

### Learning Objectives and Content Outline

#### Non-Heating Season Training

### Training Program Overview

- Training Program Overview and Goals
  - Improve building operation and reduce environmental impacts
  - Provide new solutions, and the tools needed to perform O&M tasks better/more efficiently
  - Explain the function of various HVAC systems and set performance expectations

### Training Module: Common Systems (2 Hours)

#### Lighting

Upon completion of this training module, participants will be able to:

- Recognize energy efficient lighting technology
  - Lighting Technologies
    - Common interior lighting
      - Incandescent
      - Fluorescent
      - LED
    - LED lamps and fixtures
      - LED equivalences
      - Retrofit options
    - Exterior lighting
      - High intensity discharge
      - LED
      - Retrofit options
  - Lighting Controls
    - Control types
      - Timers/clocks
      - Daylight sensors/photocells
      - Occupancy sensors
    - Sensor mounting location
    - Dimming controls
      - Stairwells, hallways, garages
      - Adjusting bi-level lighting
- Conduct maintenance and perform tests on lighting controls for proper operation
  - Lighting Maintenance



- Maintenance items
  - Cleaning fixtures
  - Replacing lamps
  - Testing controls
  - Testing emergency fixtures

## **Ventilation**

- Upon completion of this training module, participants will be able to:
  - Identify types of ventilation equipment and systems
    - Ventilation System Function and Requirements
      - Improve IAQ
      - Replace stale air
      - Remove moisture
      - Remove odors
      - Air movement
      - Ventilation Rates
    - Ventilation System Types
      - Natural ventilation
      - Rooftop exhaust
      - Supply ventilation
      - Unitized ventilation
  - Explain occupant & building issues resulting from poor ventilation
    - Ventilation Issues and Solutions
      - Balancing airflow
      - Heat recovery
      - Ventilation controls
  - Perform ventilation system maintenance
    - Ventilation Maintenance
      - Fan maintenance
      - Register maintenance
      - Ductwork cleaning

## **Enclosure**

- Upon completion of this training module, participants will be able to:
  - Identify the highest priority areas to air seal
    - Stack effect
    - Air sealing priority areas
      - Top and bottom of the building
      - Vertical shafts
      - Exterior walls, windows, and openings



- Compartmentalization
- Selected and apply the correct materials for various air sealing applications
  - Air sealing materials overview
    - Rigid materials
    - Caulks, foams, and sealants
  - Air sealing activity
    - Selecting the correct materials

### **Training Module: Domestic Hot Water (2 Hours)**

- Upon completion of this training module, participants will be able to:
  - Recognize components and proper operation of potable water supply and distribution equipment
    - Potable water system
    - Building height and water pressure requirements
      - Calculating the correct water pressure
    - Booster pumps
      - Operation and maintenance
      - Variable Frequency Drives
  - Recognize components and proper operation of domestic hot water systems
    - Domestic Hot Water Safety
      - Safe water temperatures
        - Scalding
        - Legionella
      - Mixing Valves
        - Mechanical
        - Electronic
    - Standalone Domestic Water Heaters
      - Types and components
      - Applications
      - Sequence of operation
    - Tankless Coil
      - Components
      - Applications
      - Sequence of operation
    - Indirect Water Heaters
      - Components
      - Applications
      - Sequence of operation
    - Plate and Frame
      - Components
      - Applications





- Sequence of operation
- DHW Recirculation
  - Components
  - Controls
  - Insulation
  - Maintenance
- Diagnose problems with domestic hot water production and delivery
  - DHW system troubleshooting
  - Mixing valve troubleshooting
  - Crossover troubleshooting
- Identify water leaks and opportunities for water conservation
  - Water Conservation
    - Low flow devices
    - Leaks identification/Monitoring
  - Repairing Leaks
    - Toilets
    - Showers
    - Faucets
    - Irrigation

## **Building Operations and Maintenance Training Program**

Learning Objectives and Content Outline

Heating Season Training (Steam) – 4 Hours

### **Training Program Overview**

- Training Program Overview and Goals
  - Improve building operation and reduce environmental impacts
  - Provide new solutions, and the tools needed to perform O&M tasks better/more efficiently
  - Explain the function of various HVAC systems and set performance expectations

### **Training Module: Steam Boilers (2 Hours)**

Upon completion of this training module, participants will be able to:

- Describe various types of steam boilers and their typical components
  - Boiler construction
    - Fire tube, cast iron
  - Boiler components
    - Safety valves
    - Steam pressure gauge
    - Gauge glass
    - Blowdown valves
    - Feedwater system
  - Pressure Control Function
    - High limit
    - Operating
    - Modulation
  - Pressure Control Settings
    - Main setting and differential
    - Operating range
    - Modulation range
- Explain burner modulation function and determine proper pressure control setpoints
  - Types of Burners
    - On/Off
    - Multi-Stage
    - Modulating
  - Fire-Rate Modulation Control
    - Modulation selector
    - Modulation motor and linkage arms
    - Setting the proper modulation range
  - Verifying Sequence of operation
- Recognize wet steam issues and describe possible solutions



- Wet vs dry steam
- Typical distribution issues due to wet steam
- Priming and Carryover
  - Steam exit velocity
  - High water line
  - Foaming
- Solutions
  - High fire limit
  - Cleaning and skimming
  - Eliminating/reducing chemical treatment
  - Header redesign
- Identify issues resulting in boiler water loss
  - Calculating the appropriate amount of water loss
  - Identifying and repairing leaking air vents and buried condensate return lines
- Perform routine maintenance activities
  - Daily, weekly, monthly, and annual maintenance activities (cleaning, lubricating, monitoring, etc.)
  - Determine when O&M work can be performed or when outside help is needed

### **Training Module: Steam Distribution Systems (2 Hours)**

Upon completion of this training module, participants will be able to:

- Describe the operation of a steam distribution system
  - Properties of steam
  - Steam heating cycle
  - Distribution system components
- Recognize the signs of heating imbalance
  - Steam and airflow
- Determine the appropriate location and types of air vents (1PS)
  - Types of air vents and capacities
  - Identify air vent locations and determining the quantity of air vents
  - Proper air vent installation
- Diagnose and repair issues caused by steam in returns (2PS)
  - Steam trap types, function, and maintenance requirements
  - Diagnosing failed steam traps
  - Supply side orifice plates
    - Operation and installation considerations
- Identify the causes of water hammer
  - Steam and condensate flow
  - What to look for if water hammer takes place at:
    - Beginning of the cycle
    - Mid-Cycle



- End of the cycle
- Describe the proper use of thermostatic radiator valves (TRV)
  - TRV components and operation
  - Determining the correct location
  - Installation considerations
- Perform routine maintenance activities
  - Daily, weekly, monthly, and annual maintenance activities (cleaning, lubricating, monitoring, etc.)
  - Determine when O&M work can be performed or when outside help is needed