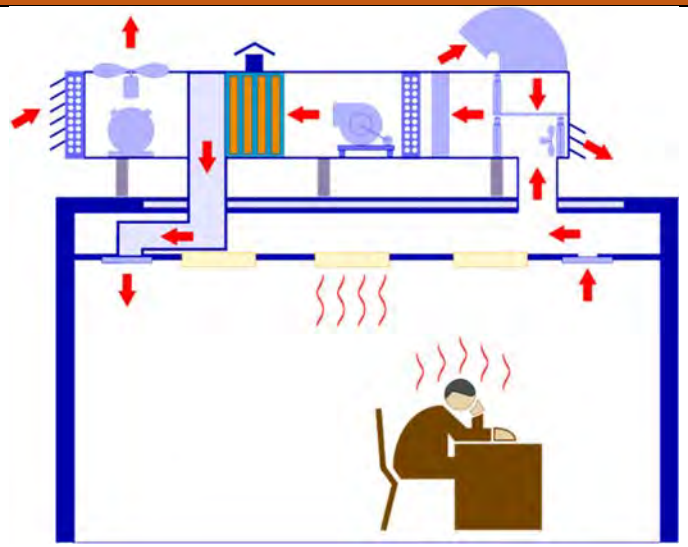
Decoding 2016 HVAC™

Let's Talk Mechanical Acceptance Testing

Mechanical Acceptance Testing

Simple Mechanical Systems



Packaged Unitary Equipment Pictured

1) Unitary or packaged equipment that each serve one zone; OR

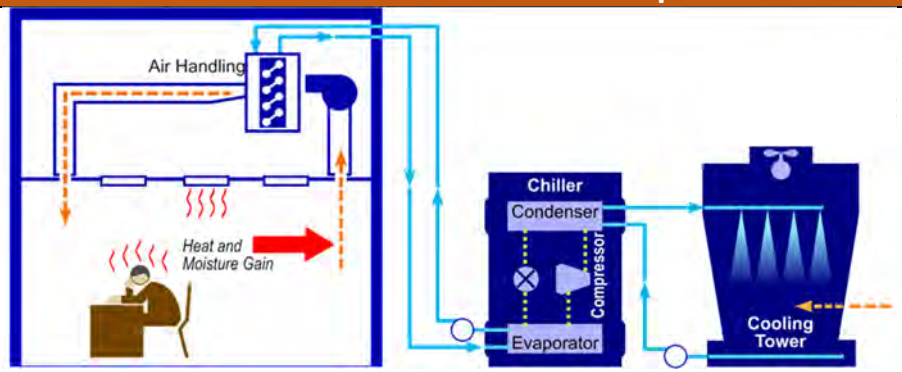
2) Two-pipe, heating only systems serving one or more zones.

Example of System Types

- Package Terminal Air Conditioner (PTAC)
- Split and Packaged Dx
- Forced Air Furnace (FAU)
- Gas Space Heater
- 2-Pipe Heating Only
- Radiant Heat Only

System Features Include:	Code §
Thermostats	§120.2(a)(b)
Ventilation	§120.1(c)
Demand Control Ventilation (DCV)	§120.1(c)
Heat Pump Controls	§120.2(d)
Shutoff and Reset Controls	§120.2(e)
Ventilation Dampers	§120.2(f)
Isolation Devices	§120.2(g)
Demand Shedding Controls	§120.2(h)
Economizer including FDD	§120.2(f)/ §140.4(e)
Zonal Controls	§140.4(d)
Variable Flow Controls	§140.4(k)(m)
Duct Systems	§140.4(l)

Complex Mechanical Systems



Built Up 4 Pipe Fan Coil Pictured

1) Fan systems each serving multiple thermostatically controlled zones; OR

2) Built-up air handler systems (non-unitary or non-packaged HVAC equipment); OR

3) Hydronic or steam heating systems; OR

4) Hydronic cooling systems.

Example of System Types

- Built-Up 4 pipe Fan Coil
- Built-Up VAV
- Built-Up Air Handling Systems
- Variable Refrigerant Flow (VRF)
- Zone Terminal Units/Fan Coils
- Hydronic Heating and Cooling

System Features Include:	Code §
Thermostats	§120.2(a)(b)
Ventilation	§120.1(c)
Demand Control Ventilation (DCV)	§120.1(c)
Shutoff and Reset Controls	§120.2(e)
Ventilation Dampers	§120.2(f)
Isolation Devices	§120.2(g)
Demand Shedding Controls	§120.2(h)
Direct Digital Controls (DDC)	§120.2(j)
Optimum Stop/Start (DDC)	§120.2(k)
Zonal Controls	§140.4(d)
Supply Temperature Reset Controls	§140.4(f)(k)
Economizer	§140.4(e)
Variable Flow Controls	§140.4(k)(m)
Isolation Valves	§140.4(k)
Ice Storage Dx (DES/DXAC) Systems	N/A
Thermal Energy Storage (TES)	§110.2

NRCA-MCH-02-A: **Outdoor Air:** Variable Air Volume Systems

Performed in conjunction with:	**Complex HVAC System**	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-07-A *Related to:* NRCA-MCH-05-A; NRCA-MCH-06-A; NRCA-MCH-07-A	 ☒ *TAB Technician* ☐ *BAS Technician* ☐ *HERS Rater*	§10-03(b)4 §120.1(b)2 §120.5(a)1	NA7.5.1.1 NA7.5.1.2	Chapter 13.4 Chapter 13.5

Purpose of the Test

This test ensures the provision of adequate outdoor air ventilation through the variable air volume air handling unit at two representative operating conditions. The test consists of measuring outdoor air values at maximum flow and at or near minimum flow. The test verifies the introduction of a minimum volume of outdoor air, in accordance with §120.1(b)2, into the air handling unit and is within 10 percent of the required volume when the system is in occupied mode at these two conditions of supply airflow. Perform this test in conjunction with NA7.5.6 (NRCA-MCH-07-A) Supply Fan Variable Flow Controls Acceptance test procedures to reduce the overall system testing time as both tests use the same two conditions of airflow for their measurements. Related acceptance tests for these systems include:

- NA7.5.4 Air Economizer Controls.
- NA7.5.5 Demand Control Ventilation (DCV) Systems (if applicable).
- NA7.5.6 Supply Fan Variable Flow Controls

Instrumentation

Performance of this test will require measuring outdoor air flow. When the system includes an airflow monitoring system (AFMS) on the outdoor air, then it may be used for the measurements if it has a calibration certificate or is field-calibrated. The instrumentation needed to perform the task may include, but is not limited to. An airflow measurement probe (for example, hot-wire anemometer or velocity pressure probe), or a watch or some equivalent device to measure time in minutes.

Test Conditions

- **The test needs an override of the normal control operations. The control system of the air handling unit and zone controls must be complete, including:**
  - Supply fan capacity control (typically a variable speed drive).
  - Air economizer control.
  - Minimum outdoor air damper control.
  - Zone airflow control (including zone thermostats and VAV boxes).
- **Installed systems shall be ready for system operation, including:**
  - Duct work
  - VAV boxes.
  - Control sensors (temperature, flow, pressure, and so forth).
  - Electrical power to air handling unit and control system components.
- **Completion of air handling unit start-up procedures, per manufacturer's recommendations. Document the initial conditions before executing system overrides or manipulation of the set points and schedules.**
- **At the end of the test, return all systems to normal. Reference NRCC-MCH-03-E or the mechanical equipment schedules to determine the total required outdoor airflow for the system.**

Estimated Time to Complete

- Construction inspection: 0.5 hours to 2 hours, depending on complexity and difficulty in calibrating the “system” controlling outdoor air flow.
- Functional testing: 1 to 3 hours, depending on the type of zone control and the number of zones.

Acceptance Criteria

Field- or factory-calibrated sensor controlling outdoor air flow with documentation attached. Measured outdoor airflow reading is within 10 percent of the total value found on the Energy Standards Mechanical Plan Check document NRCC-MCH-03-E, under the following conditions:

- Minimum system airflow or 30 percent of total design flow
- Design supply airflow

Potential Issues and Cautions

- Use caution when performing test during winter months in cold climates. Since outdoor airflow must remain constant as supply fan flow is reduced, total supply flow can approach 100 percent outdoor air. Be sure that all freeze protection and heating coil controls are functioning before performing test.
- Coordinate test procedures with the controls contractor who may assist with manipulation of the BAS to achieve the desired operating conditions.
- Ensure disabling of economizer and demand controlled ventilation controls before performing the test.

NRCA-MCH-02-A: Constant Volume Outdoor Air (new CAV systems)

Related to:	Simple HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-03-A; NRCA-MCH-05-A; NRCA-MCH-06-A	 ☒ *TAB Technician* ☐ *BAS Technician* ☐ *HERS Rater*	§10-03(b)4 §120.1(b)2 §120.5(a)1	NA7.5.1.1 NA7.5.1.2	Chapter 13.4 Chapter 13.5

Purpose of the Test

This test ensures the constant volume air handling unit provides adequate outdoor air ventilation to the spaces served under all operating conditions.

Systems requiring demand ventilation controls per §120.1(c)3 must conform to §120.1(c)4E regarding the minimum ventilation rate when the system is in occupied mode. Related acceptance tests for these systems include the following:

- NA7.5.2 Constant-Volume, Single-Zone, Unitary Air Conditioners and Heat Pump Systems
- NA7.5.4 Air Economizer Controls (if applicable)
- NA7.5.5 Demand-Controlled Ventilation Systems Acceptance (if applicable)

Instrumentation

Performance of this test will require measuring outdoor air flow. If the system was installed with an airflow monitoring station (AFMS) on the outdoor air, then it can be used for the measurements if it has a calibration certificate or is field-calibrated. The instrumentation needed to perform the task may include, but is not limited to:

- A means to measure airflow (typically either a velocity pressure probe or hot wire anemometer).
- A watch or some equivalent instrument to measure time in minutes

Test Conditions

- To perform the test, override the control system of the air handling unit. The control system of the air handling unit must be complete.
- All systems must be installed and ready for system operation, including:
  - Air economizer controls.
  - Duct work.
  - Control sensors (temperature, flow, thermostats, and so forth).
  - Electrical power to air handling unit and control system components.
  - Completion of air handling unit start-up procedures, per manufacturer's recommendations.
  - Documentation of the initial conditions before overrides or manipulation of the set points and schedules. All systems must be returned to normal at the end of the test.

Note: Systems requiring demand ventilation controls per §120.1(c)3 must conform to §120.1(c)4E regarding the minimum ventilation rate (refer to NA7.5.5 Demand Controlled Ventilation Systems Acceptance Test).

Estimated Time to Complete

- Construction inspection: 0.5 hours.
- Functional testing: 1 hour (depending on difficulty in measuring outdoor air flow)

Acceptance Criteria
• System demonstrates a means of maintaining the minimum outdoor air damper position. • Minimum damper position is marked on the outdoor air damper • Measured outdoor air flow is within 10 percent of the total value found on the Energy Standards mechanical plan check document NRCC-MCH-03-E Column M.
Potential Issues and Cautions
Do not attempt to set the minimum damper position and perform the acceptance test at the same time. The acceptance test verifies the outdoor airflow of the system after calibration and system set-up is complete. Testing costs can be reduced by conducting the acceptance test immediately after set-up is concluded.

NRCA-MCH-03-A: Constant Volume, Single-Zone, Unitary AC & Heat Pumps Systems

Related to:	**Simple** HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-02-A; NRCA-MCH-05-A; NRCA-MCH-06-A	 ☒ ***TAB Technician*** ☐ ***BAS Technician*** ☐ ***HERS Rater***	§120.1(c)2 §120.2 §120.5(a)2	NA7.5.2	Chapter 13.6

Purpose of the Test

This test verifies the components of a constant volume, single-zone, unitary air conditioner and heat pump system function correctly, including: thermostat installation and programming, supply fan, heating, cooling, and damper operation.

Testing of the economizer, outdoor air ventilation, and demand-controlled ventilation are located in the following sections of the Reference Appendices.

- NA7.5.1.2 Constant Volume System Outdoor Air Acceptance
- NA7.5.4 Air Economizer Controls (if applicable)
- NA7.5.5 Demand Control Ventilation (DCV) Systems (if applicable)

Instrumentation

Temperature meter, amp meter

Test Conditions

- Unit and thermostat installation and programming must be complete.
- HVAC system must be installed and ready for system operation, including completion of all start-up procedures, per manufacturer's recommendations.
- Document the initial conditions before overrides or manipulation of the setpoints and schedules. All systems must be returned to normal at the end of the test.

Estimated Time to Complete

- Construction inspection: 0.5 to 1 hour (depending on familiarity with thermostat programming)
- Equipment test: 1 to 2 hours

Acceptance Criteria

The following are verified through inspection:

- Thermostat is located within the space conditioning zone that is served by the respective HVAC system.
- Thermostat meets the temperature adjustment and dead band requirements of §120.2(b).
- Occupied, unoccupied, and holiday schedules have been programmed per the schedule of the facility.
- Preoccupancy purge has been programmed to meet the requirements of §120.1(c)2.

The following modes of operation function correctly:

- Occupied heating mode operation: The supply fan operates continuously, all heating stages operate, cooling is not enabled, and the outdoor air damper is at minimum position.
- Occupied operation with no heating or cooling load: The supply fan operates continuously, heating or cooling is not enabled, and the outdoor air damper is at minimum position.

- Occupied cooling mode operation: The supply fan operates continuously, all cooling stages operate, heating is not enabled, and outside damper is at minimum position.
- Unoccupied operation with no heating or cooling load: The supply fan shuts off, heating or cooling is not enabled, and the outdoor air damper is closed.
- Unoccupied operation with heating load: The supply cycles ON, heating is enabled, cooling is not enabled, and the outdoor air damper is either closed or at minimum position.
- Unoccupied cooling mode operation: The supply cycles ON, cooling is enabled, heating is not enabled, and the outdoor air damper is at minimum position.
- Manual override mode: System reverts to occupied mode, the supply fan turns ON for duration of override, heating or cooling is enabled as necessary, and the outdoor air damper opens to minimum position.

Potential Issues and Cautions

- Ensure that the supply fan runs continuously in occupied mode and cycles appropriately in unoccupied mode. Cycling refers to the supply fan running only when heating or cooling is enabled. When testing the manual override, adjust the length of the override period to minimize test time. Be sure to reset the override period back to the correct length of time.
    - Tip: Overall test time may be reduced (especially for rooftop HVAC units controlled by thermostats) if two people perform the test – one to manipulate the thermostat while someone else verifies operation at the packaged unit.
- The Energy Standards do not mandate the actual differential between occupied and unoccupied setpoints, only that the system must be adjustable down to 55°F for heating and up to 85°F for cooling and that the thermostat can be set for a 5°F dead band. Setback control is only required for climates where the winter median of extremes is less than or equal to 32°F.
- Setup control is only required for climates where the 0.5% summer design dry-bulb temperature is greater than or equal to 100°F.

NRCA-MCH-04-A: Air Distribution Systems

Related to:	**Simple** HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCV-MCH-04-H	 ☐ *TAB Technician* ☐ *BAS Technician* ☒ *HERS Rater*	§120.4(a) §120.5(a)3 §140.4(l) §141.0(b)2D	NA7.5.3	Chapter 13.7

Purpose of the Test

This test verifies all duct work associated with all nonexempt constant volume, single-zone, HVAC units (in other words, air conditioners, heat pumps, and furnaces) meet the material, installation, and insulation R-values per §120.4(a) and leakage requirements outlined either in §140.4(l) for new duct systems or §141.0(b)2D for existing duct systems.

As detailed in the Energy Standards, this test is required only for single-zone units serving less than 5,000 ft² of floor area where 25 percent or more of the duct surface area is in one of the following spaces:

- Outdoors.
- In a space directly under a roof where the U-factor of the roof is greater than the U-factor of the ceiling.
- In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces.
- In an unconditioned crawlspace.
- In other unconditioned spaces.

Within these criteria, this test applies to both new duct systems and existing duct systems that are either being extended per §141.0(b)2D or the space conditioning system is altered by the installation or replacement of space conditioning equipment per §141.0(b)2E, including replacement of the air handler, outdoor condensing unit of a split-system air conditioner or heat pump, cooling or heating coil, or the furnace heat exchanger. Existing duct systems do not have to be tested if they are insulated or sealed with asbestos.

Instrumentation

Performance of this test will require measuring duct leakage. Equipment used:

- Fan flowmeter (a fan with a calibrated orifice used to pressurize the ducts) accuracy within 3 percent of measured flow. To view a list of the current certified equipment go to: http://www.energy.ca.gov/title24/equipment_cert/ama_fas/index.html
- Digital manometer (pressure meter) accuracy within 0.2 pascals.

Duct leakage tests must be verified by a third-party HERS Rater who has been certified by a HERS Provider that has been approved by the California Energy Commission.

Test Conditions

- For newly constructed buildings, all ductwork must be accessible for visual inspection before ceiling installation.
- All ductwork and grilles should be in place before performing the fan flow test to ensure the system depicts normal operating configuration. Hence, testing must occur after visual inspection and installation of the diffusers.
- HVAC system must be installed and ready for system operation, including completion of all start-up procedures, per manufacturer's recommendations.

Estimated Time to Complete

- Construction Inspection: 0.5 to 2 hours, depending on duct access for visual inspections and availability of construction material documentation (that is, cut sheets and so forth)

- Equipment Test: 3 to 6 hours, depending on how long it takes to seal all supply diffusers and return grills.

Acceptance Criteria

- Flexible ducts are not compressed or constricted in any way.
- Duct connections meet the requirements of §120.4 (new ducts only).
- Joints and seams are properly sealed according to requirements of §120.4 (new ducts only).
- Duct R-values meet the minimum requirements of §120.4(a) (new ducts only).
- Insulation is protected from damage and suitable for outdoor usage per §120.4(f) (new ducts only).
- The leakage fraction for new HVAC ducts does not exceed 6 percent per §140.4(l), where the leakage fraction is calculated by dividing total measured leakage flow rate by the total fan system flow rate.
- The leakage fraction for existing HVAC ducts does not exceed either 15 percent or overall system leakage is reduced by a 60 percent per §141.0(b)2D. The leakage fraction is calculated by either dividing total measured leakage flow rate by the total fan system flow rate or by comparing “pre-modification” and “post-modification” measured system leakage values.
- Obtain HERS Rater field verification as described in Reference Nonresidential Appendix NA1.

Potential Issues and Cautions

- If this test is to be applied to existing duct systems that are having alterations made to the ducts or the HVAC equipment attached to the ducts, test the system leakage before making the alterations.
- Ensure all the supply and return diffusers/grills are sealed tightly, all access panels are in place, and duct ends are sealed tightly before leakage testing.
- After the test, remember to remove all blockages from the supply and return ducts (that is, where the supply and return ducts at the HVAC unit were blanked off). Seal any holes drilled in the supply and return ducts for the static pressure probes.
- Since a certified California HERS Rater must also verify duct leakage performance, it may be prudent to coordinate this test with the HERS Rater so that the HERS Rater can witness/verify the test simultaneously.

NRCA-MCH-05-A : Air Economizer Controls

Related to:	Simple and Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-02-A; NRCA-MCH-03-A; NRCA-MCH-05-A; NRCA-MCH-06-A	 ☐ *TAB Technician* ☒ *BAS Technician (economizer control)* ☐ *HERS Rater*	§120.5(a)4 §140.4(e)	NA7.5.4	Chapter 13.8
		If the economizer is factory installed and certified, a valid factory certificate is required to document acceptance testing exception.		

Purpose of the Test

Functionally Testing an air economizer cycle verifies that an HVAC system uses outdoor air to satisfy space-cooling loads. There are two types of economizer controls: stand-alone packages and DDC controls. The stand-alone packages are commonly associated with small unitary rooftop HVAC equipment. DDC controls are typically associated with built-up or large packaged air handling systems.
Cooling fan systems > 54,000 Btu/hr must have an economizer. Air economizers must be able to provide 100 percent of the design supply air with outside air; water economizers must be able to provide 100 percent of the design cooling load at 50°F dry-bulb and 45°F wet-bulb.
The in-field economizer functional tests do not have to be conducted for units that are factory-installed and certified operational by the manufacturer to the Energy Commission's economizer quality control requirements. A copy of the manufacturer's certificate must be attached to the NRCA-MCH-05-A. Regardless of whether the economizer is field- or factory-installed, complete the construction inspection, including the compliance with high temperature lockout temperature setpoints.

Instrumentation

Instrumentation to perform the test includes:

- Hand-held temperature probe (must be calibrated within the past year).
- Device capable of calculating enthalpy (must be calibrated within the past year)
- 1.2 kOhm resistor (when specified by the manufacturer).
- 620 Ohm resistor (when specified by the manufacturer).

Test Conditions

- Equipment installation is complete (including HVAC unit, duct work, sensors, control system, thermostats).
- Non-DDC DX systems are required to have a two-stage thermostat.
- The HVAC system must be ready for system operation, including completion of all start-up procedures per manufacturer's recommendations.
- For those units having DDC controls, it may be necessary to use the building automation system (BAS) to override or temporarily modify the variable(s) to achieve the desired control. BAS programming for the economizer, cooling valve control, and related safeties must be complete.
- For built-up systems all interlocks and safeties must be operable – for example, freeze protection, limit switches, static pressure cut-out, and so on.
- Document the initial conditions before overrides or manipulation of the settings. All systems must be returned to normal at the end of the test.
- Before conducting the test, demand control ventilation systems must be disabled, if applicable.

Estimated Time to Complete

- Construction Inspection: 0.5 to 1 hours (depending on familiarity with the controls)
- Functional Testing: 0.5 to 2 hours (depending on familiarity with the controls and issues that arise during testing)

Acceptance Criteria

- If the economizer is factory installed and certified, a valid factory certificate is required for acceptance. No additional equipment tests are necessary.
- Air economizer lockout setpoint complies with Energy Standards Table 140.4-B per §140.4(e)3. This table is reproduced in Table 13-6 located below.
- Outside sensor location accurately reads true outdoor air temperature and is not affected by exhaust air or other heat sources.
- All sensors are located appropriately to achieve the desired control.
- During economizer mode, the outdoor air damper modulates open to a maximum position, and the return air damper modulates 100 percent closed.
- The outdoor air damper is 100 percent open before mechanical cooling is enabled and remains at 100 percent open while mechanical cooling is enabled (economizer integration when used for compliance with §140.4(e)2B). The economizer is capable of providing partial cooling even when additional mechanical cooling is required to meet the load. For unit controls, the outdoor air damper may not begin to close until the leaving air temperature is below 45°F.
- When the economizer is disabled, the outdoor air damper closes to a minimum position, the return damper modulates 100 percent open, and mechanical cooling remains enabled.
- If the unit has heating capability, the outdoor air damper remains at minimum position when heating is enabled. When the unit is turned off or otherwise disabled, the outdoor air damper closes.

Potential Issues and Cautions

- If conditions are below freezing when test is performed, coil(s) may freeze when operating at 100 percent outdoor air.
- Outdoor air and relief dampers should be closed when the system is in unoccupied and warm-up modes, preventing problems with unconditioned air entering the building during unoccupied hours.
- If the damper interlocks fail and the outdoor air damper does not open before the return damper closes, damage to the air handling unit or associated duct work may occur.
- Air economizers with poor mixing can have excessively stratified air streams that can cause comfort problems or freeze stat trips. Mixing problems are more likely to occur as the VAV system reduces flow, leading to reduced velocities in the mixing box and through the dampers.
- Check for exterior doors standing open and other signs of building over pressurization when all units are on full economizer cooling (100 percent OSA).

NRCA-MCH-06-A: Demand Control Ventilation (DCV) Systems

Related to:	**Simple** and **Complex** HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-02-A; NRCA-MCH-03-A; NRCA-MCH-05-A	 ☐ ***TAB Technician*** ☒ ***BAS Technician*** ☐ ***HERS Rater***	§120.1(c)3 §120.1(c)4 §120.5(a)5	NA7.5.5	Chapter 13.8
		Two people would be beneficial to this documentation of this test.		

Purpose of the Test

The purpose of the test is to verify that systems required to employ demand controlled ventilation (refer to §120.1(c)3) can vary outside ventilation flow rates based on maintaining interior carbon dioxide (CO_2) concentration setpoints. Demand Controlled ventilation refers to an HVAC system's ability to reduce outdoor air ventilation flow below design values when the space served is at less than design occupancy.CO_2 is a good indicator of occupancy load and is the basis used for modulating ventilation flow rates.

Instrumentation

To perform the test, it may be necessary to vary and possibly measure (if calibration is necessary) ambient CO_2 levels. The instrumentation needed to perform the task may include, but is not limited to:

- Hand-held reference CO_2 probe calibrated to ±10 ppm
- Manufacturer's calibration kit
- Calibrated CO_2/air mixtures

Test Conditions

- Equipment installation is complete (including HVAC unit, duct work, sensors, and control system).
- HVAC system must be ready for system operation, including completion of all start-up procedures per manufacturer's recommendations.
- Building automation system (BAS) programming (if applicable) for the air handler and demand Controlled ventilation strategy must be complete. To perform the test, it may be necessary to use BAS to override or temporarily modify the CO_2 sensor reading.
- Air Economizer is disabled so that it will not interfere with outdoor air damper operation during test.
- Document the initial conditions before overrides or manipulation of the settings. All systems must be returned to normal at the end of the test.

Estimated Time to Complete

- Construction inspection: 0.5 to 1 hours (depending on CO2 sensor calibration)
- Functional testing: 1 to 2 hours (depending on how ambient CO2 concentration levels are manipulated, system response time to variations in CO2)

Acceptance Criteria

- Each CO_2 sensor is factory calibrated (with calibration certificate) or field calibrated.
- Each CO_2 sensor is wired correctly to the controls to ensure proper control of the outdoor air damper.
- Each CO_2 sensor is located correctly within the space 3 to 6 ft above the floor.
- Interior CO_2 concentration setpoint is ≤600 ppm plus outdoor air CO_2 value if dynamically measured or ≤1000 ppm if no OSA sensor is provided.
- A minimum OSA setting is provided whenever the system is in Occupied mode per §120.1(c)4E regardless of space CO_2 readings.
- A maximum OSA damper position for DCV control can be established per the *Exception* to §120.1(c)4C, regardless of space CO_2 readings.

- The outdoor air damper modulates open when the CO_2 concentration within the space exceeds setpoint,
- The outdoor air damper modulates closed (toward minimum position) when the CO_2 concentration within the space is below setpoint.

Potential Issues and Cautions

- Lock out the economizer control during the test. Outdoor air damper may not modulate correctly if the economizer control strategy is controlling damper operation.
- Overall test time may be reduced (especially for rooftop HVAC units) if two people perform the test - one to vary the CO_2 concentration while someone else verifies operation of the outdoor air dampers.
- During the testing of the DCV controls, the outside damper will modulate open. Care should be taken to prevent freezing of coils when testing with cold temperatures outside.

NRCA-MCH-07-A: Supply Fan Variable Flow Controls

Related to:	**Complex** HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-02-A	 ☐ ***TAB Technician*** ☒ ***BAS Technician*** ☐ ***HERS Rater***	§120.5(a)6 §140.4(c)2B§140.4(c)2C	NA7.5.6	Chapter 13.10

Purpose of the Test

The purpose of the test is to ensure that the supply fan in a variable air volume application modulates to meet system airflow demand. In most applications, the individual variable air valve (VAV) boxes serving each space will modulate the amount of air delivered to the space based on heating and cooling requirements. As a result, the total supply airflow provided by the central air handling unit must also vary to maintain sufficient airflow through each VAV box. Airflow is typically controlled using a variable frequency drive (VFD) to modulate supply fan speed and vary system airflow. The most common strategy for controlling the VFD is to measure and maintain static pressure within the duct.

Related acceptance tests for these systems include the following:

- NA7.5.1.1 Variable Air Volume Systems Outdoor Air Acceptance

Instrumentation

The instrumentation needed to perform the task may include, but is not limited to:

- Differential pressure gauge (must be calibrated within the past year)
- Pitot tube
- Drill

Test Conditions

If applicable, supply air temperature reset should be disabled during testing to prevent any unwanted interaction.

All systems and components must be installed and ready for system operation, including:

- Duct work
- VAV boxes
- Static pressure sensor(s) (note multiple sensors with separate control loops are often used on large systems with multiple branches)
- Electrical power to air handling unit
- Air handling unit start-up procedures are complete, per manufacturer's recommendations
- BAS programming for the operation of the air handling unit and VAV boxes must be complete, including but not limited to:
- Supply fan motor control, either VFD or ECM motor control
- VAV box control (including zone temperature sensors and maximum/minimum flow rates)

Before testing, ensure all schedules, setpoints, operating conditions, and control parameters are documented. All systems must be returned to normal at the end of the test.

This test can and should be performed in conjunction with NA7.5.1.1 Variable Air Volume Systems Outdoor Air Acceptance test procedures.

Estimated Time to Complete

- Construction inspection: 0.5 to 1.5 hours (depending on sensor calibration and minimum VFD speed verification)
- Functional testing: 1 to 2 hours (depending on how total fan power at design airflow is determined and system control stability)

Acceptance Criteria

- Static pressure sensor(s) is field calibrated to within 10 percent of reference sensor, with differential pressure gauge and pitot tube.
- For systems without DDC controls to the zone level the pressure sensor setpoint is less than 1/3 of the supply fan design static pressure.
- For systems with DDC controls with VAV boxes reporting to the central control panel, the pressure setpoint is reset by zone demand (box damper position or a trim and respond algorithm or other method that dynamically reduces duct static pressure setpoint as low as possible while maintaining adequate pressure at the VAV box zone(s) of greatest demand).
- At full flow:
  - Supply fan maintains discharge static pressure within ± 10 percent of the current operating control static pressure setpoint
  - Supply fan control stabilizes within 5 minute period.
  - At minimum flow (at least 30 percent of total design flow):
  - Supply fan controls modulate to decrease capacity.
  - Current operating setpoint has decreased (for systems with DDC to the zone level)
  - Supply fan maintains discharge static pressure within ± 10 percent of the current operating setpoint.

Potential Issues and Cautions

- Ensure that all disabled reset sequences are enabled upon completion of this test.
- Coordinate test procedures with the controls contractor since they may be needed to assist with manipulation of the BAS to achieve the desired operating conditions.

NRCA-MCH-08-A: Valve Leakage

Related to:	Simple and Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-10-A	 ☐ *TAB Technician* ☒ *BAS Technician* ☐ *HERS Rater*	§120.5(a)8 §140.4(k)1 §140.4(k)2 §140.4(k)3 §140.4(k)5 §140.4(k)6	NA7.5.7	Chapter 13.11

Purpose of the Test

This test ensures that control valves serving variable flow systems are designed to withstand the pump pressure over the full range of operation. Valves with insufficient actuators will lift under certain conditions causing water to leak and loss of flow control. This test applies to the variable flow systems covered by §140.4(k)1 Chilled and hot-water variable flow systems, §140.4(k)2 Chiller isolation valves, §140.4(k)3 Boiler isolation valves, and §140.4(k)5 Water-cooled air conditioner and hydronic heat pump systems.

Related acceptance tests for these systems include the following:

- NA7.5.9 Hydronic System Variable Flow Controls Acceptance
- Testing time will be greatly reduced if these acceptance tests are done simultaneously.

Instrumentation

Performance of this test will require measuring differential pressure across pumps. The instrumentation needed to perform the task may include, but is not limited to either a:

- Differential pressure gauge or
- Handheld hydronic manometer

For accurate comparison with the pump curves, measure using the taps on the pump casing. Taps on the inlet and discharge piping to the pumps will not correlate to the pump curves.

Test Conditions

- The whole hydronic system must be complete – all coils, control valves, and pumps installed; all piping is pressure tested, flushed, cleaned, filled with water; BAS controls, if applicable.
- All equipment start-up procedures are complete, per manufacturer's recommendations.
- Document the initial conditions before overrides or manipulation of the BAS. All systems must be returned to normal at the end of the test.

Estimated Time to Complete

- Construction inspection: 0.5 to 2 hours (depending on availability of construction documentation and complexity of the system.)
- Functional testing: 30 minutes to 3 hours (depending on the complexity of the system and the number of valves)

Acceptance Criteria

Provisions have been made for variable flow:

- System has no flow when all coils are closed and the pump is turned on.

Potential Issues and Cautions
• The Acceptance Agent will likely need access to the EMCS during testing. • Running a pump in a “dead head” condition (no flow) for more than 5 minutes can damage the pump seals or motor. Care must be taken to set up the test so that the pump only needs to run for 5 minutes or less. • If balance valves are used for isolation of three-way valves or pumps, their initial position must be noted prior to using them for shut off of flow so that they can be returned to their initial position at the end of the test.

NRCA-MCH-09-A: Supply Water Temperature Reset Controls

Complex HVAC System

☐ ***TAB Technician***
☒ ***BAS Technician***
☐ ***HERS Rater***

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)9 §140.4(k)4	NA7.5.8	Chapter 13.8

Applies to chilled and hot water systems that are not designed for variable flow and that have a design capacity ≥ 500 kBtuh

Purpose of the Test

This test ensures that both the chilled water and hot water supply temperatures are automatically reset based on either building loads or outdoor air temperature, as indicated in the control sequences. Many HVAC systems are served by central chilled and heating hot water plants. The supply water operating temperatures must meet peak loads when the system is operating at design conditions. As the loads vary, the supply water temperatures can be adjusted to satisfy the new operating conditions. Typically the chilled water supply temperature can be raised as the cooling load decreases, and heating hot water supply temperature can be lowered as the heating load decreases.

This requirement only applies to chilled and hot water systems that are not designed for variable flow and that have a design capacity greater than or equal to 500 kBtuh (thousand BTU's per hour) , according to §140.4(k)4.

Instrumentation

Performance of this test will require measuring water temperatures as well as possibly air temperatures. The instrumentation needed to perform the task may include, but is not limited to:

- Hand-held temperature probes for ice water or drywell bath. Devices must be calibrated within the last year.

Test Conditions

To perform the test, use the building automation system (BAS) to manipulate system operation to achieve the desired control. BAS programming for the operation of the chillers, boilers, air handling units, and pumps must include but may not be limited to:

- Supply water temperature control,
- Equipment start-stop control,
- Installed and calibrated control sensors, and
- Tuned control loops.

All systems must be installed and ready for system operation, including:

- Chillers, boilers, pumps, air handling units, valves, and piping;
- Control sensors (temperature, humidity, flow, pressure, etc.)

Verify all piping is pressure tested, flushed, cleaned, and filled with water. Confirm electric power supply to all equipment. Verify start-up procedures for all pieces of equipment are complete, per manufacturer's recommendations

Document the initial conditions before overrides or manipulation of the BAS. All systems must be returned to normal at the end of the test.

Estimated Time to Complete

- Construction inspection: 0.5 to 1 hours (depending on availability of construction documentation (i.e. plumbing drawings, material cut sheets, specifications, etc.) as well as sensor calibration.)
- Functional testing: 1 to 2 hours (depending on familiarity with BAS, method employed to vary operating parameters, and time interval between control command and system response)

Acceptance Criteria
• Supply water temperature sensors are field calibrated, to within one percent of calibrated reference sensor, with supporting documentation attached to MECH-09A document. • Sensor performance complies with specifications. • Supply water reset works according to control schedule, and actual water temperature is within 2 percent of control setpoint.
Potential Issues and Cautions
• If the hot water temperature reset tests when there is minimal heating load, make sure to test the low end of the reset first (coldest hot water supply temperature). If the hottest supply water temperature is tested first, it may be difficult to dissipate the heat in the hot water loop without artificially creating a heating load. Waiting for a small heating load to dissipate the heat in the loop could add significant time to the test procedure. • Where humidity control is required, chilled water supply water reset is not recommended.

NRCA-MCH-10-A: Hydronic System Variable Flow Control

Related to:	**Complex** HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-08-A	 ☐ ***TAB Technician*** ☒ ***BAS Technician*** ☐ ***HERS Rater***	§120.5(a)7 §140.4(k)1 §140.4(k)5 §140.4(k)6	NA7.5.9	Chapter 13.13
		Not required on heating hot water systems with variable flow designs or for condensing water serving only water cooled chillers.		

Purpose of the Test

All hydronic variable flow chilled water and water-loop heat pump systems with total circulating pump power larger than 5 hp shall vary system flow rate by modulating pump speed using either a variable frequency drive (VFD) or equivalent according to §140.4(k)6. Pump speed and flow must be controlled as a function of differential pressure, and pump motor demand must be no more than 30 percent design wattage at 50 percent design flow.

As the loads within the building fluctuate, control valves should modulate the amount of water passing through each coil and add or remove the desired amount of energy from the air stream to satisfy the load. In the case of water-loop heat pumps, each two-way control valve associated with a heat pump closes when not operating. The purpose of the test is to ensure that, as each control valve modulates, the pump variable frequency drive (VFD) responds accordingly to meet system water flow requirements.

Note that this is not required on heating hot water systems with variable flow designs or for condensing water serving only water cooled chillers.

The related acceptance tests for this systems is:

- NA7.5.7 Valve Leakage Test (if applicable)

Instrumentation

The instrumentation needed to perform the task may include, but is not limited to:

- Differential pressure gauge (hydronic manometer)

Test Conditions

To perform the test, use the control system to manipulate system operation to achieve the desired control. At a minimum, control system programming for the operation of the central equipment, control valves, and pumps must include, but not be limited to:

- Equipment start-stop control,
- Installed and calibrated control sensors, and
- Tuned control loops.
- All systems must be installed and ready for system operation, including:
- Heat pumps, cooling towers, boilers, pumps, control valves, piping, etc.
- Control sensors (temperature, flow, pressure, etc.)

Verify all piping is pressure tested, flushed, cleaned, and filled with water. Verify electrical power supply to all equipment. Confirm start-up procedures for all pieces of equipment are complete, per manufacturer's recommendations.

Document the initial conditions before overrides or manipulation of the BAS. Return all systems to their initial condition after test.

Estimated Time to Complete
• Construction inspection: 0.5 to 1 hour (depending on availability of construction documentation – i.e. plumbing drawings, material cut sheets, specifications, etc – as well as sensor calibration) • Functional testing: 2 to 4 hours (depending on familiarity with BAS, method employed to vary operating parameters, verification method for system flow and VFD power)
Acceptance Criteria
• Differential pressure sensor(s) are field calibrated. • For systems without DDC to individual coils, pressure sensor(s) are located at or near the most remote HX or control valve, or the HX requiring the greatest differential pressure. • For systems with DDC to individual coils, the pressure sensor(s) has no location restriction, but are reset according to the valve requiring the greatest pressure and shall be no less than 80 percent open. • System controls to the setpoint stably.
Potential Issues and Cautions
Difficulties could be encountered with manipulating the control system if not familiar with the programming language. Therefore, a controls contractor should be on-site to assist with adjusting system operation and overriding controls.

NRCA-MCH-11-A: Automatic Demand Shed Control

Related to:	**Simple and Complex** HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-18-A	 ☐ ***TAB Technician*** ☒ ***BAS Technician*** ☐ ***HERS Rater***	§120.2(h) §120.5(a)10	NA7.5.10	Chapter 13.14

Purpose of the Test

All control systems with DDC to the zone level are required to enable centralized demand shed at non-critical control zones from either a single software or hardware point in the system §120.2(h). Field studies have shown that in typical commercial buildings resetting the zone temperatures up by 2°F to 4°F during on-peak times can reduce the peak electrical cooling demand by as much as 30 percent. This test ensures the central demand shed sequences have been properly programmed into the DDC system.

Instrumentation

The instrumentation needed to perform the task may include, but is not limited to:

- The front end computer to the DDC system.

Test Conditions

To perform the test, use the control system to manipulate system. The entire HVAC installation and control system must be completed prior.

Estimated Time to Complete

- Construction inspection: 0.5 hour to review the EMCS programming
- Functional testing: 0.5 to 1 hour (depending on familiarity with BAS)

Acceptance Criteria

The control system changes the setpoints of non-critical zones on activation of a single central hardware or software point. Then the system restores the initial setpoints when the point is released.

Potential Issues and Cautions

Difficulties could be encountered with manipulating the control system if not familiar with the programming language. Therefore, a controls contractor should be on-site to assist with the testing.

NRCA-MCH-12-A: FDD for Packaged DX Units

Related to:	**Simple** HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-02-A	 ☐ *TAB Technician* ☒ *BAS Technician* ☐ *HERS Rater*	§120.2(i) §120.5(a)11	NA7.5.11	Chapter 13.15
		Two people would be beneficial to this documentation of this test.		

Purpose of the Test

The purpose of this test is to verify proper fault detection and reporting for automated fault detection and diagnostics systems for packaged DX units. Automated FDD systems ensure proper equipment operation by identifying and diagnosing common equipment problems such as temperature sensor faults, low airflow or faulty economizer operation.
FDD systems help to maintain equipment efficiency closer to rated conditions over the life of the equipment.

Instrumentation

~~The system test for refrigerant charge requires a calibrated refrigerant gauge with an accuracy of plus or minus 3 percent.~~

Test Conditions

- Packaged unit and thermostat installation along with programming must be complete.
- HVAC system must be installed and ready for operation, including completion of all start-up procedures, per manufacturer's recommendations.
- Prior to FDD verification, test the system operating modes. When the system includes a field-installed air economizer, test the economizer per NRCA-MCH-02-A.

Estimated Time to Complete

- Construction inspection: 0.5 hour
- Functional testing: 1 to 2 hours
- ~~FDD systems have the capability to report alarms to a remote server; accessible via a Web interface. It may be helpful to have two people conducting the test – one to perform testing on the unit and a second to verify reporting of the alarm to the remote interface.~~

Acceptance Criteria

- The FDD system is able to detect a disconnected outside air temperature sensor and report the fault.
- The FDD system is able to detect excess outside air and report the fault.
- The FDD system is able to detect a stuck outdoor air economizer damper and report the fault.
- ~~The saturated discharge and saturated suction temperatures must be measured within 5°F of a calibrated refrigerant gauge.~~

Potential Issues and Cautions

Compared to the pressure sensors, the temperature sensors can have a longer response time to reach a steady-state condition. Therefore, the FDD algorithms may have trouble working properly during transitional states – for example, when the fan or compressor first turns on. The tester should be aware of the potential for false alarms.

NRCA-MCH-13-A: FDD for Air Handling Units and Zone Terminal Units

Complex HVAC System

☐ ***TAB Technician***
☒ ***BAS Technician***
☐ ***HERS Rater***

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)12	NA7.5.12	Chapter 13.16

An FDD system that does not pass this test may still be installed, but no compliance credit will be given.
A minimum of 5% of the terminal boxes (VAV box) shall be tested.

Purpose of the Test

Fault detection and diagnostics can also be used to detect common faults with air handling units and zone terminal units. Many FDD tools are standalone software products that process trend data offline. Maintenance problems with built-up air handlers and variable air volume boxes are often not detected by energy management systems because the required data and analytical tools are not available. Performing the FDD analysis within the distributed unit controllers is more practical because of the large volume of data. The acceptance tests are designed to verify that the system detects common faults in air handling units and terminal units. FDD systems for air handling units and zone terminal units require DDC controls to the zone level. Successful completion of this test provides a compliance credit when using the performance approach. An FDD system that does not pass this test may still be installed, but no compliance credit will be given.

Instrumentation

FDD tests for air handling units and zone terminal units require no additional instrumentation for testing, since control algorithms are embedded in unit controllers.

Test Conditions

- The air handling unit should be installed and the heating, cooling and economizer modes of operation tested. To perform the test, use the building automation system (BAS) to manipulate system operation to achieve the desired control. BAS programming for the operation of the chillers, boilers, air handling units, and pumps must be complete.
- All equipment startup procedures must have been completed per manufacturer's instructions. All control sensors must be installed and control loops tuned.
- Document the initial conditions before any overrides to the building automation system.
- **Minimum of 5% of the VAV boxes are to be tested.**

Estimated Time to Complete

Acceptance tests will take 1-2 hours for each air handler. Time for acceptance testing for terminal units depends on the number of boxes to be tested.

Acceptance Criteria

- The system is able to detect common faults with air handling units, such as sensor failures, damper failures, actuator failures, or improper operating modes.
- The system is able to detect and report common faults with zone terminal units, such as damper failure, actuator failure, or a control tuning issue.

Potential Issues and Cautions

Difficulties could be encountered with manipulating the control system if not familiar with the programming language. Therefore, a controls contractor should be on-site to assist with the testing.

NRCA-MCH-14-A: Distributed Energy Storage DX AC System

Related to:	**Simple** HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-02-A; NRCA-MCH-03-A; NRCA-MCH-05-A	 ☐ ***TAB Technician*** ☐ ***BAS Technician*** ☐ ***HERS Rater***	§120.5(a)13	NA7.5.13	Chapter 13.17
		Distributed energy storage system third party submittal form should be verified.		

Purpose of the Test

This test verifies proper operation of distributed energy storage DX systems. Distributed energy systems reduce peak demand by operating during off peak hours and storing cooling, usually in the form of ice. During peak cooling hours the ice is melted to avoid compressor operation.

Instrumentation

Distributed energy storage acceptance tests require no additional instrumentation for testing.

Test Conditions

- The DX equipment should be installed and operational.
- Perform pre-startup installation procedures as specified by the manufacturer.
- Verify that the building cooling is controlled by a standard indoor HVAC thermostat and not by factory installed controls.
- Verify that ice making is not controlled by the thermostat.
- The water tank should be filled to the proper level as specified by the manufacturer prior to the start of the test.
- Verify refrigerant piping connects and the system is charged with refrigerant.

Estimated Time to Complete

- Construction Inspection: 0.5 hours
- Acceptance Tests: 2 hours

Acceptance Criteria

- Verify nighttime ice making operation.
- Verify that tank discharges during on-peak cooling periods.
- Verify that the compressor does not run and the tank does not discharge when there is no cooling demand during on-peak periods.
- Verify that the system does not operate during a morning shoulder period when there is no cooling demand.
- Verify that the system operates in direct mode (with compressor running) during the morning shoulder time period.

Potential Issues and Cautions

- These tests only apply to systems with storage capacity less than 100 ton-hours.
- Systems with storage above 100 ton-hours should be modeled using the thermal energy storage compliance option.
- Be sure the water tank is filled to the proper level indicated by the manufacturer prior to the start of the tests.
- The tests require override of the system controller programming. Be sure to record the system settings prior to the start of the testing, and restore the system settings to their original values upon completion of the tests.

NRCA-MCH-15-A: Thermal Energy Storage (TES) System

	Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
	 ☐ *TAB Technician* ☒ *BAS Technician* ☐ *HERS Rater*	§120.5(a)14	NA7.5.14	Chapter 13.18

Purpose of the Test

This test verifies proper operation of thermal energy storage (TES) systems. TES systems reduce energy consumption during peak demand periods by shifting energy consumption to nighttime. Operation of the thermal energy storage compressor during the night produces cooling energy, which is stored in the form of cooled fluid or ice in tanks. During peak cooling hours the thermal storage is used for cooling to prevent the need for chiller operation.

Benefits of the Test

The test will ensure that the TES system is able to charge the storage tank during off-peak hours and conversely discharge the storage tank during on peak hours. Since the chiller may operate more efficiently at night when ambient temperatures are lower, the system may save cooling energy in some climate zones.

Instrumentation

TES acceptance tests require no additional instrumentation for testing.

Test Conditions

- The chiller, EMS, piping, and components should be installed and operational.
- The thermal storage tank should be without charge, or even partially charged (not fully charged), at the start of testing.
- The system should be configured with an on-peak cooling period (tank discharge) and an off-peak charging period.
- The cooling load can be met by storage if the tank has stored energy available or by compressor cooling if there is no stored energy available.

Estimated Time to Complete

- Construction Inspection: 0.5 hours
- Acceptance Tests: 2 hours

Acceptance Criteria

The TES system and the chilled water plant is controlled and monitored by an EMS.

Verify:

- The TES system stores energy in storage/charge mode.
- The storage charging stops when an end of charge signal is generated.
- The TES system starts discharging with the compressor(s) in discharge mode.
- The TES does not discharge and the cooling load is met by the compressor(s) in mechanical cooling only mode.
- The TES discharges with the chiller sharing the load during discharge and mechanical cooling mode.
- Storage does not discharge and all compressors are off during the off/storage-secure mode.
- When applicable, tanks can be charged while serving in active cooling mode during charge-plus cooling mode.

Potential Issues and Cautions

- Potential damage to the chiller, pumps, storage tanks, etc., by improper manipulation of the control system.
- Perform this test with the assistance of the controls vendor or facility operator.

NRCA-MCH-16-A: Supply Air Temperature Reset Controls

	Simple and Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
	 ☒ *TAB Technician* ☒ *BAS Technician* ☐ *HERS Rater*	§140.4(f) §140.4(d) §120.5(a)15	NA7.5.15	Chapter 13.19

Purpose of the Test

The purpose of the test is to ensure that the supply air temperature in a constant or variable air volume application serving multiple zones, according to §140.4(f), modulates to meet system heating and cooling loads.

- Space conditioning systems must have zone level controls to avoid reheat, re-cool, and simultaneous cooling and heating (§140.4(d)); or, must have controls to reset supply air temperature (SAT) by at least 25 percent of the difference between the design supply-air temperature and the design room air temperature (§140.4(f)2).
- Air distribution systems serving zones with constant loads shall be designed for the air flows resulting from the fully reset (e.g. lowest/highest) supply air temperature.
- The requirements for SAT reset apply to both CAV and VAV systems. Exceptions include:
  - Systems with specific humidity needs for exempt process loads (computer rooms or spaces serving only IT equipment are not exempt),
  - Zones served by space conditioning systems in which at least 75 percent of the energy for reheating, or providing warm air in mixing systems, is provided from a site-recovered or site-solar energy source,
  - Systems in which supply air temperature reset would increase overall building energy use, and.
  - Systems with controls to prevent reheat, re-cool, and/or simultaneous cooling and heating
- Supply air temperature may be reset in response to building loads, zone temperature, outside air temperature, or any other appropriate variable.

Instrumentation

- The instrumentation needed to perform the task may include, but is not limited to:
- Hand-held temperature probe or temperature data logger, which was calibrated within the last year with date of calibration noted on the Acceptance Document MECH 16-A.

Test Conditions

Confirm all systems and components are installed and ready for system operation, including:

- Duct work
- Terminal boxes
- Heating and/or cooling coils
- Outside air dampers and controls
- Supply air temperature sensor(s)
- Electrical power to air handling unit

Air handling unit start-up procedures should be complete, per manufacturer's recommendations. If applicable, BAS programming for the operation of the air handling unit and terminal boxes should be complete, including but not limited to:

- Heating and cooling coil temperature control
- Terminal box control (including zone temperature sensors and reheat coils)
- Discharge air temperature sensor

Controls for economizer or outside air damper should be disabled during testing to prevent any unwanted interaction.
Before testing, ensure all schedules, set points, operating conditions, and control parameters are documented. All systems must be returned to normal at the end of the test.
Document current supply air temperature.

Estimated Time to Complete

- Construction inspection: 0.5 to 1 hours (depending on sensor calibration)
- Functional testing: 0.5 to 1 hours (depending on system control stability)

Acceptance Criteria

Construction Inspection Criteria: The temperature sensor(s) must be factory calibrated, field calibrated by a TAB technician, or field checked by test technician with a calibrated standard. Calibration certificate or other supporting documentation must be provided.
Functional Testing: For each system, the test criteria include:

- Supply air temperature controls modulate as intended.
- Actual supply air temperature decreases to meet the new set point within +/- 2°F.
- Supply air temperature stabilizes within 15 minutes. Supply air temperature and temperature setpoint must be documented in the acceptance form.

Potential Issues and Cautions

- Coordinate test procedures with the controls contractor and building staff, if possible, since they may be needed to assist with manipulation of the BAS to achieve the desired operating conditions.
- Check to make sure that chilled / hot water coils, if used, are not already fully open and calling for maximum cooling / heating. In this case, reverse Steps 1 and 2 and change the set point range as necessary to allow system to operate within acceptable bounds.
- In general, take care to avoid demand peaks exceeding what would be encountered during the normal operation of the building.
- Ensure that all disabled reset sequences are enabled upon completion of this test.

NRCA-MCH-17-A: Condenser Water Temperature Reset Controls

	Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
	 ☐ *TAB Technician* ☒ *BAS Technician* ☐ *HERS Rater*	Required if this control strategy is implemented.	NA7.5.16	Chapter 13.20

Purpose of the Test

The intent of the test is to verify that the condenser water supply (entering condenser water) temperature is automatically reset as indicated in the control sequences; based upon building loads, outdoor air wet-bulb temperature, or another appropriate control variable. All cooling tower system components (e.g. fans, spray pumps) should operate per the control sequences to maintain the proper condenser water temperature and pressure set points.

- Chilled water plants serve many buildings, responding to the varying cooling loads throughout the year. As the loads vary, the chilled water supply temperatures adjust to satisfy the new operating conditions. Often, water-cooled chilled water plants can decrease the condenser water temperature in times of low cooling load. This occurrence can be demonstrated by running the cooling tower fans at a higher speed, staging on additional fans, or varying water distribution across the tower fill by closing and opening bypass valves. As a result, the cooling tower produces an energy penalty, however the chiller efficiency and the overall plant efficiency improves.
- The requirement for condenser water reset acceptance only applies to those chilled water systems with a cooling tower implementing some kind of condenser water temperature reset control.
- There is no code requirement that chilled water plants employ this type of control. However, if condenser water temperature reset is implemented, then it must be tested per the Energy Standards. The purpose of this test is not to evaluate whether a particular control sequence is the most appropriate for the facility, but whether the system follows the intended control sequence.

Instrumentation

Performance of this test will require measuring water temperatures, and possibly air temperature, relative humidity, system pressures, and system flow rates. The instrumentation needed to perform the task may include, but is not limited to:

- Hand-held temperature probe to calibrate or check existing sensors
- Humidity sensor or wet bulb temperature probe / psychrometer

Installed sensors should be checked for accuracy, and may be used for testing where appropriate. Any instruments used for testing or checking other sensors must be calibrated within the past year, with date of calibration noted on the Acceptance Document.

Test Conditions

To perform the test, it may be necessary to use the building automation system (BAS) to manipulate system operation to achieve the desired control. BAS programming for the operation of the chillers, cooling towers, air handling units, and pumps must be complete, including but not limited to:

- Chilled water and condenser water temperature control
- Equipment start-stop control
- All installed and calibrated control sensors
- Tuned Control loops

All systems must be installed and ready for system operation, including:

- Chillers, cooling towers, pumps, air handling units, valves, and piping.

- Control sensors (temperature, humidity, flow, pressure, valve position, etc.)
- Safeties, interlocks, and alarms (e.g. high/low water alarms, vibration, back-up system operation)

Verify all piping is pressure tested, balanced, flushed, cleaned, and filled with water. Verify electrical power is supplied to all equipment. Confirm start-up procedures for all equipment must be complete, per manufacturer's recommendations. At a minimum, all components and systems served by the chiller and cooling tower should have completed pre-functional checks and be capable of safe operation.
Document the initial conditions before overrides or manipulation of the BAS. Return all systems to their initial condition after test.

Estimated Time to Complete

- Construction inspection: 1 to 3 hours (depending on availability of construction documentation – i.e. plumbing drawings, material cut sheets, specifications, etc. – as well as sensor calibration records.)
- Functional testing: 2 to 5 hours (depending on familiarity with BAS, method employed to vary operating parameters, ambient conditions, building loads, and time interval between control command and system response)

Acceptance Criteria

Construction Inspection: All ambient temperature and relative humidity sensors used by the controller must be either calibrated (manufacturer calibrated with calibration certificates or field calibrated by TAB technician), or field checked against a calibrated sensor by the person performing the test.
Functional Test: System must meet the following criteria during the test:

- Condenser water temperature controls modulate as intended.
- Actual condenser water supply temperature decreases to meet new set point within ± 2°F.
- Cooling tower fan(s) stage properly and/or adjust speed accordingly to meet lower set point.
- Chiller load amps decrease.

Potential Issues and Cautions

- Condenser water temperature reset is most effective on a moderately warm day. When testing during cold weather conditions, make sure that freeze protection controls are installed and functional to prevent equipment damage. Also ensure the conditioned spaces do not fall below safe temperatures, as this may cause discomfort or unsafe working conditions.
- If conducting this test during hot weather conditions, make sure the chiller load amps don't increase as the condenser water temperature **increases**. If so, you will need to conduct this test on a cooler day. Likewise, stop the test if the chiller begins to surge.
- This test does not require operation of the plant equipment across all operating stages, so it is not necessary, nor desirable, that the system experience peak load conditions. However, the system cooling load must be sufficiently high to run the test. If necessary, artificially increase the load to perform the functional tests, or wait until a time of stable chiller operation. If necessary, reverse Steps 1 & 2 in the functional test based on atmospheric conditions and building loads.
- If the system is designed to employ variable flow simultaneously with temperature reset, allow the system to operate as programmed but take care that the water flow rate stays within the minimum and maximum flow rate limits for the chiller(s) and cooling tower(s). Minimum flow through a cooling tower is important to provide even water distribution and full wetting of the fill to prevent scaling.
- Exemption: There is an important exemption associated with this functional test to provide flexibility given the range of chilled water plant operations, as follows: If the control sequence differs significantly from that implied by the tests, and / or has already been tested during the building commissioning process, attach a description of the control sequence, a description of the tests that were done to verify the system operates according to the sequence, the test results, and a plot of any associated trend data.

NRCA-MCH-18-A: Energy Management Control System

Related to:	**Simple and Complex** HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-11-A	 ☐ *TAB Technician* ☒ *BAS Technician* ☐ *HERS Rater*	§110.2(e) §120.2(h) §120.5(a)17	No NA7 Guidance	Chapter 13.21
		Lighting requirements may also apply		

Purpose of the Test

This acceptance test ensures the central control system, when installed, is properly installed and configured and capable of meeting the applicable requirements of the Energy Standards. The EMCS is a complex, highly customized control system with many opportunities for installation and programming problems.

Instrumentation

N/A

Test Conditions

All systems and components must be installed, powered and ready for system operation, including:

- Controllers
- Actuators
- Sensors
- EMCS programming

All of the regular installation, start-up, testing, and commissioning tasks that a controls contractor normally performs during an EMCS installation should be complete before this test is conducted.

Estimated Time to Complete

1 to 2 hours, depending on familiarity with the EMCS, complexity of the EMCS, and the number of control points.

Acceptance Criteria

Test passes if all Construction Inspection boxes are checked and all Functional Testing results are “yes’.

Potential Issues and Cautions

- This basic list of recommendations is intended to validate the readiness of the EMCS for any required acceptance criteria specified in the Energy Standards. This check should not take the place of a more comprehensive start-up testing or commissioning effort.
- This acceptance test should be completed prior to conducting the other acceptance tests that rely on the EMCS.

Nonresidential

New HVAC: Simple and Complex Systems

HVAC Simple Systems

	Mandatory Requirements								Prescriptive Requirements			
Space Conditioning Equipment [A]	Zone Thermostat[F] §120.2(a), (b) Setback Capable[G]	DCV[H] §120.1(c)	Heat Pump Controls[I] §120.2(d)	Shutoff and Reset[J] §120.2(e)	Ventilation Dampers §120.2(f) Automatic close upon fan shutdown[L]	Isolation Devices[N] §120.2(g)	Demand Shedding[O] §120.2(h)	Economizer FDD[P] §120.2(i)	Zone Control[Q] §140.4(d)	Supply Temperature Reset[R] §140.4(f)	Economizer[P, S] §140.4(e)1- 5	Variable Flow Control[T] §140.4(k)6 §140.4(m)
Package Terminal Air Conditioner [B,C]	YES[D]	YES	no	YES[K]	YES	no	YES	YES	YES	YES	no	YES[U]
Unitary Air Conditioners and Condensing Units [D]	YES	YES	no	YES[K]	YES	no	no	YES	no	no	YES	YES[U]
Unitary Heat Pumps [E]	YES	YES	YES	YES[K]	YES	no	no	YES	no	no	YES	YES[U]
Applied Heat Pumps[E]	YES	YES	YES	YES[K]	YES	YES	YES	YES	YES	no	YES	YES[U]
Forced Air Furnace	YES	YES	no	YES[K]	YES[M]	no	YES	no	no	no	no	no
Unit Heater	YES	no	no	YES[K]	no	no	no	no	no	no	no	no

A Central Energy Management Control System (EMCS) should be installed at building site for optimal equipment operation and coordination.

B Configurations vary between availability of central plant in design or reliance on self-contained heating and cooling.

C Special application requirements for Hotels, High-rise Residential, and Perimeter Zoning. Setback capable terminal devices should be used except where zone is not on EMCS. In that case, capability of four programmable control periods per 24 hours is required (§110.2(c)).

D Stand-alone single room window units are exempt (See §110.2(c)).

E Air or water source configuration.

F An EMCS may perform the setback functions.

G Set back the zone temperature setpoints to 55°F or lower for heating and 85°F or higher for cooling. Where used to control both heating and cooling, and where changeover between heating and cooling modes is automatic, the thermostatic controls shall be capable of providing a temperature dead band of at least 5°F, within which heating and cooling are both shut off or minimized.

H Demand Control Ventilation. See §120.1(c) 3, 4 and 5 for additional CO2 concentration setpoint information and sensor location requirements.

I Heat pumps with supplementary electric resistance heat have control requirements.

J Must include automatic restart to maintain setback temperatures as necessary.

K Must include automatic time switch OR occupancy sensor OR 4-hour timer. 7-day programmable local control exemption.

L Assumes system has ventilation capacity at the terminal device. Damper is to reduce ventilation to zero during unoccupied periods. Exemptions for; gravity dampers, combustion air paths, 24-hour operation, or local law jurisdiction.

M Reference to combustion air requirements.

N For systems serving multiple zones totaling more than 25,000 ft^2. A zone need not be isolated if demonstrated that it must be heated or cooled continuously.

O Include settings capable of disabling, manually controlling, or automatically operating equipment. Applies to HVAC systems with DDC to the zone level.

P Fault detection and diagnostics (FDD) systems are commonly available for packaged HVAC units, and can be integrated directly by the manufacturer. These are required for all new air-cooled unitary direct-expansion systems with cooling capacity of 54 kBtu/h (4 ½ tons) or greater. Controls include economizer checks and refrigerant diagnostics. The systems can report failures or suboptimal conditions that impact efficiency. Required acceptance tests for these systems may be found in Reference Appendix NA7.5.11.

Q Simultaneous heat and cool prevention except for variable-air-volume and other system types listed in this section. Ambient conditions also provide lockout for seasonal operation only per §140.4(n).

R A reset strategy defined and applied to the supply air stream of the unit or terminal device.

S Exemptions apply where: (1) outside air conditions are undesirable, (2) high-rise residential, (3) adverse effects of other systems, like dehumidification, (4) high cooling efficiency systems [Table 140.1-A] (5) computer rooms served per §140.9(a).

T Air-side applications referred to in respective code language. Central EMCS necessary for remote system operation and ability to oversee all space-conditioning equipment and pumping needs.

U Variable Frequency Drive necessary to operate supply fan speed control at the unit.

Acceptance Tests: HVAC Simple Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-03-A Constant Volume, Single-zone, Unitary A/C and HP	NRCA-MCH04-A Air Distribution Duct Leakage	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-12-A Fault Detection and Diagnostic for DX Systems	NRCA-MCH-13-A Fault Detection and Diagnostic for AHUs	NRCA-MCH-16-A Supply Air Temp Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	YES	no	no	no	no	no	no	no	no	no	YES
DCV	YES	YES	no	YES	YES	YES	no	no	no	no	no	YES
Heat Pump Controls	no	YES	no	no	no	no	no	no	no	no	no	no
Shutoff and Reset	no	YES	no	no	no	no	no	YES	no	no	no	YES
Ventilation Dampers	YES	YES	YES	YES	no	YES	no	no	no	no	no	YES
Isolation Devices	no	YES	YES	no	no	no	YES	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	YES	no	no	YES	YES	no	YES
Zone Control	no	YES	no	no	no	no	YES	YES	no	no	no	YES
Supply Temp. Reset	no	no	no	no	no	no	no	no	no	no	YES	YES
Variable Flow Control	no	no	no	no	no	YES	YES	no	no	no	no	YES
Duct Systems	YES	no	YES	no	no	no	no	no	no	no	no	no

A Test is only applicable if an EMCS is present

HVAC Complex Systems

	Mandatory Requirements								Prescriptive Requirements				
Space Conditioning Equipment[A]	Zone Thermostat[C] §120.2(a), (b) Setback Capable[D]	DCV[E] §120.1(c)	Shutoff and Reset[F] §120.2(e)	VentilationDampers §120.2(f) Automatic close upon fan shutdown[H]	Isolation Devices[I] §120.2(g)	Demand Shedding[J] §120.2(h)	DDC §120.2(j)	Optimum Start Stop §120.2(k) (new in 2016)	Zone Control[K] §140.4(d)	Supply Temperature Reset §140.4(f) §140.4(k)4	Economizer[N] §140.4(e)1- 5	Variable Flow Control[O] §140.4(k)6 §140.4(m)	Isolation §140.4(k)2 §140.4(k)3
Boiler	no	no	YES[G]	no	no	YES	YES	YES	YES	YES[L]	no	no	YES
Air-cooled Chiller	no	no	YES[G]	no	no	YES	YES	YES	YES	YES[M]	no	YES	YES
Water-cooled Chiller	no	no	YES[G]	no	no	YES	YES	YES	YES	YES[M]	no	YES	YES
Variable Refrigerant Flow (VRF)	YES	YES	YES[G]	no	YES	YES	no	no	YES	YES	YES	YES	no
Air Handling Systems & Zones[B]	YES	YES	YES[G]	YES	YES	YES	YES	YES	YES	YES	YES	YES	no
Zone Terminal Units or Fan Coils	YES	no	YES[G]	no	no	YES	YES	YES	YES	YES	no	YES	no

A Central Energy Management Control System (EMCS) should be installed at building site for optimal equipment operation and coordination.

B Applies to fan systems serving multiple thermostatically controlled zones, and to built-up air handler systems (non-unitary or nonpackaged HVAC equipment).

C An EMCS may perform the setback functions.

D Heating and cooling set point dead band of ±5°F should be implemented on all temperature set points. Applies only to equipment with heating AND cooling capability. Set back the zone temperature set points to 55°F or lower for heating and 85°F or higher for cooling.

E Demand Control Ventilation. See §120.1(c) 3, 4 and 5 for additional CO_2 concentration set point information and sensor location requirements.

F Must include automatic restart to maintain setback temperatures as necessary.

G Must include automatic time switch OR occupancy sensor OR 4-hour timer. 7-day programmable local control exemption.

H Reference to mechanical room ventilation fan where chillers are located.

I For systems serving multiple zones totaling more than 25,000 ft^2. A zone need not be isolated if demonstrated that it must be heated or cooled continuously.

J Include settings capable of disabling, manually controlling, or automatically operating equipment. Applies to HVAC systems with DDC to the zone level.

K Simultaneous heat and cool prevention except for variable-air-volume and other system types listed in this section. Ambient conditions also provide lockout for seasonal operation only.

L Referred to as "Hot Water Supply Temperature Reset".

M Referred to as "Chilled Water Supply Temperature Reset".

N Exemptions apply where: (1) outside air conditions are undesirable, (2) high-rise residential, (3) adverse effects of other systems, like dehumidification, (4) high cooling efficiency systems [Table 140.1-A] (5) computer rooms served per §140.9(a).

O Includes reference to both water and air-side applications referred to in respective code language. Central EMCS necessary for remote system operation and ability to oversee all space-conditioning equipment and pumping needs.

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

A Test is only applicable if an EMCS is present

For More Information

Primary Sources

- Energy Standards Section 110.2 – Mandatory Requirements for Space-Conditioning Equipment:
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1102mandatoryrequirementsforspaceconditioningequipment.htm
- Energy Standards Section 120.1 – Requirements for Ventilation:
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1201requirementsforventilation.htm
- Energy Standards Section 120.2 – Required Controls for Space-Conditioning Systems:
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1202requiredcontrolsforspaceconditioningsystems.htm
- Energy Standards Section 140.4 – Prescriptive Requirements for Space-Conditioning Systems:
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1404prescriptiverequirementsforspaceconditioningsystems.htm
- Energy Standards Section 140.9 – Prescriptive Requirements for Covered Processes:
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1409prescriptiverequirementsforcoveredprocesses.htm
- Energy Standards Reference Appendix NA7– Installation and Acceptance Requirements for Nonresidential Buildings and Covered Processes:
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/appendixna7installationandacceptancerequirementsfornonresidentia.htm

California Energy Commission Information & Services

- Energy Standards Hotline: 1-800-772-3300 (Free) or Title24@energy.ca.gov
- Online Resource Center:
  energy.ca.gov/title24/orc/
  – The Energy Commission's main web portal for Energy Standards, including information, documents, and historical information

Additional Resources

- Energy Code Ace:
  EnergyCodeAce.com
  – An online "one-stop-shop" providing free resources and training to help appliance and building industry professionals decode and comply with Title 24, Part 6 and Title 20. The site is administered by California's investor-owned utilities.
  Please register with the site and select an industry role for your profile in order to receive messages about all our free offerings!

This program is funded by California utility customers under the auspices of the California Public Utilities Commission and in support of the California Energy Commission.

Decoding 2016 HVAC

Let's Talk Mechanical Acceptance Testing

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Pacific Gas and Electric Company®

This program is funded by California utility customers under the auspices of the California Public Utilities Commission and in support of the California Energy Commission.

Who Are We?

Gina Rodda
Gabel Energy
gina@gabelenergy.com

GABEL ENERGY
BUILDING ENERGY ANALYSIS + ENERGY CODE COMPLIANCE

Host: Gina Rodda

Gina Rodda, our host for the Decoding Talk series, is a Certified Energy Analyst (CEA), and LEED Accredited Professional (AP).

She is involved in providing residential and non-residential energy calculations for a variety of building types throughout California; an instructor of full day trainings; and host of various webinars specific to Title 24 (Part 6) Building Energy Efficiency Standards.

Gina has been in the energy modeling field since 1991, starting the *ninth* California building energy code cycle of her career.

Who Are We?

David Wylie
ASWB Engineering
dwylie@aswb-engineering.com

Guest Speaker: David Wylie

David Wylie (the "W" of ASWB Engineering) is Principal Engineer, VP Education & Training at ASWB Engineering, and has a wide range of energy engineering experience, including research, development, program design, measurement, feasibility study of electrical and mechanical systems, and energy supply for commercial and industrial facilities.

He has a college teaching credential, teaches what he knows from experience, and has developed over 20 courses that address energy-efficient systems. David takes sophisticated engineering concepts and relates them in a way you can understand — in a friendly and practical way.

Several of David's articles have been published in trade magazines, and he has written a book titled "New Refrigerants for Air Conditioning and Refrigeration Systems."

Nonresidential Mechanical Acceptance Testing

- Understand which NRCA forms are required for HVAC new construction and changeouts;
- Review who and when the tests should be completed and documented for final permit;
- Provide an overview of the structure and testing methodology of mechanical acceptance testing.

Agenda

Agenda for Today **Approx. Length**

- Welcome..... 5 minutes
- Why?!..... 10 minutes
- Let's Talk
  - *Challenge A:* ..... *15 minutes*
  - *Challenge B:* ..... *35 minutes*
  - *Challenge C:* ..... *35 minutes*
  - *Challenge D:* ..... *10 minutes*
- Next Steps..... 5 minutes
- Wrap Up..... 5 minutes

Why?

What? Title 24 Part 6: Energy Code

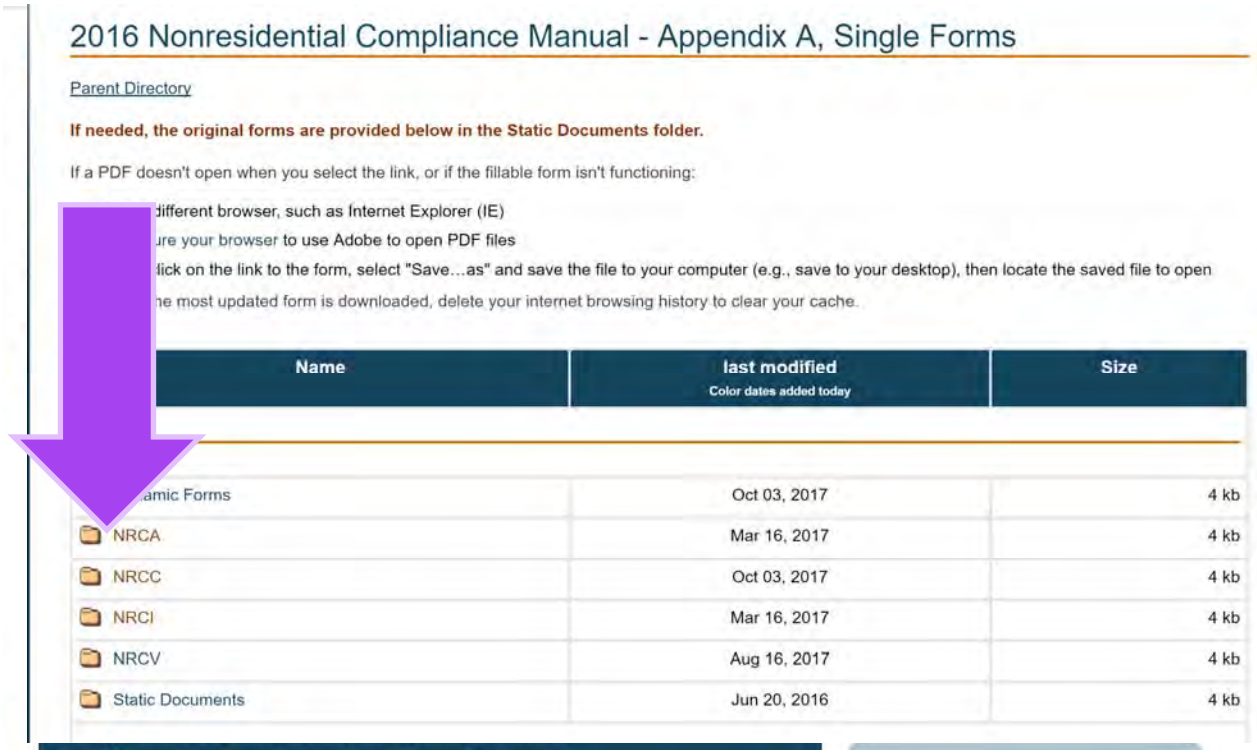
http://www.energy.ca.gov/title24/2016standards/index.html

Where to get the NRCA forms

http://www.energy.ca.gov/2015publications/CEC-400-2015-033/appendices/forms/

CEC Website

- All the forms live with the "Manual"
- The CEC has quick links to the forms throughout the website



2016 Nonresidential Compliance Manual - Appendix A, Single Forms

Parent Directory

If needed, the original forms are provided below in the Static Documents folder.

If a PDF doesn't open when you select the link, or if the fillable form isn't functioning:

different browser, such as Internet Explorer (IE)

ure your browser to use Adobe to open PDF files

lick on the link to the form, select "Save...as" and save the file to your computer (e.g., save to your desktop), then locate the saved file to open

he most updated form is downloaded, delete your internet browsing history to clear your cache.

Name	last modified Color dates added today	Size
amic Forms	Oct 03, 2017	4 kb
NRCA	Mar 16, 2017	4 kb
NRCC	Oct 03, 2017	4 kb
NRCI	Mar 16, 2017	4 kb
NRCV	Aug 16, 2017	4 kb
Static Documents	Jun 20, 2016	4 kb

Our Question To You

1. *In your experience, have all mechanical equipment installations included the correct acceptance testing procedures?*
2. *What are your top 3 concerns regarding mechanical acceptance testing?*
3. *If you could wave your magic wand, mechanical acceptance testing would include _____ to further assist the industry?*

1. Average response: 50% of the time

Which forms are required. Where, when and by who?

one form

Handouts

2016 ENERGY CODE

Ace Resources Title 24, Part 6 Fact Sheet

Nonresidential

Commissioning

Decoding 2016 HVAC™

Let's Talk Mechanical Acceptance Testing

Mechanical Acceptance Testing

Simple Mechanical Systems

1) Unitary or packaged equipment that each serve one zone; OR

System Features Include:	Code §
Thermostats	§120.2(a)(b)
Ventilation	§120.1(c)
Demand Control Ventilation (DCV)	§120.1(c) §120.2(d) §120.2(e) §120.2(f) §120.2(g) §120.2(h) §120.2(f)/ §140.4(e) §140.4(d) §140.4(k)(m) §140.4(l)

2016 ENERGY CODE

Ace Resources Title 24, Part 6 Triggers

Nonresidential

New HVAC: Simple and Complex Systems

HVAC Simple Systems

Space Conditioning Equipment [A]	Mandatory Requirements: Zone Thermostat [B] §120.2(a), (b) Setback Capable [B]	DCV [H] §120.1(c)	Heat Pump Controls [I] §120.2(d)	Shutoff and Reset [J] §120.2(e)	Ventilation Dampers §120.2(f) Automatic close upon fan shutdown [L]	Isolation Devices [M] §120.2(g)	Demand Shedding [O] §120.2(h)	Economizer FDD [P] §120.2(i)	Prescriptive Requirements: Zone Control [Q] §140.4(d)	Supply Temperature Reset [R] §140.4(f)	Economizer [F, S] §140.4(e)1- 5	Variable Flow Control [T] §140.4(k)5 §140.4(m)	Code §
Package Terminal Air Conditioner [B,C]	YES [D]	YES	no	YES [K]	YES	no	YES	YES	YES	YES	no	YES [U]	§120.2(a)(b) §120.1(c) §120.1(c) §120.2(e) §120.2(f) §120.2(g) §120.2(h) §120.2(j) §120.2(k) §140.4(d) §140.4(f)(k) §140.4(e) §140.4(k)(m) §140.4(k) N/A §110.2
Unitary Air Conditioners and Condensing Units [B]	YES	YES	no	YES [K]	YES	no	no	YES	no	no	YES	YES [U]	
Unitary Heat Pumps [E]	YES	YES	YES	YES [K]	YES	no	no	YES	no	no	YES	YES [U]	
Applied Heat Pumps [E]	YES	YES	YES	YES [K]	YES	YES	YES	YES	YES	no	YES	YES [U]	
Forced Air Furnace	YES	YES	no	YES [K]	YES [M]	no	YES	no	no	no	no	no	
Unit Heater	YES	no	no	YES [K]	no	no	no	no	no	no	no	no	

A Central Energy Management Control System [EMCS] should be installed at building site for optimal equipment operation and coordination

B Configurations vary between availability of central plant in design or reliance on self-contained heating and cooling

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F An EMCS may perform the setback functions

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H Demand Control Ventilation. See §120.1(c) 3, 4 and 5 for additional CO2 concentration setpoint information and sensor location requirements

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M Reference to combustion air requirements

N For systems serving multiple zones totaling more than 25,000 ft². A zone need not be isolated if demonstrated that it must be heated or cooled continuously

O Include settings capable of disabling, manually controlling, or automatically operating equipment. Applies to HVAC systems with DDC to the zone level

P Fault detection and diagnostics (FDD) systems are commonly available for packaged HVAC units, and can be integrated directly by the manufacturer. These are required for all new air-cooled unitary direct-expansion systems with cooling capacity of 54 kBtu/h (4 ½ tons) or greater. Controls include economizer checks and refrigerant diagnostics. The systems can report failures or suboptimal conditions that impact efficiency. Required acceptance tests for these systems may be found in Reference Appendix NA7.5.11

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S Exemptions apply where: (1) outside air conditions are undesirable, (2) high-rise residential, (3) adverse effects of other systems, like dehumidification, (4) high cooling efficiency systems [Table 140.1-A] (5) computer rooms served per §140.9(a)

T Air-side applications referred to in respective code language. Central EMCS necessary for remote system operation and ability to oversee all space-conditioning equipment and pumping needs.

U Variable Frequency Drive necessary to operate supply fan speed control at the unit

EnergyCodeAce.com

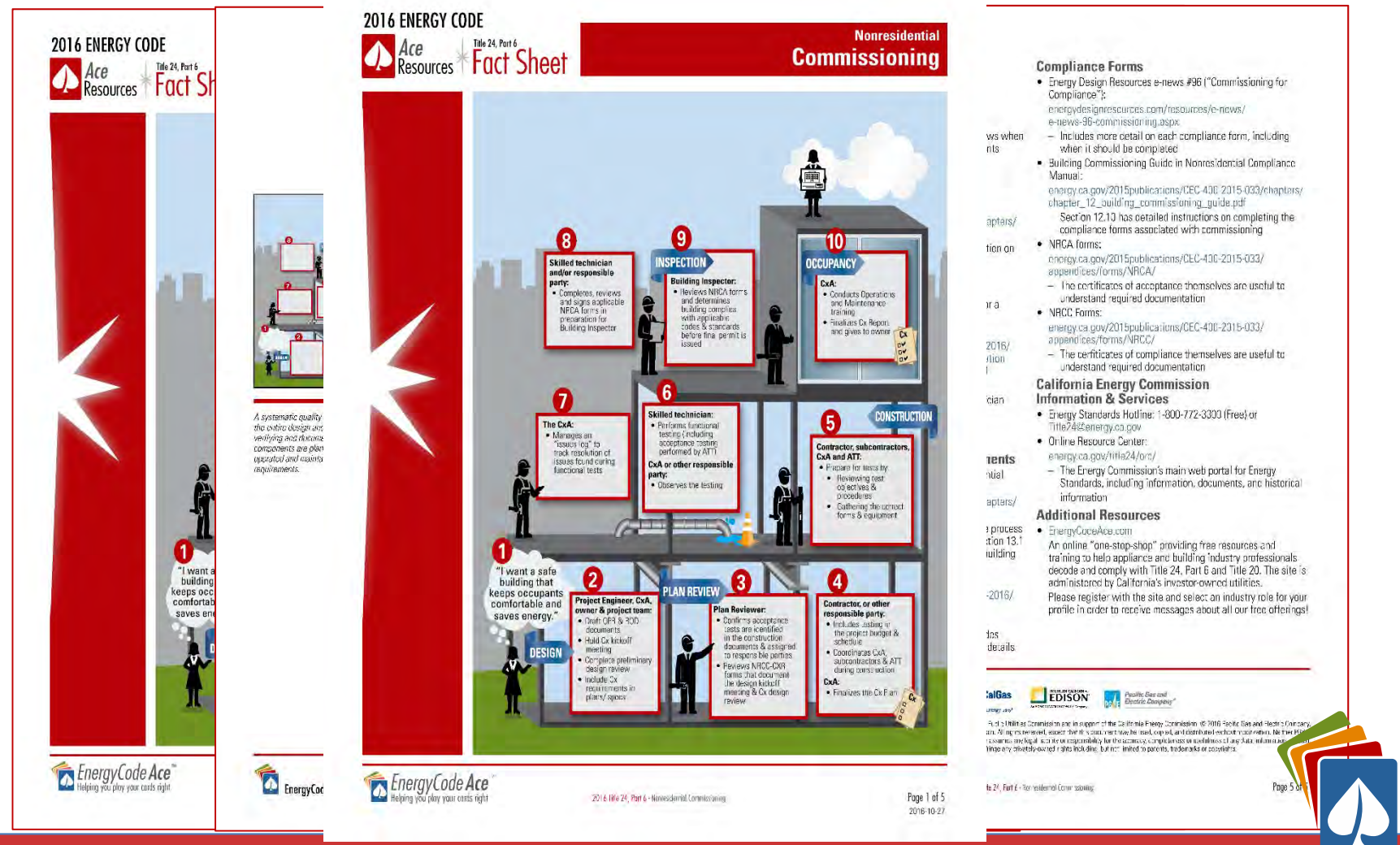
2016 Title 24, Part 6 - Nonresidential New HVAC: Simple and Complex Systems Triggers

Page 1 of 5

2017-01-03

- Energy Code Ace Commissioning Factsheet
- Decoding Talk "Information Sheet" on the who what and why of Mechanical Acceptance Testing including:
  - Energy Code Ace NR HVAC Trigger Sheet

Ace Resources™

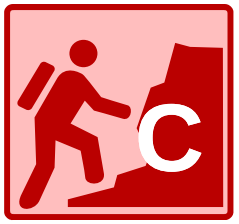


Let's Talk

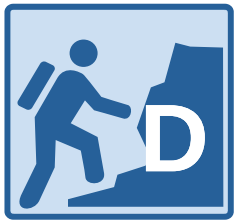
Challenges

- Challenge A:
  - Who, What and When

- Challenge B:
  - Simple Systems (Unitary)

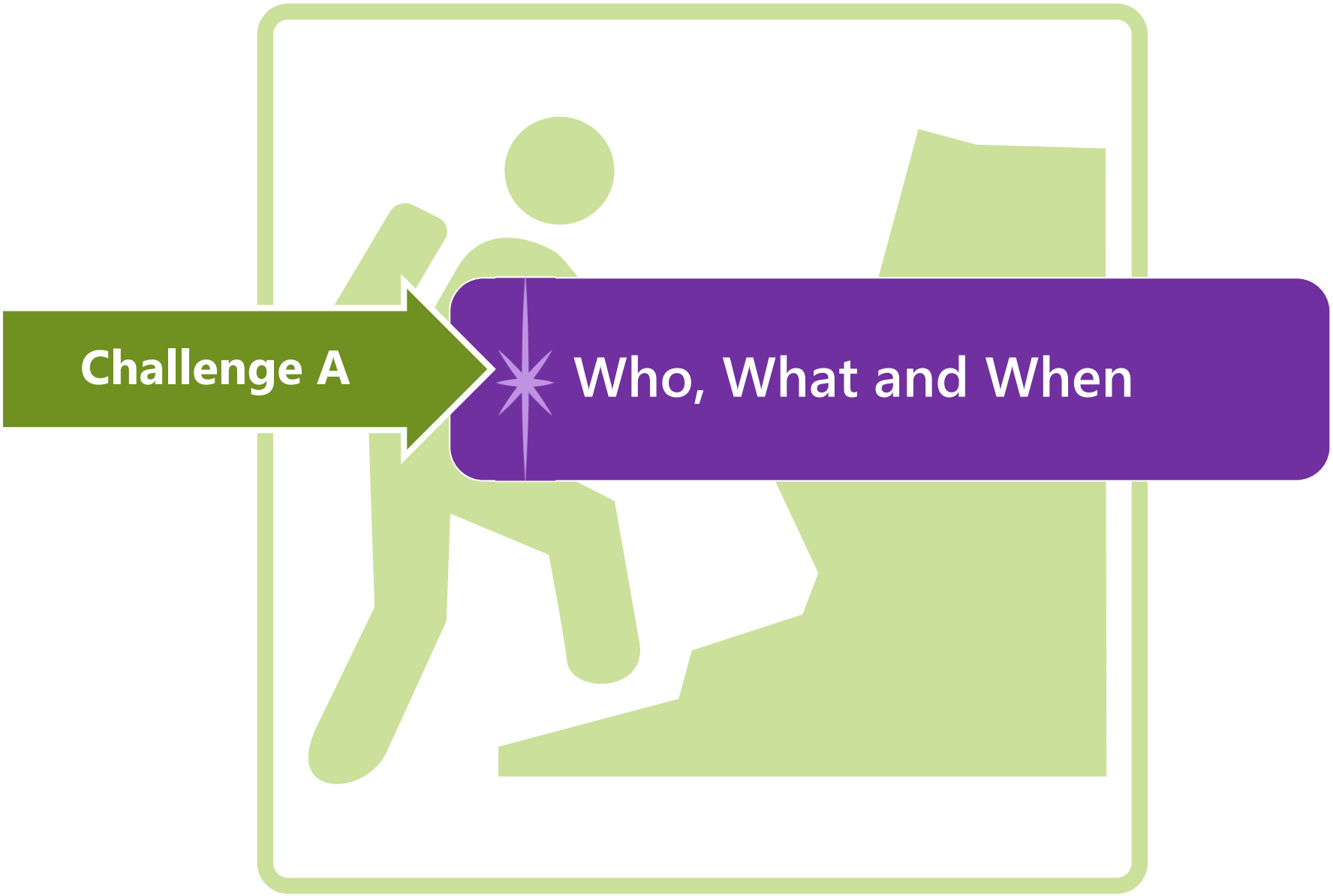


- Challenge C:
  - Complex Systems (Built Up)



- Challenge D:
  - HVAC Changeouts

Challenge A



Who, What and When

Who

- Currently a "certified" Acceptance Test Technician (ATT) is not required BUT THE TESTING IS!
- To be done by installing Contractor(s)

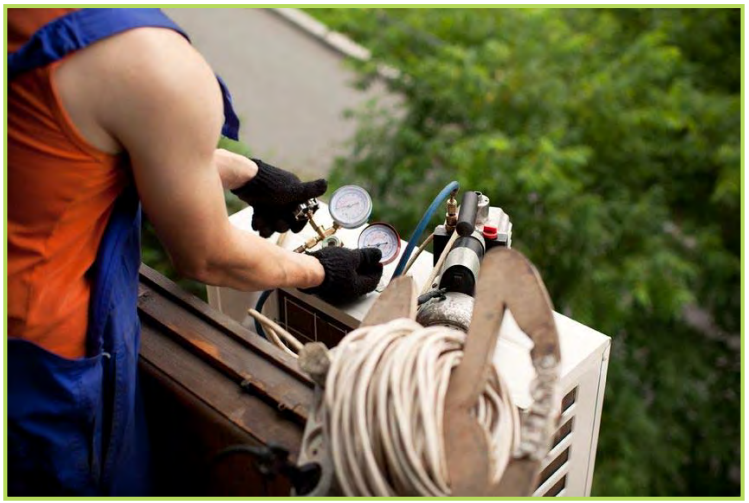
What

- Depending on HVAC feature, an applicable NRCA (Certificate of Acceptance) form outlines the testing criteria to be completed *successfully* before final permit.

When

- After the HVAC equipment is installed but BEFORE final permit.
- All NRCA forms to be provide to Building Owner

Who are the ATT's?



NA7.5.1 Outdoor Air Ventilation Systems

NA7.5.2 Constant Volume, Single Zone Unitary Air Conditioners and Heat Pumps

NA7.5.4 Air Economizer Controls

NA7.5.5 Demand Control Ventilation Systems

NA 7.5.6 Supply Fan Variable Flow Controls

NA7.5.7, NA7.5.9 Hydronic System Variable Flow Controls

NA7.5.10 Automatic Demand Shed Controls

§10-103.2 – NONRESIDENTIAL MECHANICAL ACCEPTANCE TEST TRAINING AND CERTIFICATION

- Certification requirements shall take effect when the Energy Commission finds that each of the following conditions are met.
- **Until such time that, Field Technicians are allowed to complete the acceptance test requirements in Section 120.5 without completing the Acceptance Test Technician certification requirements.**

Who are the ATTCP's?

ATTCP's

California State Pipe Trades Council (CSPTC): Union
www.calpipes.org

National Energy Management Institute Committee (NEMIC): Union
www.attcp.org

National Environmental Balancing Bureau (NEBB): Open to All
www.nebb.org

§10-103.2 – NONRESIDENTIAL MECHANICAL ACCEPTANCE TEST TRAINING AND CERTIFICATION

- Mechanical Acceptance Test Technician Certification Provider (ATTCP) approved by the Energy Commission, provide reasonable access to certification for technicians, who can be:
  - Professional engineers,
  - Licensed architects,
  - HVAC installers,
  - Mechanical contractors,
  - Testing and Balancing (TAB) certified technicians,
  - Controls installation and startup contractors and
  - Certified commissioning professionals

AND who have verifiable training, experience and expertise in HVAC systems.

National Environmental Balancing Bureau

1st step will be verification of experience.

Menu approach to testing qualifications.

- Can be certified in just one acceptance testing area.
- Can be certified in ALL for acceptance testing areas.
- If you go through the program now (2013 code), recertification is an update test for 2016 (*when available*).

✧ Get a price break on fees associated with the program if you sign up *now*.

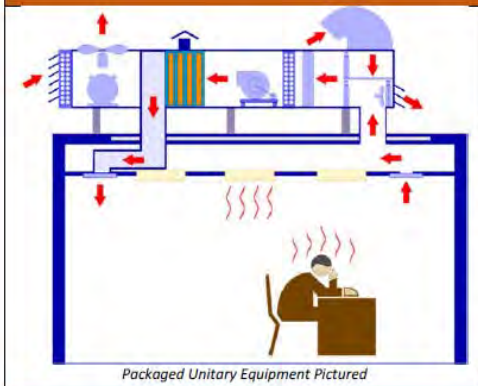
What Is Being Tested?

HVAC Equipment Types

Decoding 2016 HVAC™
Let's Talk Mechanical Acceptance Testing

Mechanical Acceptance Testing

Simple Mechanical Systems



Packaged Unitary Equipment Pictured

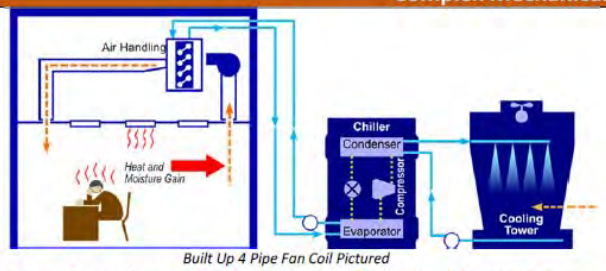
1) *Unitary or packaged equipment that each serve one zone; OR*
2) *Two-pipe, heating only systems serving one or more zones.*

Example of System Types

- Package Terminal Air Conditioner (PTAC)
- Split and Packaged Dx
- Forced Air Furnace (FAU)
- Gas Space Heater
- 2-Pipe Heating Only
- Radiant Heat Only

System Features Include:	Code §
Thermostats	§120.2(a)(b)
Ventilation	§120.1(c)
Demand Control Ventilation (DCV)	§120.1(c)
Heat Pump Controls	§120.2(d)
Shutoff and Reset Controls	§120.2(e)
Ventilation Dampers	§120.2(f)
Isolation Devices	§120.2(g)
Demand Shedding Controls	§120.2(h)
Economizer including FDD	§120.2(f)/ §140.4(e)
Zonal Controls	§140.4(d)
Variable Flow Controls	§140.4(k)(m)
Duct Systems	§140.4(l)

Complex Mechanical Systems



Built Up 4 Pipe Fan Coil Pictured

1) *Fan systems each serving multiple thermostatically controlled zones; OR*
2) *Built-up air handler systems (non-unitary or non-packaged HVAC equipment); OR*
3) *Hydronic or steam heating systems; OR*
4) *Hydronic cooling systems.*

Example of System Types

- Built-Up 4 pipe Fan Coil
- Built-Up VAV
- Built-Up Air Handling Systems
- Variable Refrigerant Flow (VRF)
- Zone Terminal Units/Fan Coils
- Hydronic Heating and Cooling

System Features Include:	Code §
Thermostats	§120.2(a)(b)
Ventilation	§120.1(c)
Demand Control Ventilation (DCV)	§120.1(c)
Shutoff and Reset Controls	§120.2(e)
Ventilation Dampers	§120.2(f)
Isolation Devices	§120.2(g)
Demand Shedding Controls	§120.2(h)
Direct Digital Controls (DDC)	§120.2(j)
Optimum Stop/Start (DDC)	§120.2(k)
Zonal Controls	§140.4(d)
Supply Temperature Reset Controls	§140.4(f)(k)
Economizer	§140.4(e)
Variable Flow Controls	§140.4(k)(m)
Isolation Valves	§140.4(k)
Ice Storage Dx (DES/DXAC) Systems	N/A
Thermal Energy Storage (TES)	§110.2

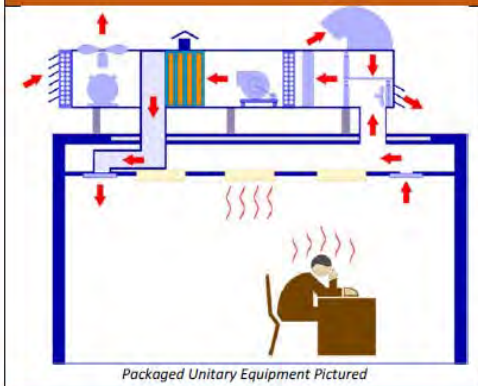
What Is Being Tested?

HVAC Equipment Features

Decoding 2016 HVAC™
Let's Talk Mechanical Acceptance Testing

Mechanical Acceptance Testing

Simple Mechanical Systems



Packaged Unitary Equipment Pictured

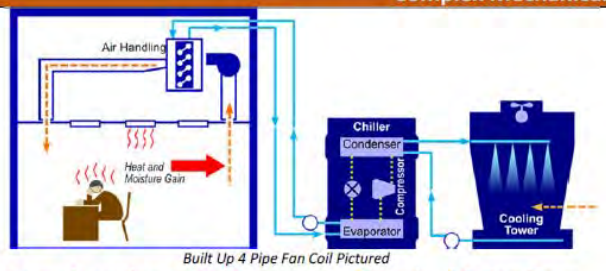
1) *Unitary or packaged equipment that each serve one zone; OR*
2) *Two-pipe, heating only systems serving one or more zones.*

Example of System Types

- Package Terminal Air Conditioner (PTAC)
- Split and Packaged Dx
- Forced Air Furnace (FAU)
- Gas Space Heater
- 2-Pipe Heating Only
- Radiant Heat Only

System Features Include:	Code §
Thermostats	§120.2(a)(b)
Ventilation	§120.1(c)
Demand Control Ventilation (DCV)	§120.1(c)
Heat Pump Controls	§120.2(d)
Shutoff and Reset Controls	§120.2(e)
Ventilation Dampers	§120.2(f)
Isolation Devices	§120.2(g)
Demand Shedding Controls	§120.2(h)
Economizer including FDD	§120.2(f)/ §140.4(e)
Zonal Controls	§140.4(d)
Variable Flow Controls	§140.4(k)(m)
Duct Systems	§140.4(l)

Complex Mechanical Systems



Built Up 4 Pipe Fan Coil Pictured

1) *Fan systems each serving multiple thermostatically controlled zones; OR*
2) *Built-up air handler systems (non-unitary or non-packaged HVAC equipment); OR*
3) *Hydronic or steam heating systems; OR*
4) *Hydronic cooling systems.*

Example of System Types

- Built-Up 4 pipe Fan Coil
- Built-Up VAV
- Built-Up Air Handling Systems
- Variable Refrigerant Flow (VRF)
- Zone Terminal Units/Fan Coils
- Hydronic Heating and Cooling

System Features Include:	Code §
Thermostats	§120.2(a)(b)
Ventilation	§120.1(c)
Demand Control Ventilation (DCV)	§120.1(c)
Shutoff and Reset Controls	§120.2(e)
Ventilation Dampers	§120.2(f)
Isolation Devices	§120.2(g)
Demand Shedding Controls	§120.2(h)
Direct Digital Controls (DDC)	§120.2(j)
Optimum Stop/Start (DDC)	§120.2(k)
Zonal Controls	§140.4(d)
Supply Temperature Reset Controls	§140.4(f)(k)
Economizer	§140.4(e)
Variable Flow Controls	§140.4(k)(m)
Isolation Valves	§140.4(k)
Ice Storage Dx (DES/DXAC) Systems	N/A
Thermal Energy Storage (TES)	§110.2

What Is Being Tested?

HVAC Equipment Classification

NRCA-MCH-02-A: **Outdoor Air:** Variable Air Volume Systems

Performed in conjunction with:	Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-07-A				
Related to:				
NRCA-MCH-05-A;	☒ *TAB Technician*	§10-03(b)4	NA7.5.1.1	Chapter 13.4
NRCA-MCH-06-A;	☐ *BAS Technician*	§120.1(b)2	NA7.5.1.2	Chapter 13.5
NRCA-MCH-07-A	☐ *HERS Rater*	§120.5(a)1		

Purpose of the Test

This test ensures the provision of adequate outdoor air ventilation through the variable air volume air handling unit at two representative operating conditions. The test consists of measuring outdoor air values at maximum flow and at or near minimum flow. The test verifies the introduction of a minimum volume of outdoor air, in accordance with §120.1(b)2, into the air handling unit and is within 10 percent of the required volume when the system is in occupied mode at these two conditions of supply airflow. Perform this test in conjunction with NA7.5.6 (NRCA-MCH-07-A) Supply Fan Variable Flow Controls Acceptance test procedures to reduce the overall system testing time as both tests use the same two conditions of airflow for their measurements. Related acceptance tests for these systems include:

- NA7.5.4 Air Economizer Controls.
- NA7.5.5 Demand Control Ventilation (DCV) Systems (if applicable).
- NA7.5.6 Supply Fan Variable Flow Controls

Instrumentation

Performance of this test will require measuring outdoor air flow. When the system includes an airflow monitoring system (AFMS) on the outdoor air, then it may be used for the measurements if it has a calibration certificate or is field-calibrated. The instrumentation needed to perform the task may include, but is not limited to. An airflow measurement probe (for example, hot-wire anemometer or velocity pressure probe), or a watch or some equivalent device to measure time in minutes.

Test Conditions

- **The test needs an override of the normal control operations. The control system of the air handling unit and zone controls must be complete, including:**
  - Supply fan capacity control (typically a variable speed drive).
  - Air economizer control.
  - Minimum outdoor air damper control.
  - Zone airflow control (including zone thermostats and VAV boxes).
- **Installed systems shall be ready for system operation, including:**
  - Duct work
  - VAV boxes.
  - Control sensors (temperature, flow, pressure, and so forth).
  - Electrical power to air handling unit and control system components.
- **Completion of air handling unit start-up procedures, per manufacturer's recommendations. Document the initial conditions before executing system overrides or manipulation of the set points and schedules.**
- **At the end of the test, return all systems to normal. Reference NRCC-MCH-03-E or the mechanical equipment schedules to determine the total required outdoor airflow for the system.**

Who is Doing The Testing?

Who Should Be There WITH Installing Contractor

NRCA-MCH-02-A: Outdoor Air: Variable Air Volume Systems

Performed in conjunction with:	Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-07-A				
Related to:				
NRCA-MCH-05-A;	☒ *TAB Technician*	§10-03(b)4	NA7.5.1.1	Chapter 13.4
NRCA-MCH-06-A;	☐ *BAS Technician*	§120.1(b)2	NA7.5.1.2	Chapter 13.5
NRCA-MCH-07-A	☐ *HERS Rater*	§120.5(a)1		

Purpose of the Test

This test ensures the provision of adequate outdoor air ventilation through the variable air volume air handling unit at two representative operating conditions. The test consists of measuring outdoor air values at maximum flow and at or near minimum flow. The test verifies the introduction of a minimum volume of outdoor air, in accordance with §120.1(b)2, into the air handling unit and is within 10 percent of the required volume when the system is in occupied mode at these two conditions of supply airflow. Perform this test in conjunction with NA7.5.6 (NRCA-MCH-07-A) Supply Fan Variable Flow Controls Acceptance test procedures to reduce the overall system testing time as both tests use the same two conditions of airflow for their measurements. Related acceptance tests for these systems include:

- NA7.5.4 Air Economizer Controls.
- NA7.5.5 Demand Control Ventilation (DCV) Systems (if applicable).

TAB: Testing, Adjusting, Air Balancing Technician
BAS: Building Automation Systems Technician
HERS: Home Energy Rating System Rater
3rd party

  - VAV boxes.
  - Control sensors (temperature, flow, pressure, and so forth).
  - Electrical power to air handling unit and control system components.
- **Completion of air handling unit start-up procedures, per manufacturer's recommendations. Document the initial conditions before executing system overrides or manipulation of the set points and schedules.**
- **At the end of the test, return all systems to normal. Reference NRCC-MCH-03-E or the mechanical equipment schedules to determine the total required outdoor airflow for the system.**

What Does Code Require?

What is being tested, and where to find information

NRCA-MCH-02-A: Outdoor Air: Variable Air Volume Systems

Performed in conjunction with:	Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-07-A				
Related to:				
NRCA-MCH-05-A;	☒ *TAB Technician*	§10-03(b)4	NA7.5.1.1	Chapter 13.4
NRCA-MCH-06-A;	☐ *BAS Technician*	§120.1(b)2	NA7.5.1.2	Chapter 13.5
NRCA-MCH-07-A	☐ *HERS Rater*	§120.5(a)1		

Purpose of the Test

This test ensures the provision of adequate outdoor air ventilation through the variable air volume air handling unit at two representative operating conditions. The test consists of measuring outdoor air values at maximum flow and at or near minimum flow. The test verifies the introduction of a minimum volume of outdoor air, in accordance with §120.1(b)2, into the air handling unit and is within 10 percent of the required volume when the system is in occupied mode at these two conditions of supply airflow. Perform this test in conjunction with NA7.5.6 (NRCA-MCH-07-A) Supply Fan Variable Flow Controls Acceptance test procedures to reduce the overall system testing time as both tests use the same two conditions of airflow for their measurements. Related acceptance tests for these systems include:

- NA7.5.4 Air Economizer Controls.
- NA7.5.5 Demand Control Ventilation (DCV) Systems (if applicable).
- NA7.5.6 Supply Fan Variable Flow Controls

Instrumentation

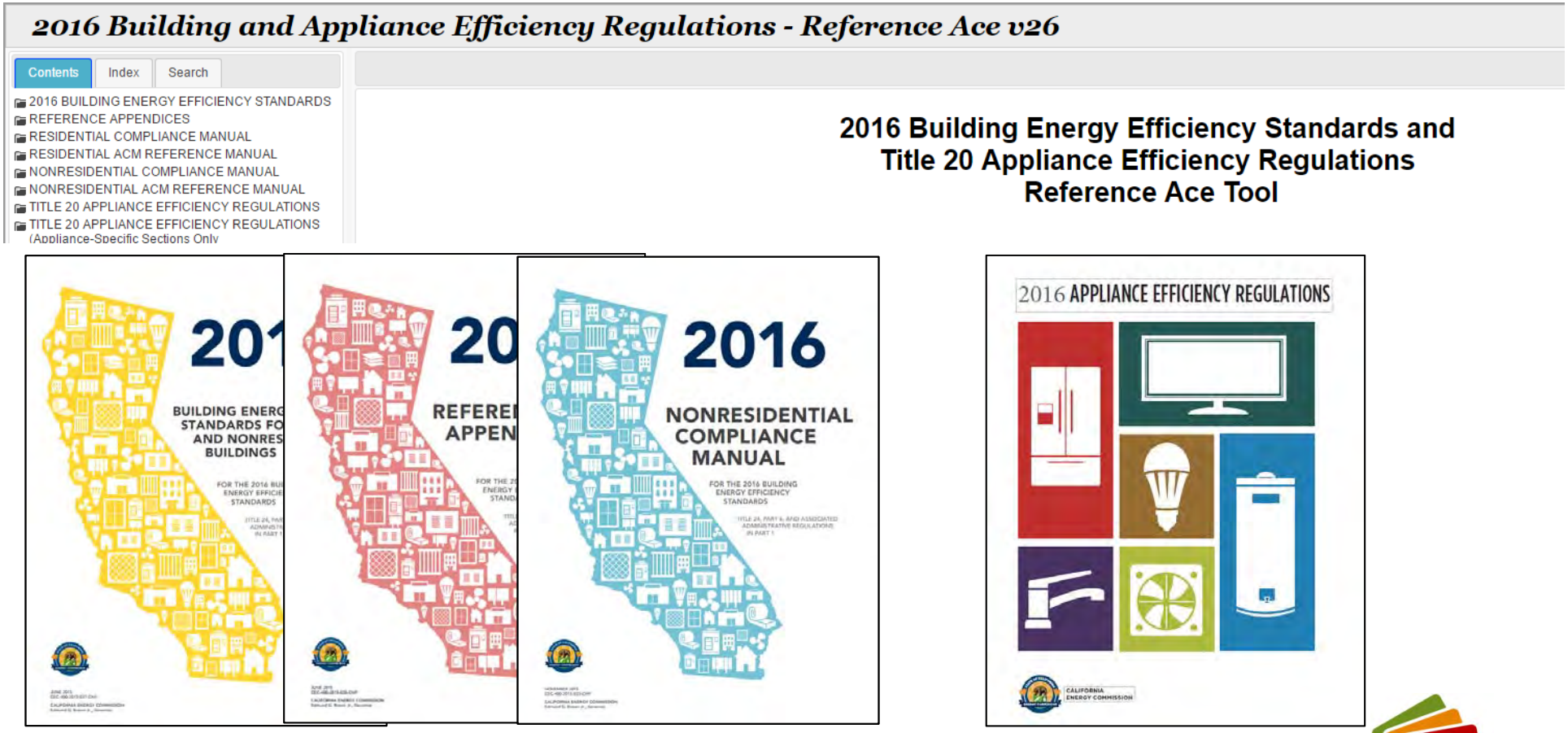
Performance of this test will require measuring outdoor air flow. When the system includes an airflow monitoring system (AFMS) on the outdoor air, then it may be used for the measurements if it has a calibration certificate or is field-calibrated. The instrumentation needed to perform the task may include, but is not limited to. An airflow measurement probe (for example, hot-wire anemometer or velocity pressure probe), or a watch or some equivalent device to measure time in minutes.

Test Conditions

- **The test needs an override of the normal control operations. The control system of the air handling unit and zone controls must be complete, including:**
  - Supply fan capacity control (typically a variable speed drive).
  - Air economizer control.
  - Minimum outdoor air damper control.
  - Zone airflow control (including zone thermostats and VAV boxes).
- **Installed systems shall be ready for system operation, including:**
  - Duct work
  - VAV boxes.
  - Control sensors (temperature, flow, pressure, and so forth).
  - Electrical power to air handling unit and control system components.
- **Completion of air handling unit start-up procedures, per manufacturer's recommendations. Document the initial conditions before executing system overrides or manipulation of the set points and schedules.**
- **At the end of the test, return all systems to normal. Reference NRCC-MCH-03-E or the mechanical equipment schedules to determine the total required outdoor airflow for the system.**

Ace Tools™

Helps you navigate the Standards using key word search capabilities, hyperlinked tables and related sections



EnergyCodeAce.com/tools

"At-A-Glance" Tables from NR Manual

NRCA-MCH-14-A: Distributed Energy Storage DX AC System

Related to:
NRCA-MCH-02-A;
NRCA-MCH-03-A;
NRCA-MCH-05-A

Simple HVAC System

- ☐ *TAB Technician*
- ☐ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)13	NA7.5.13	Chapter 13.17

Distributed energy storage system third party submittal form should be verified.

Purpose of the Test

This test verifies proper operation of distributed energy storage DX systems. Distributed energy systems reduce peak demand by operating during off peak hours and storing cooling, usually in the form of ice. During peak cooling hours the ice is melted to avoid compressor operation.

Instrumentation

Distributed energy storage acceptance tests require no additional instrumentation for testing.

Test Conditions

- The DX equipment should be installed and operational.
- Perform pre-startup installation procedures as specified by the manufacturer.
- Verify that the building cooling is controlled by a standard indoor HVAC thermostat and not by factory installed controls.
- Verify that ice making is not controlled by the thermostat.
- The water tank should be filled to the proper level as specified by the manufacturer prior to the start of the test.
- Verify refrigerant piping connects and the system is charged with refrigerant.

Estimated Time to Complete

- Construction Inspection: 0.5 hours
- Acceptance Tests: 2 hours

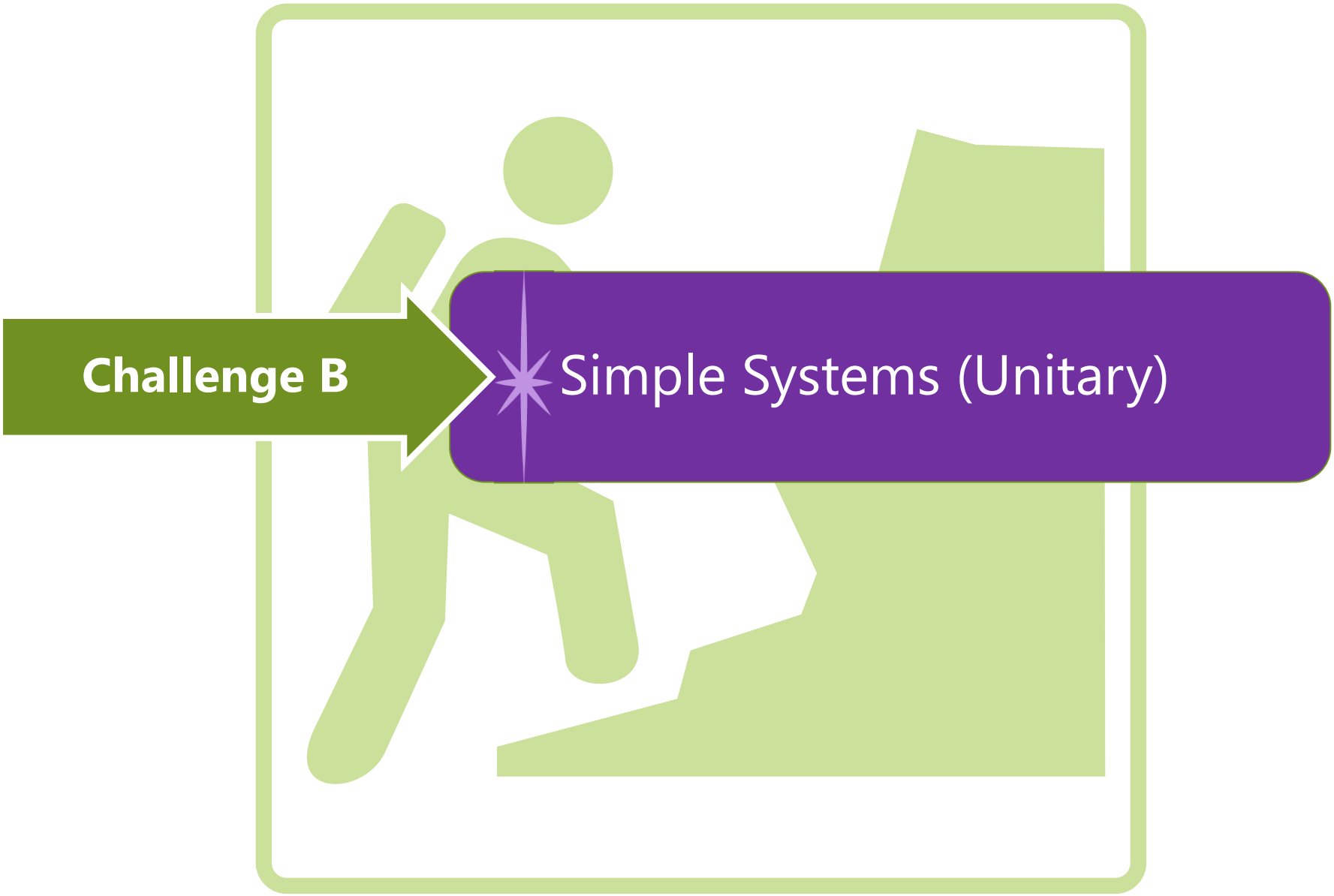
Acceptance Criteria

- Verify nighttime ice making operation.
- Verify that tank discharges during on-peak cooling periods.
- Verify that the compressor does not run and the tank does not discharge when there is no cooling demand during on-peak periods.
- Verify that the system does not operate during a morning shoulder period when there is no cooling demand.
- Verify that the system operates in direct mode (with compressor running) during the morning shoulder time period.

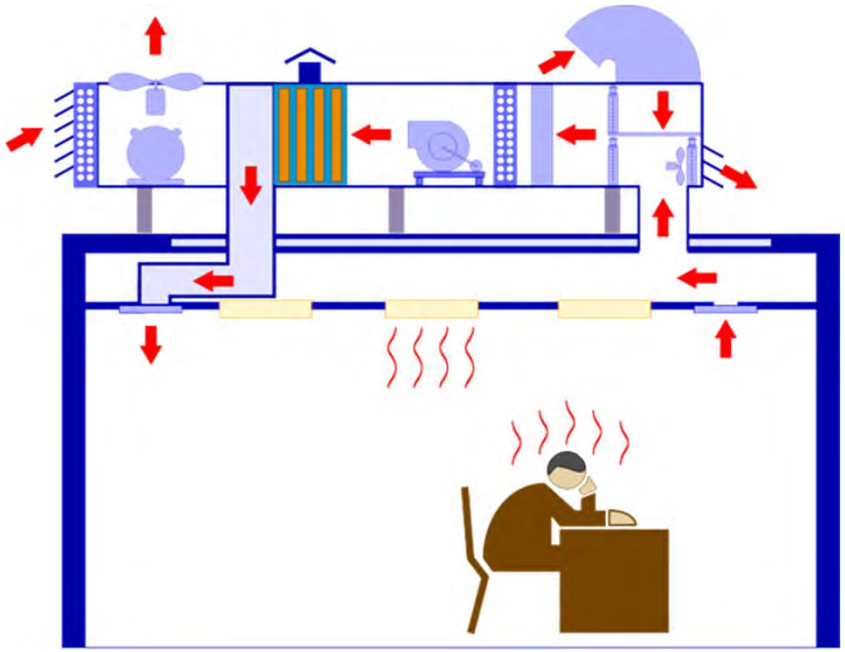
Potential Issues and Cautions

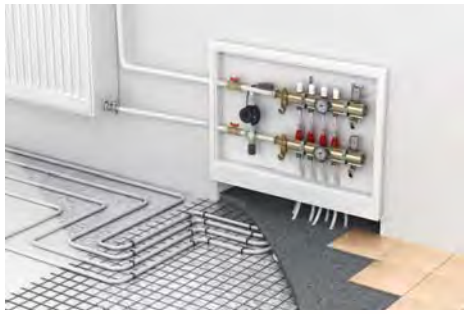
- These tests only apply to systems with storage capacity less than 100 ton-hours.
- Systems with storage above 100 ton-hours should be modeled using the thermal energy storage compliance option.
- Be sure the water tank is filled to the proper level indicated by the manufacturer prior to the start of the tests.
- The tests require override of the system controller programming. Be sure to record the system settings prior to the start of the testing, and restore the system settings to their original values upon completion of the tests.

Challenge B



Simple (Unitary) Equipment





HVAC Simple Systems

	Mandatory Requirements								Prescriptive Requirements			
Space Conditioning Equipment [A]	Zone Thermostat [F] §120.2(a), (b) Setback Capable [G]	DCV [H] §120.1(c)	Heat Pump Controls [I] §120.2(d)	Shutoff and Reset [J] §120.2(e)	Ventilation Dampers §120.2(f) Automatic close upon fan shutdown [L]	Isolation Devices [N] §120.2(g)	Demand Shedding [O] §120.2(h)	Economizer FDD [P] §120.2(i)	Zone Control [Q] §140.4(d)	Supply Temperature Reset [R] §140.4(f)	Economizer [P,S] §140.4(e)1- 5	Variable Flow Control [T] §140.4(k)6 §140.4(m)
Package Terminal Air Conditioner [B,C]	YES [D]	YES	no	YES [K]	YES	no	YES	YES	YES	YES	no	YES [U]
Unitary Air Conditioners and Condensing Units [D]	YES	YES	no	YES [K]	YES	no	no	YES	no	no	YES	YES [U]
Unitary Heat Pumps [E]	YES	YES	YES	YES [K]	YES	no	no	YES	no	no	YES	YES [U]
Applied Heat Pumps [E]	YES	YES	YES	YES [K]	YES	YES	YES	YES	YES	no	YES	YES [U]
Forced Air Furnace	YES	YES	no	YES [K]	YES [M]	no	YES	no	no	no	no	no
Unit Heater	YES	no	no	YES [K]	no	no	no	no	no	no	no	no

Simple (Unitary) Equipment

Ventilation

Acceptance Tests: HVAC Simple Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-03-A Constant Volume, Single-zone, Unitary A/C and HP	NRCA-MCH04-A Air Distribution Duct Leakage	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-12-A Fault Detection and Diagnostic for DX Systems	NRCA-MCH-13-A Fault Detection and Diagnostic for AHUs	NRCA-MCH-16-A Supply Air Temp Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	YES	no	no	no	no	no	no	no	no	no	YES
DCV	YES	YES	no	YES	YES	YES	no	no	no	no	no	YES
Heat Pump Controls	no	YES	no	no	no	no	no	no	no	no	no	no
Shutoff and Reset	no	YES	no	no	no	no	no	YES	no	no	no	YES
Ventilation Dampers	YES	YES	YES	YES	no	YES	no	no	no	no	no	YES
Isolation Devices	no	YES	YES	no	no	no	YES	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	YES	no	no	YES	YES	no	YES
Zone Control	no	YES	no	no	no	no	YES	YES	no	no	no	YES
Supply Temp. Reset	no	no	no	no	no	no	no	no	no	no	YES	YES
Variable Flow Control	no	no	no	no	no	YES	YES	no	no	no	no	YES
Duct Systems	YES	no	YES	no	no	no	no	no	no	no	no	no

NRCA-MCH-02-A: Constant Volume Outdoor Air (new CAV systems)

Related to:
NRCA-MCH-03-A;
NRCA-MCH-05-A;
NRCA-MCH-06-A

Simple HVAC System

- [X] *TAB Technician*
- [ ] *BAS Technician*
- [ ] *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§10-03(b)4 §120.1(b)2 §120.5(a)1	NA7.5.1.1 NA7.5.1.2	Chapter 13.4 Chapter 13.5

Simple (Unitary) Equipment: Ventilation

NRCA-MCH-02-A: Constant Volume Outdoor Air (new CAV systems)

Related to:	Simple HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-03-A; NRCA-MCH-05-A; NRCA-MCH-06-A	 [X] *TAB Technician* [ ] *BAS Technician* [ ] *HERS Rater*	§10-03(b)4 §120.1(b)2 §120.5(a)1	NA7.5.1.1 NA7.5.1.2	Chapter 13.4 Chapter 13.5

Acceptance Criteria

- System demonstrates a means of maintaining the minimum outdoor air damper position.
- Minimum damper position is marked on the outdoor air damper
- Measured outdoor air flow is within 10 percent of the total value found on the Energy Standards mechanical plan check document NRCC-MCH-03-E Column M.

Potential Issues and Cautions

Do not attempt to set the minimum damper position and perform the acceptance test at the same time. The acceptance test verifies the outdoor airflow of the system after calibration and system set-up is complete. Testing costs can be reduced by conducting the acceptance test immediately after set-up is concluded.

- A means to measure airflow (typically either a velocity pressure probe or hot wire anemometer).
- A watch or some equivalent instrument to measure time in minutes

Test Conditions

- To perform the test, override the control system of the air handling unit. The control system of the air handling unit must be complete.
- All systems must be installed and ready for system operation, including:
  - Air economizer controls.
  - Duct work.
  - Control sensors (temperature, flow, thermostats, and so forth).
  - Electrical power to air handling unit and control system components.
  - Completion of air handling unit start-up procedures, per manufacturer's recommendations.
  - Documentation of the initial conditions before overrides or manipulation of the set points and schedules. All systems must be returned to normal at the end of the test.

Note: Systems requiring demand ventilation controls per §120.1(c)3 must conform to §120.1(c)4E regarding the minimum ventilation rate (refer to NA7.5.5 Demand Controlled Ventilation Systems Acceptance Test).

Estimated Time to Complete

- Construction inspection: 0.5 hours.
- Functional testing: 1 hour (depending on difficulty in measuring outdoor air flow)

Simple (Unitary) Equipment

Unitary Systems

Acceptance Tests: HVAC Simple Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Ai	NRCA-MCH-03-A Constant Volume, Single-zone, Unitary A/C and HP	NRCA-MCH04-A Air Distribution Duct Leakage	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-12-A Fault Detection and Diagnostic for DX Systems	NRCA-MCH-13-A Fault Detection and Diagnostic for AHUs	NRCA-MCH-16-A Supply Air Temp Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	YES	no	no	no	no	no	no	no	no	no	YES
DCV	YES	YES	no	YES	YES	YES	no	no	no	no	no	YES
Heat Pump Controls	no	YES	no	no	no	no	no	no	no	no	no	no
Shutoff and Reset	no	YES	no	no	no	no	no	YES	no	no	no	YES
Ventilation Dampers	YES	YES	YES	YES	no	YES	no	no	no	no	no	YES
Isolation Devices	no	YES	YES	no	no	no	YES	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	YES	no	no	YES	YES	no	YES
Zone Control	no	YES	no	no	no	no	YES	YES	no	no	no	YES
Supply Temp. Reset	no	no	no	no	no	no	no	no	no	no	YES	YES
Variable Flow Control	no	no	no	no	no	YES	YES	no	no	no	no	YES
Duct Systems	YES	no	YES	no	no	no	no	no	no	no	no	no

NRCA-MCH-03-A: Constant Volume, Single-Zone, Unitary AC & Heat Pumps Systems

Related to:	Simple HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-02-A; NRCA-MCH-05-A; NRCA-MCH-06-A	 ☒ *TAB Technician* ☐ *BAS Technician* ☐ *HERS Rater*	§120.1(c)2 §120.2 §120.5(a)2	NA7.5.2	Chapter 13.6

Simple (Unitary) Equipment: Systems

NRCA-MCH-03-A: Constant Volume, Single-Zone, Unitary AC & Heat Pumps Systems

Related to:	Simple HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-02-A; NRCA-MCH-05-A; NRCA-MCH-06-A	 ☒ *TAB Technician* ☐ *BAS Technician* ☐ *HERS Rater*	§120.1(c)2 §120.2 §120.5(a)2	NA7.5.2	Chapter 13.6

Purpose of the Test

- Occupied cooling mode operation: The supply fan operates continuously, all cooling stages operate, heating is not enabled, and outside damper is at minimum position.
- Unoccupied operation with no heating or cooling load: The supply fan shuts off, heating or cooling is not enabled, and the outdoor air damper is closed.
- Unoccupied operation with heating load: The supply cycles ON, heating is enabled, cooling is not enabled, and the outdoor air damper is either closed or at minimum position.
- Unoccupied cooling mode operation: The supply cycles ON, cooling is enabled, heating is not enabled, and the outdoor air damper is at minimum position.
- Manual override mode: System reverts to occupied mode, the supply fan turns ON for duration of override, heating or cooling is enabled as necessary, and the outdoor air damper opens to minimum position.

Potential Issues and Cautions

- Ensure that the supply fan runs continuously in occupied mode and cycles appropriately in unoccupied mode. Cycling refers to the supply fan running only when heating or cooling is enabled. When testing the manual override, adjust the length of the override period to minimize test time. Be sure to reset the override period back to the correct length of time.
  - Tip: Overall test time may be reduced (especially for rooftop HVAC units controlled by thermostats) if two people perform the test – one to manipulate the thermostat while someone else verifies operation at the packaged unit.
- The Energy Standards do not mandate the actual differential between occupied and unoccupied setpoints, only that the system must be adjustable down to 55°F for heating and up to 85°F for cooling and that the thermostat can be set for a 5°F dead band. Setback control is only required for climates where the winter median of extremes is less than or equal to 32°F.
- Setup control is only required for climates where the 0.5% summer design dry-bulb temperature is greater than or equal to 100°F.

outdoor air damper is at minimum position.

Simple (Unitary) Equipment

Duct Systems §140.4(l)

Acceptance Tests: HVAC Simple Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-03-A Constant Volume, Single-zone Unitary A/C and HP	NRCA-MCH04-A Air Distribution Duct Leakage	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-12-A Fault Detection and Diagnostic for DX Systems	NRCA-MCH-13-A Fault Detection and Diagnostic for AHUs	NRCA-MCH-16-A Supply Air Temp Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	YES	no	no	no	no	no	no	no	no	no	YES
DCV	YES	YES	no	YES	YES	YES	no	no	no	no	no	YES
Heat Pump Controls	no	YES	no	no	no	no	no	no	no	no	no	no
Shutoff and Reset	no	YES	no	no	no	no	no	YES	no	no	no	YES
Ventilation Dampers	YES	YES	YES	YES	no	YES	no	no	no	no	no	YES
Isolation Devices	no	YES	YES	no	no	no	YES	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	YES	no	no	YES	YES	no	YES
Zone Control	no	YES	no	no	no	no	YES	YES	no	no	no	YES
Supply Temp. Reset	no	no	no	no	no	no	no	no	no	no	YES	YES
Variable Flow Control	no	no	no	no	no	YES	YES	no	no	no	no	YES
Duct Systems	YES	no	YES	no	no	no	no	no	no	no	no	no

NRCA-MCH-04-A: Air Distribution Systems

Related to:	Simple HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCV-MCH-04-H	 [X] *TAB Technician* [ ] *BAS Technician* [ ] *HERS Rater*	§120.4(a) §120.5(a)3 §140.4(l) §141.0(b)2D	NA7.5.3	Chapter 13.7

Simple (Unitary) Equipment: Duct Systems

NRCA-MCH-04-A: Air Distribution Systems

Related to:	**Simple** HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCV-MCH-04-H	☐ *TAB Technician* ☐ *BAS Technician* ☒ *HERS Rater*	§120.4(a) §120.5(a)3 §140.4(l) §141.0(b)2D	NA7.5.3	Chapter 13.7

Purpose of the Test

This test verifies all duct work associated with all nonexempt constant volume, single-zone, HVAC units (in other words, air conditioners, heat pumps, and furnaces) meet the material, installation, and insulation R-values per §120.4(a) and leakage requirements outlined either in §140.4(l) for new duct systems or §141.0(b)2D for existing duct systems.

As detailed in the Energy Standards, this test is required only for single-zone units serving less than 5,000 ft² of floor area where 25 percent or more of the duct surface area is in one of the following spaces:

- Outdoors.
- In a space directly under a roof where the U-factor of the roof is greater than the U-factor of the ceiling.
- In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces.
- In an unconditioned crawlspace.
- In other unconditioned spaces.

Within these criteria, this test applies to both new duct systems and existing duct systems that are either being extended per §141.0(b)2D or the space conditioning system is altered by the installation or replacement of space conditioning equipment per §141.0(b)2E, including replacement of the air handler, outdoor condensing unit of a split-system air conditioner or heat pump, cooling or heating coil, or the furnace heat exchanger. Existing duct systems do not have to be tested if they are insulated or sealed with asbestos.

Instrumentation

Performance of this test will require measuring duct leakage. Equipment used:

- Fan flowmeter (a fan with a calibrated orifice used to pressurize the ducts) accuracy within 3 percent of measured flow. To view a list of the current certified equipment go to: http://www.energy.ca.gov/title24/equipment_cert/ama_fas/index.html
- Digital manometer (pressure meter) accuracy within 0.2 pascals.

Duct leakage tests must be verified by a third-party HERS Rater who has been certified by a HERS Provider that has been approved by the California Energy Commission.

Test Conditions

- For newly constructed buildings, all ductwork must be accessible for visual inspection before ceiling installation.
- All ductwork and grilles should be in place before performing the fan flow test to ensure the system depicts normal operating configuration. Hence, testing must occur after visual inspection and installation of the diffusers.
- HVAC system must be installed and ready for system operation, including completion of all start-up procedures, per manufacturer's recommendations.

Estimated Time to Complete

- Construction Inspection: 0.5 to 2 hours, depending on duct access for visual inspections and availability of construction material documentation (that is, cut sheets and so forth)

Simple (Unitary) Equipment

Economizers

Acceptance Tests: HVAC Simple Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-03-A Constant Volume, Single-zone, Unitary A/C and HP	NRCA-MCH04-A Air Distribution Duct Leakage	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-12-A Fault Detection and Diagnostic for DX Systems	NRCA-MCH-13-A Fault Detection and Diagnostic for AHUs	NRCA-MCH-16-A Supply Air Temp Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	YES	no	no	no	no	no	no	no	no	no	YES
DCV	YES	YES	no	YES	YES	YES	no	no	no	no	no	YES
Heat Pump Controls	no	YES	no	no	no	no	no	no	no	no	no	no
Shutoff and Reset	no	YES	no	no	no	no	no	YES	no	no	no	YES
Ventilation Dampers	YES	YES	YES	YES	no	YES	no	no	no	no	no	YES
Isolation Devices	no	YES	YES	no	no	no	YES	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	YES	no	no	YES	YES	no	YES
Zone Control	no	YES	no	no	no	no	YES	YES	no	no	no	YES
Supply Temp. Reset	no	no	no	no	no	no	no	no	no	no	YES	YES
Variable Flow Control	no	no	no	no	no	YES	YES	no	no	no	no	YES
Duct Systems	YES	no	YES	no	no	no	no	no	no	no	no	no

NRCA-MCH-05-A : Air Economizer Controls

Related to:

NRCA-MCH-02-A;
NRCA-MCH-03-A;
NRCA-MCH-05-A;
NRCA-MCH-06-A

Simple and Complex HVAC System

☐ *TAB Technician*
☒ *BAS Technician*
☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)4 §140.4(e)	NA7.5.4	Chapter 13.8

If the economizer is factory installed and certified, a valid factory certificate is required to document acceptance testing exception.

Simple (Unitary) Equipment: Economizers

NRCA-MCH-05-A : Air Economizer Controls

Related to:	Simple and Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-02-A; NRCA-MCH-03-A; NRCA-MCH-05-A; NRCA-MCH-06-A	☐ *TAB Technician* ☒ *BAS Technician* ☐ *HERS Rater*	§120.5(a)4 §140.4(e)	NA7.5.4	Chapter 13.8
		If the economizer is factory installed and certified, a valid factory certificate is required to document acceptance testing exception.		

Purpose of the Test

Acceptance Criteria

- If the economizer is factory installed and certified, a valid factory certificate is required for acceptance. No additional equipment tests are necessary.
- Air economizer lockout setpoint complies with Energy Standards Table 140.4-B per §140.4(e)3. This table is reproduced in Table 13-6 located below.
- Outside sensor location accurately reads true outdoor air temperature and is not affected by exhaust air or other heat sources.
- All sensors are located appropriately to achieve the desired control.
- During economizer mode, the outdoor air damper modulates open to a maximum position, and the return air damper modulates 100 percent closed.
- The outdoor air damper is 100 percent open before mechanical cooling is enabled and remains at 100 percent open while mechanical cooling is enabled (economizer integration when used for compliance with §140.4(e)2B). The economizer is capable of providing partial cooling even when additional mechanical cooling is required to meet the load. For unit controls, the outdoor air damper may not begin to close until the leaving air temperature is below 45°F.
- When the economizer is disabled, the outdoor air damper closes to a minimum position, the return damper modulates 100 percent open, and mechanical cooling remains enabled.
- If the unit has heating capability, the outdoor air damper remains at minimum position when heating is enabled. When the unit is turned off or otherwise disabled, the outdoor air damper closes

on.

- Document the initial conditions before overrides or manipulation of the settings. All systems must be returned to normal at the end of the test.
- Before conducting the test, demand control ventilation systems must be disabled, if applicable.

Estimated Time to Complete

- Construction Inspection: 0.5 to 1 hours (depending on familiarity with the controls)
- Functional Testing: 0.5 to 2 hours (depending on familiarity with the controls and issues that arise during testing)

Acceptance Criteria

Simple (Unitary) Equipment

Ventilation

Acceptance Tests: HVAC Simple Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-03-A Constant Volume, Single-zone, Unitary A/C and HP	NRCA-MCH04-A Air Distribution Duct Leakage	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-12-A Fault Detection and Diagnostic for DX Systems	NRCA-MCH-13-A Fault Detection and Diagnostic for AHUs	NRCA-MCH-16-A Supply Air Temp Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	YES	no	no	no	no	no	no	no	no	no	YES
DCV	YES	YES	no	YES	YES	YES	no	no	no	no	no	YES
Heat Pump Controls	no	YES	no	no	no	no	no	no	no	no	no	no
Shutoff and Reset	no	YES	no	no	no	no	no	YES	no	no	no	YES
Ventilation Dampers	YES	YES	YES	YES	no	YES	no	no	no	no	no	YES
Isolation Devices	no	YES	YES	no	no	no	YES	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	YES	no	no	YES	YES	no	YES
Zone Control	no	YES	no	no	no	no	YES	YES	no	no	no	YES
Supply Temp. Reset	no	no	no	no	no	no	no	no	no	no	YES	YES
Variable Flow Control	no	no	no	no	no	YES	YES	no	no	no	no	YES
Duct Systems	YES	no	YES	no	no	no	no	no	no	no	no	no

NRCA-MCH-06-A: Demand Control Ventilation (DCV) Systems

Related to:
NRCA-MCH-02-A;
NRCA-MCH-03-A;
NRCA-MCH-05-A

Simple and Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.1(c)3 §120.1(c)4 §120.5(a)5	NA7.5.5	Chapter 13.8

Two people would be beneficial to this documentation of this test.

Simple (Unitary) Equipment: Ventilation

NRCA-MCH-06-A: Demand Control Ventilation (DCV) Systems

Related to:
NRCA-MCH-02-A;
NRCA-MCH-03-A;
NRCA-MCH-05-A

Simple and Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.1(c)3 §120.1(c)4 §120.5(a)5	NA7.5.5	Chapter 13.8

Two people would be beneficial to this documentation of this test.

Purpose of the Test

The purpose of the test is to verify that systems required to employ demand controlled ventilation (refer to §120.1(c)3) can vary outside ventilation flow rates based on maintaining interior carbon dioxide (CO_2) concentration setpoints. Demand Controlled ventilation refers to an

Instrumentation

To perform the test, it may be necessary to vary and possibly measure (if calibration is necessary) ambient CO_2 levels. The instrumentation needed to perform the task may include, but is not limited to:

- Hand-held reference CO_2 probe calibrated to ±10 ppm
- Manufacturer's calibration kit
- Calibrated CO_2/air mixtures

Test Conditions

- Equipment installation is complete (including HVAC unit, duct work, sensors, and control system).
- HVAC system must be ready for system operation, including completion of all start-up procedures per manufacturer's recommendations.
- Building automation system (BAS) programming (if applicable) for the air handler and demand Controlled ventilation strategy must be complete. To perform the test, it may be necessary to use BAS to override or temporarily modify the CO_2 sensor reading.
- Air Economizer is disabled so that it will not interfere with outdoor air damper operation during test.
- Document the initial conditions before overrides or manipulation of the settings. All systems must be returned to normal at the end of the test.

Estimated Time to Complete

- Construction inspection: 0.5 to 1 hours (depending on CO2 sensor calibration)
- Functional testing: 1 to 2 hours (depending on how ambient CO2 concentration levels are manipulated, system response time to variations in CO2)

Acceptance Criteria

- Each CO_2 sensor is factory calibrated (with calibration certificate) or field calibrated.
- Each CO_2 sensor is wired correctly to the controls to ensure proper control of the outdoor air damper.
- Each CO_2 sensor is located correctly within the space 3 to 6 ft above the floor.
- Interior CO_2 concentration setpoint is ≤600 ppm plus outdoor air CO_2 value if dynamically measured or ≤1000 ppm if no OSA sensor is provided.
- A minimum OSA setting is provided whenever the system is in Occupied mode per §120.1(c)4E regardless of space CO_2 readings.
- A maximum OSA damper position for DCV control can be established per the *Exception* to §120.1(c)4C, regardless of space CO_2 readings.
- The outdoor air damper modulates open when the CO_2 concentration within the space exceeds setpoint,

Simple (Unitary) Equipment

Boilers (Hydronic)

Acceptance Tests: HVAC Simple Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-03-A Constant Volume, Single-zone, Unitary A/C and HP	NRCA-MCH04-A Air Distribution Duct Leakage	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-12-A Fault Detection and Diagnostic for DX Systems	NRCA-MCH-13-A Fault Detection and Diagnostic for AHUs	NRCA-MCH-16-A Supply Air Temp Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	YES	no	no	no	no	no	no	no	no	no	YES
DCV	YES	YES	no	YES	YES	YES	no	no	no	no	no	YES
Heat Pump Controls	no	YES	no	no	no	no	no	no	no	no	no	no
Shutoff and Reset	no	YES	no	no	no	no	no	YES	no	no	no	YES
Ventilation Dampers	YES	YES	YES	YES	no	YES	no	no	no	no	no	YES
Isolation Devices	no	YES	YES	no	no	no	YES	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	YES	no	no	YES	YES	no	YES
Zone Control	no	YES	no	no	no	no	YES	YES	no	no	no	YES
Supply Temp. Reset	no	no	no	no	no	no	no	no	no	no	YES	YES
Variable Flow Control	no	no	no	no	no	YES	YES	no	no	no	no	YES
Duct Systems	YES	no	YES	no	no	no	no	no	no	no	no	no

NRCA-MCH-08-A: Valve Leakage

Related to:
NRCA-MCH-10-A

Simple and Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)8 §140.4(k)1 §140.4(k)2 §140.4(k)3 §140.4(k)5 §140.4(k)6	NA7.5.7	Chapter 13.11

Simple (Unitary) Equipment: Boilers (Hydronic)

NRCA-MCH-08-A: Valve Leakage

Related to:	Simple and Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-10-A	 ☐ TAB Technician ☒ BAS Technician ☐ HERS Rater	§120.5(a)8 §140.4(k)1 §140.4(k)2 §140.4(k)3 §140.4(k)5 §140.4(k)6	NA7.5.7	Chapter 13.11

Potential Issues and Cautions

- The Acceptance Agent will likely need access to the EMCS during testing.
- Running a pump in a "dead head" condition (no flow) for more than 5 minutes can damage the pump seals or motor. Care must be taken to set up the test so that the pump only needs to run for 5 minutes or less.
- If balance valves are used for isolation of three-way valves or pumps, their initial position must be noted prior to using them for shut off of flow so that they can be returned to their initial position at the end of the test.

Performance of this test will require measuring differential pressure across pumps. The instrumentation needed to perform the task may include, but is not limited to either a:

- Differential pressure gauge or
- Handheld hydronic manometer

For accurate comparison with the pump curves, measure using the taps on the pump casing. Taps on the inlet and discharge piping to the pumps will not correlate to the pump curves.

Test Conditions

- The whole hydronic system must be complete – all coils, control valves, and pumps installed; all piping is pressure tested, flushed, cleaned, filled with water; BAS controls, if applicable.
- All equipment start-up procedures are complete, per manufacturer's recommendations.
- Document the initial conditions before overrides or manipulation of the BAS. All systems must be returned to normal at the end of the test.

Estimated Time to Complete

- Construction inspection: 0.5 to 2 hours (depending on availability of construction documentation and complexity of the system.)
- Functional testing: 30 minutes to 3 hours (depending on the complexity of the system and the number of valves)

Acceptance Criteria

Provisions have been made for variable flow:

- System has no flow when all coils are closed and the pump is turned on.

Simple (Unitary) Equipment

Controls

Acceptance Tests: HVAC Simple Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-03-A Constant Volume, Single-zone, Unitary A/C and HP	NRCA-MCH04-A Air Distribution Duct Leakage	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-12-A Fault Detection and Diagnostic for DX Systems	NRCA-MCH-13-A Fault Detection and Diagnostic for AHUs	NRCA-MCH-16-A Supply Air Temp Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	YES	no	no	no	no	no	no	no	no	no	YES
DCV	YES	YES	no	YES	YES	YES	no	no	no	no	no	YES
Heat Pump Controls	no	YES	no	no	no	no	no	no	no	no	no	no
Shutoff and Reset	no	YES	no	no	no	no	no	YES	no	no	no	YES
Ventilation Dampers	YES	YES	YES	YES	no	YES	no	no	no	no	no	YES
Isolation Devices	no	YES	YES	no	no	no	YES	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	YES	no	no	YES	YES	no	YES
Zone Control	no	YES	no	no	no	no	YES	YES	no	no	no	YES
Supply Temp. Reset	no	no	no	no	no	no	no	no	no	no	YES	YES
Variable Flow Control	no	no	no	no	no	YES	YES	no	no	no	no	YES
Duct Systems	YES	no	YES	no	no	no	no	no	no	no	no	no

NRCA-MCH-11-A: Automatic Demand Shed Control

Related to:
NRCA-MCH-18-A

Simple and Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.2(h) §120.5(a)10	NA7.5.10	Chapter 13.14

Simple (Unitary) Equipment: Controls

NRCA-MCH-11-A: Automatic Demand Shed Control

Related to:	Simple and Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-18-A	 ☐ *TAB Technician* ☒ *BAS Technician* ☐ *HERS Rater*	§120.2(h) §120.5(a)10	NA7.5.10	Chapter 13.14

Purpose of the Test

All control systems with DDC to the zone level are required to enable centralized demand shed at non-critical control zones from either a single software or hardware point in the system §120.2(h). Field studies have shown that in typical commercial buildings resetting the zone temperatures up by 2°F to 4°F during on-peak times can reduce the peak electrical cooling demand by as much as 30 percent. This test ensures the central demand shed sequences have been properly programmed into the DDC system.

Instrumentation

The instrumentation needed to perform the task may include, but is not limited to:

- The front end computer to the DDC system.

Test Conditions

To perform the test, use the control system to manipulate system. The entire HVAC installation and control system must be completed prior.

Estimated Time to Complete

- Construction inspection: 0.5 hour to review the EMCS programming
- Functional testing: 0.5 to 1 hour (depending on familiarity with BAS)

Acceptance Criteria

The control system changes the setpoints of non-critical zones on activation of a single central hardware or software point. Then the system restores the initial setpoints when the point is released.

Potential Issues and Cautions

Difficulties could be encountered with manipulating the control system if not familiar with the programming language. Therefore, a controls contractor should be on-site to assist with the testing.

Simple (Unitary) Equipment

Economizers

Acceptance Tests: HVAC Simple Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-03-A Constant Volume, Single-zone, Unitary A/C and HP	NRCA-MCH04-A Air Distribution Duct Leakage	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-12-A Fault Detection and Diagnostic for DX Systems	NRCA-MCH-13-A Fault Detection and Diagnostic for AHUs	NRCA-MCH-16-A Supply Air Temp Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	YES	no	no	no	no	no	no	no	no	no	YES
DCV	YES	YES	no	YES	YES	YES	no	no	no	no	no	YES
Heat Pump Controls	no	YES	no	no	no	no	no	no	no	no	no	no
Shutoff and Reset	no	YES	no	no	no	no	no	YES	no	no	no	YES
Ventilation Dampers	YES	YES	YES	YES	no	YES	no	no	no	no	no	YES
Isolation Devices	no	YES	YES	no	no	no	YES	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	YES	no	no	YES	YES	no	YES
Zone Control	no	YES	no	no	no	no	YES	YES	no	no	no	YES
Supply Temp. Reset	no	no	no	no	no	no	no	no	no	no	YES	YES
Variable Flow Control	no	no	no	no	no	YES	YES	no	no	no	no	YES
Duct Systems	YES	no	YES	no	no	no	no	no	no	no	no	no

NRCA-MCH-12-A: FDD for Packaged DX Units

Related to:
NRCA-MCH-02-A

Simple HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.2(i) §120.5(a)11	NA7.5.11	Chapter 13.15

Two people would be beneficial to this documentation of this test.

Simple (Unitary) Equipment: Economizers

NRCA-MCH-12-A: FDD for Packaged DX Units

Related to:	**Simple** HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-02-A	☐ *TAB Technician* ☒ *BAS Technician* ☐ *HERS Rater*	§120.2(i) §120.5(a)11	NA7.5.11	Chapter 13.15
		Two people would be beneficial to this documentation of this test.		

Purpose of the Test

The purpose of this test is to verify proper fault detection and reporting for automated fault detection and diagnostics systems for packaged DX units. Automated FDD systems ensure proper equipment operation by identifying and diagnosing common equipment problems such as temperature sensor faults, low airflow or faulty economizer operation.
FDD systems help to maintain equipment efficiency closer to rated conditions over the life of the equipment.

Instrumentation

~~The system test for refrigerant charge requires a calibrated refrigerant gauge with an accuracy of plus or minus 3 percent.~~

Test Conditions

- Packaged unit and thermostat installation along with programming must be complete.
- HVAC system must be installed and ready for operation, including completion of all start-up procedures, per manufacturer's recommendations.
- Prior to FDD verification, test the system operating modes. When the system includes a field-installed air economizer, test the economizer per NRCA-MCH-02-A.

Estimated Time to Complete

- Construction inspection: 0.5 hour
- Functional testing: 1 to 2 hours
- ~~FDD systems have the capability to report alarms to a remote server; accessible via a Web interface. It may be helpful to have two people conducting the test – one to perform testing on the unit and a second to verify reporting of the alarm to the remote interface.~~

Acceptance Criteria

- The FDD system is able to detect a disconnected outside air temperature sensor and report the fault.
- The FDD system is able to detect excess outside air and report the fault.
- The FDD system is able to detect a stuck outdoor air economizer damper and report the fault.
- ~~The saturated discharge and saturated suction temperatures must be measured within 5°F of a calibrated refrigerant gauge.~~

Potential Issues and Cautions

Compared to the pressure sensors, the temperature sensors can have a longer response time to reach a steady-state condition. Therefore, the FDD algorithms may have trouble working properly during transitional states – for example, when the fan or compressor first turns on. The tester should be aware of the potential for false alarms.

Simple (Unitary) Equipment

Controls

NRCA-MCH-14-A: Distributed Energy Storage DX AC System

Related to:
NRCA-MCH-02-A;
NRCA-MCH-03-A;
NRCA-MCH-05-A

Simple HVAC System

- ☐ *TAB Technician*
- ☐ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)13	NA7.5.13	Chapter 13.17

Distributed energy storage system third party submittal form should be verified.

Purpose of the Test

This test verifies proper operation of distributed energy storage DX systems. Distributed energy systems reduce peak demand by operating during off peak hours and storing cooling, usually in the form of ice. During peak cooling hours the ice is melted to avoid compressor operation.

Instrumentation

Distributed energy storage acceptance tests require no additional instrumentation for testing.

Test Conditions

- The DX equipment should be installed and operational.
- Perform pre-startup installation procedures as specified by the manufacturer.
- Verify that the building cooling is controlled by a standard indoor HVAC thermostat and not by factory installed controls.
- Verify that ice making is not controlled by the thermostat.
- The water tank should be filled to the proper level as specified by the manufacturer prior to the start of the test.
- Verify refrigerant piping connects and the system is charged with refrigerant.

Estimated Time to Complete

- Construction Inspection: 0.5 hours
- Acceptance Tests: 2 hours

Acceptance Criteria

- Verify nighttime ice making operation.
- Verify that tank discharges during on-peak cooling periods.
- Verify that the compressor does not run and the tank does not discharge when there is no cooling demand during on-peak periods.
- Verify that the system does not operate during a morning shoulder period when there is no cooling demand.
- Verify that the system operates in direct mode (with compressor running) during the morning shoulder time period.

Potential Issues and Cautions

- These tests only apply to systems with storage capacity less than 100 ton-hours.
- Systems with storage above 100 ton-hours should be modeled using the thermal energy storage compliance option.
- Be sure the water tank is filled to the proper level indicated by the manufacturer prior to the start of the tests.
- The tests require override of the system controller programming. Be sure to record the system settings prior to the start of the testing, and restore the system settings to their original values upon completion of the tests.

Simple (Unitary) Equipment

Controls

Acceptance Tests: HVAC Simple Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-03-A Constant Volume, Single-zone, Unitary A/C and HP	NRCA-MCH04-A Air Distribution Duct Leakage	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-12-A Fault Detection and Diagnostic for DX Systems	NRCA-MCH-13-A Fault Detection and Diagnostic for AHUs	NRCA-MCH-16-A Supply Air Temp Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	YES	no	no	no	no	no	no	no	no	no	YES
DCV	YES	YES	no	YES	YES	YES	no	no	no	no	no	YES
Heat Pump Controls	no	YES	no	no	no	no	no	no	no	no	no	no
Shutoff and Reset	no	YES	no	no	no	no	no	YES	no	no	no	YES
Ventilation Dampers	YES	YES	YES	YES	no	YES	no	no	no	no	no	YES
Isolation Devices	no	YES	YES	no	no	no	YES	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	YES	no	no	YES	YES	no	YES
Zone Control	no	YES	no	no	no	no	YES	YES	no	no	no	YES
Supply Temp. Reset	no	no	no	no	no	no	no	no	no	no	YES	YES
Variable Flow Control	no	no	no	no	no	YES	YES	no	no	no	no	YES
Duct Systems	YES	no	YES	no	no	no	no	no	no	no	no	no

NRCA-MCH-16-A: Supply Air Temperature Reset Controls

	Simple and Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
	☒ TAB Technician ☒ BAS Technician ☐ HERS Rater	§140.4(f) §140.4(d) §120.5(a)15	NA7.5.15	Chapter 13.19

Simple (Unitary) Equipment: Controls

NRCA-MCH-16-A: Supply Air Temperature Reset Controls

Simple and Complex HVAC System

- [X] *TAB Technician*
- [X] *BAS Technician*
- [ ] *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§140.4(f) §140.4(d) §120.5(a)15	NA7.5.15	Chapter 13.19

Purpose of the Test

The purpose of the test is to ensure that the supply air temperature in a constant or variable air volume application serving multiple zones, according to §140.4(f), modulates to meet system heating and cooling loads.

- Space conditioning systems must have zone level controls to avoid reheat, re-cool, and simultaneous cooling and heating (§140.4(d)); or, must have controls to reset supply air temperature (SAT) by at least 25 percent of the difference between the design supply-air temperature and the design room air temperature (§140.4(f)2).
- Air distribution systems serving zones with constant loads shall be designed for the air flows resulting from the fully reset (e.g. lowest/highest) supply air temperature.
- The requirements for SAT reset apply to both CAV and VAV systems. Exceptions include:
  - Systems with specific humidity needs for exempt process loads (computer rooms or spaces serving only IT equipment are not exempt),
  - Zones served by space conditioning systems in which at least 75 percent of the energy for reheating, or providing warm air in mixing systems, is provided from a site-recovered or site-solar energy source,
  - Systems in which supply air temperature reset would increase overall building energy use, and.
  - Systems with controls to prevent reheat, re-cool, and/or simultaneous cooling and heating
- Supply air temperature may be reset in response to building loads, zone temperature, outside air temperature, or any other appropriate variable.

- Duct work
- Terminal boxes
- Heating and/or cooling coils
- Outside air dampers and controls
- Supply air temperature sensor(s)
- Electrical power to air handling unit

Air handling unit start-up procedures should be complete, per manufacturer's recommendations. If applicable, BAS programming for the operation of the air handling unit and terminal boxes should be complete, including but not limited to:

Simple (Unitary) Equipment

Controls

Acceptance Tests: HVAC Simple Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-03-A Constant Volume, Single-zone, Unitary A/C and HP	NRCA-MCH04-A Air Distribution Duct Leakage	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-12-A Fault Detection and Diagnostic for DX Systems	NRCA-MCH-13-A Fault Detection and Diagnostic for AHUs	NRCA-MCH-16-A Supply Air Temp Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	YES	no	no	no	no	no	no	no	no	no	YES
DCV	YES	YES	no	YES	YES	YES	no	no	no	no	no	YES
Heat Pump Controls	no	YES	no	no	no	no	no	no	no	no	no	no
Shutoff and Reset	no	YES	no	no	no	no	no	YES	no	no	no	YES
Ventilation Dampers	YES	YES	YES	YES	no	YES	no	no	no	no	no	YES
Isolation Devices	no	YES	YES	no	no	no	YES	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	YES	no	no	YES	YES	no	YES
Zone Control	no	YES	no	no	no	no	YES	YES	no	no	no	YES
Supply Temp. Reset	no	no	no	no	no	no	no	no	no	no	YES	YES
Variable Flow Control	no	no	no	no	no	YES	YES	no	no	no	no	YES
Duct Systems	YES	no	YES	no	no	no	no	no	no	no	no	no

NRCA-MCH-18-A: Energy Management Control System

Related to:
NRCA-MCH-11-A

Simple and Complex HVAC System

- ☐ TAB Technician
- ☒ BAS Technician
- ☐ HERS Rater

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§110.2(e) §120.2(h) §120.5(a)17	No NA7 Guidance	Chapter 13.21
Lighting requirements may also apply		

Simple (Unitary) Equipment: Controls

NRCA-MCH-18-A: Energy Management Control System

Related to:	Simple and Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-11-A	 ☐ TAB Technician ☒ BAS Technician ☐ HERS Rater	§110.2(e) §120.2(h) §120.5(a)17	No NA7 Guidance	Chapter 13.21
		Lighting requirements may also apply		

Instrumentation

N/A

Test Conditions

All systems and components must be installed, powered and ready for system operation, including:

- Controllers
- Actuators
- Sensors
- EMCS programming

All of the regular installation, start-up, testing, and commissioning tasks that a controls contractor normally performs during an EMCS installation should be complete before this test is conducted.

Estimated Time to Complete

1 to 2 hours, depending on familiarity with the EMCS, complexity of the EMCS, and the number of control points.

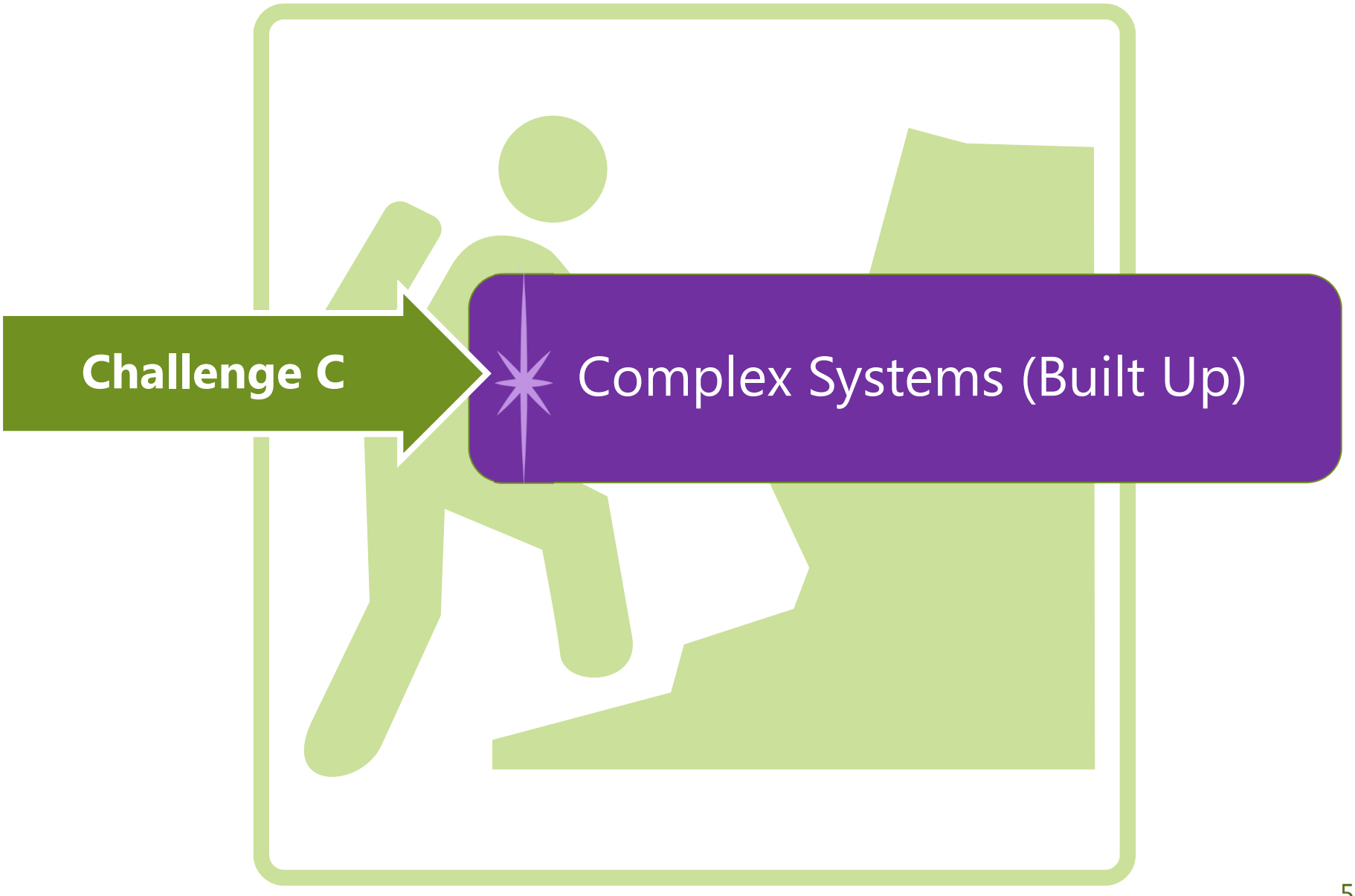
Acceptance Criteria

Test passes if all Construction Inspection boxes are checked and all Functional Testing results are "yes'.

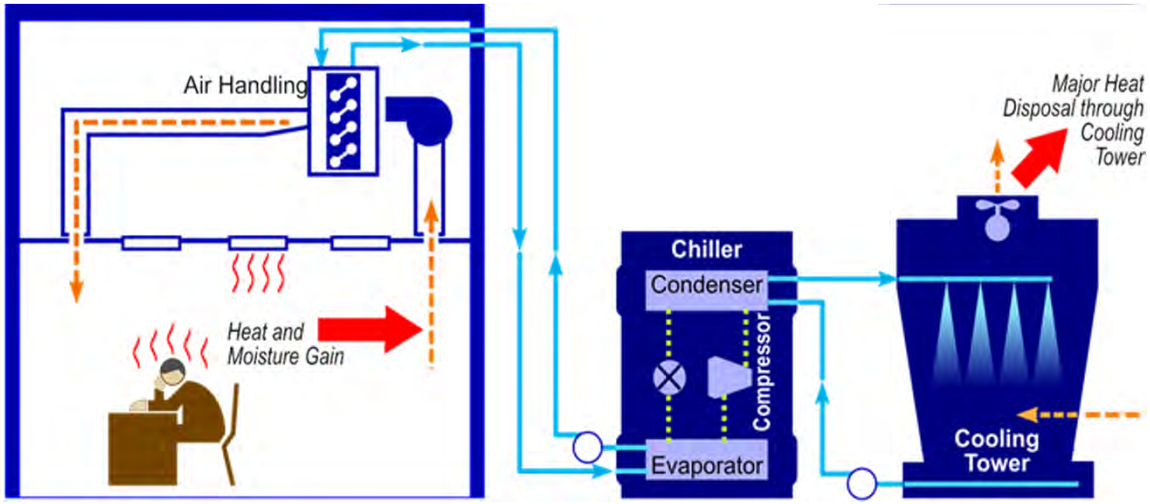
Potential Issues and Cautions

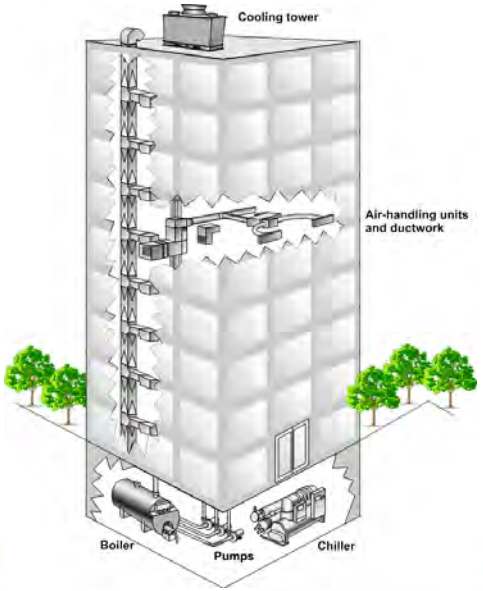
- This basic list of recommendations is intended to validate the readiness of the EMCS for any required acceptance criteria specified in the Energy Standards. This check should not take the place of a more comprehensive start-up testing or commissioning effort.
- This acceptance test should be completed prior to conducting the other acceptance tests that rely on the EMCS.

Challenge C



Complex Equipment





HVAC Complex Systems

	Mandatory Requirements								Prescriptive Requirements				
Space Conditioning Equipment[A]	Zone Thermostat[C] §120.2(a), (b) Setback Capable[D]	DCV[E] §120.1(c)	Shutoff and Reset[F] §120.2(e)	VentilationDampers §120.2(f) Automatic close upon fan shutdown[H]	Isolation Devices[I] §120.2(g)	Demand Shedding[J] §120.2(h)	DDC §120.2(j)	Optimum Start Stop §120.2(k) (new in 2016)	Zone Control[K] §140.4(d)	Supply Temperature Reset §140.4(f) §140.4(k)4	Economizer[N] §140.4(e)1- 5	Variable Flow Control[O] §140.4(k)6 §140.4(m)	Isolation §140.4(k)2 §140.4(k)3
Boiler	no	no	YES[G]	no	no	YES	YES	YES	YES	YES[L]	no	no	YES
Air-cooled Chiller	no	no	YES[G]	no	no	YES	YES	YES	YES	YES[M]	no	YES	YES
Water-cooled Chiller	no	no	YES[G]	no	no	YES	YES	YES	YES	YES[M]	no	YES	YES
Variable Refrigerant Flow (VRF)	YES	YES	YES[G]	no	YES	YES	no	no	YES	YES	YES	YES	no
Air Handling Systems & Zones[B]	YES	YES	YES[G]	YES	YES	YES	YES	YES	YES	YES	YES	YES	no
Zone Terminal Units or Fan Coils	YES	no	YES[G]	no	no	YES	YES	YES	YES	YES	no	YES	no

Complex Equipment

Ventilation

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-02-A: Outdoor Air: Variable Air Volume Systems

Performed in conjunction with:	Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-07-A				
Related to:				
NRCA-MCH-05-A;	☒ *TAB Technician*	§10-03(b)4	NA7.5.1.1	Chapter 13.4
NRCA-MCH-06-A;	☐ *BAS Technician*	§120.1(b)2	NA7.5.1.2	Chapter 13.5
NRCA-MCH-07-A	☐ *HERS Rater*	§120.5(a)1		

Complex Equipment: Ventilation

NRCA-MCH-02-A: Outdoor Air: Variable Air Volume Systems

Performed in conjunction with:	Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-07-A				
Related to:				
NRCA-MCH-05-A;	☒ *TAB Technician*	§10-03(b)4	NA7.5.1.1	Chapter 13.4
NRCA-MCH-06-A;	☐ *BAS Technician*	§120.1(b)2	NA7.5.1.2	Chapter 13.5
NRCA-MCH-07-A	☐ *HERS Rater*	§120.5(a)1		

Purpose of the Test

This test ensures the provision of adequate outdoor air ventilation through the variable air volume air handling unit at two representative operating conditions. The test consists of measuring outdoor air values at maximum flow and at or near minimum flow. The test verifies the introduction of a minimum volume of outdoor air, in accordance with §120.1(b)2, into the air handling unit and is within 10 percent of the required

Acceptance Criteria

Field- or factory-calibrated sensor controlling outdoor air flow with documentation attached. Measured outdoor airflow reading is within 10 percent of the total value found on the Energy Standards Mechanical Plan Check document NRCC-MCH-03-E, under the following conditions:

- Minimum system airflow or 30 percent of total design flow
- Design supply airflow

Instrumentation

Performance of this test will require measuring outdoor air flow. When the system includes an airflow monitoring system (AFMS) on the outdoor air, then it may be used for the measurements if it has a calibration certificate or is field-calibrated. The instrumentation needed to perform the task may include, but is not limited to. An airflow measurement probe (for example, hot-wire anemometer or velocity pressure probe), or a watch or some equivalent device to measure time in minutes.

Test Conditions

- **The test needs an override of the normal control operations. The control system of the air handling unit and zone controls must be complete, including:**
  - Supply fan capacity control (typically a variable speed drive).
  - Air economizer control.
  - Minimum outdoor air damper control.
  - Zone airflow control (including zone thermostats and VAV boxes).
- **Installed systems shall be ready for system operation, including:**
  - Duct work
  - VAV boxes.
  - Control sensors (temperature, flow, pressure, and so forth).
  - Electrical power to air handling unit and control system components.
- **Completion of air handling unit start-up procedures, per manufacturer's recommendations. Document the initial conditions before executing system overrides or manipulation of the set points and schedules.**
- **At the end of the test, return all systems to normal. Reference NRCC-MCH-03-E or the mechanical equipment schedules to determine the total required outdoor airflow for the system.**

Complex Equipment

Economizers

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-05-A : Air Economizer Controls

Related to:

NRCA-MCH-02-A;
NRCA-MCH-03-A;
NRCA-MCH-05-A;
NRCA-MCH-06-A

Simple and Complex HVAC System

☐ *TAB Technician*
☒ *BAS Technician*
☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)4 §140.4(e)	NA7.5.4	Chapter 13.8

If the economizer is factory installed and certified, a valid factory certificate is required to document acceptance testing exception.

Complex Equipment

Ventilation

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-06-A: Demand Control Ventilation (DCV) Systems

Related to:

NRCA-MCH-02-A;
NRCA-MCH-03-A;
NRCA-MCH-05-A

Simple and Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.1(c)3 §120.1(c)4 §120.5(a)5	NA7.5.5	Chapter 13.8

Two people would be beneficial to this documentation of this test.

Complex Equipment

Ventilation

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-07-A: Supply Fan Variable Flow Controls

Related to:
NRCA-MCH-02-A

Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)6 §140.4(c)2B§140. 4(c)2C	NA7.5.6	Chapter 13.10

Complex Equipment: Ventilation

NRCA-MCH-07-A: Supply Fan Variable Flow Controls

Related to:	Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-02-A	☐ TAB Technician ☒ BAS Technician ☐ HERS Rater	§120.5(a)6 §140.4(c)2B§140.4(c)2C	NA7.5.6	Chapter 13.10

Purpose of the Test

The purpose of the test is to ensure that the supply fan in a variable air volume application modulates to meet system airflow demand. In most applications, the individual variable air valve (VAV) boxes serving each space will modulate the amount of air delivered to the space based on heating and cooling requirements. As a result, the total supply airflow provided by the central air handling unit must also vary to maintain sufficient airflow through each VAV box. Airflow is typically controlled using a variable frequency drive (VFD) to modulate supply fan speed and vary system airflow. The most common strategy for controlling the VFD is to measure and maintain static pressure within the duct.

Related acceptance tests for these systems include the following:

- NA7.5.1.1 Variable Air Volume Systems Outdoor Air Acceptance

Instrumentation

The instrumentation needed to perform the task may include, but is not limited to:

- Differential pressure gauge (must be calibrated within the past year)
- Pitot tube
- Drill

Test Conditions

If applicable, supply air temperature reset should be disabled during testing to prevent any unwanted interaction.

All systems and components must be installed and ready for system operation, including:

- Duct work
- VAV boxes
- Static pressure sensor(s) (note multiple sensors with separate control loops are often used on large systems with multiple branches)
- Electrical power to air handling unit
- Air handling unit start-up procedures are complete, per manufacturer's recommendations
- BAS programming for the operation of the air handling unit and VAV boxes must be complete, including but not limited to:
- Supply fan motor control, either VFD or ECM motor control
- VAV box control (including zone temperature sensors and maximum/minimum flow rates)

Before testing, ensure all schedules, setpoints, operating conditions, and control parameters are documented. All systems must be returned to normal at the end of the test.

This test can and should be performed in conjunction with NA7.5.1.1 Variable Air Volume Systems Outdoor Air Acceptance test procedures.

Estimated Time to Complete

- Construction inspection: 0.5 to 1.5 hours (depending on sensor calibration and minimum VFD speed verification)
- Functional testing: 1 to 2 hours (depending on how total fan power at design airflow is determined and system control stability)

Complex Equipment

Pumps

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-08-A: Valve Leakage

Related to:
NRCA-MCH-10-A

Simple and Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)8 §140.4(k)1 §140.4(k)2 §140.4(k)3 §140.4(k)5 §140.4(k)6	NA7.5.7	Chapter 13.11

Complex Equipment

Controls

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-09-A: Supply Water Temperature Reset Controls

Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)9 §140.4(k)4	NA7.5.8	Chapter 13.8

Applies to chilled and hot water systems that are not designed for variable flow and that have a design capacity ≥ 500 kBtuh

Complex Equipment: Controls

NRCA-MCH-09-A: Supply Water Temperature Reset Controls

Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)9 §140.4(k)4	NA7.5.8	Chapter 13.8

Applies to chilled and hot water systems that are not designed for variable flow and that have a design capacity ≥ 500 kBtuh

Purpose of the Test

This test ensures that both the chilled water and hot water supply temperatures are automatically reset based on either building loads or outdoor air temperature, as indicated in the control sequences. Many HVAC systems are served by central chilled and heating hot water plants. The supply water operating temperatures must meet peak loads when the system is operating at design conditions. As the loads vary, the supply water temperatures can be adjusted to satisfy the new operating conditions. Typically the chilled water supply temperature can be raised as the cooling load decreases, and heating hot water supply temperature can be lowered as the heating load decreases.
This requirement only applies to chilled and hot water systems that are not designed for variable flow and that have a design capacity greater than or equal to 500 kBtuh (thousand BTU's per hour), according to §140.4(k)4.

Instrumentation

Performance of this test will require measuring water temperatures as well as possibly air temperatures. The instrumentation needed to perform the task may include, but is not limited to:

- Hand-held temperature probes for ice water or drywell bath. Devices must be calibrated within the last year.

Test Conditions

To perform the test, use the building automation system (BAS) to manipulate system operation to achieve the desired control. BAS programming for the operation of the chillers, boilers, air handling units, and pumps must include but may not be limited to:

- Supply water temperature control,
- Equipment start-stop control,
- Installed and calibrated control sensors, and
- Tuned control loops.

All systems must be installed and ready for system operation, including:

- Chillers, boilers, pumps, air handling units, valves, and piping;
- Control sensors (temperature, humidity, flow, pressure, etc.)

Verify all piping is pressure tested, flushed, cleaned, and filled with water. Confirm electric power supply to all equipment. Verify start-up procedures for all pieces of equipment are complete, per manufacturer's recommendations
Document the initial conditions before overrides or manipulation of the BAS. All systems must be returned to normal at the end of the test.

Estimated Time to Complete

- Construction inspection: 0.5 to 1 hours (depending on availability of construction documentation (i.e. plumbing drawings, material cut sheets, specifications, etc.) as well as sensor calibration.)
- Functional testing: 1 to 2 hours (depending on familiarity with BAS, method employed to vary operating parameters, and time interval between control command and system response)

Complex Equipment

Pumps

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-10-A: Hydronic System Variable Flow Control

Related to:
NRCA-MCH-08-A

Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)7 §140.4(k)1 §140.4(k)5 §140.4(k)6	NA7.5.9	Chapter 13.13

Not required on heating hot water systems with variable flow designs or for condensing water serving only water cooled chillers.

Complex Equipment: Pumps

NRCA-MCH-10-A: Hydronic System Variable Flow Control

Related to:	Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
NRCA-MCH-08-A	☐ *TAB Technician* ☒ *BAS Technician* ☐ *HERS Rater*	§120.5(a)7 §140.4(k)1 §140.4(k)5 §140.4(k)6	NA7.5.9	Chapter 13.13
		Not required on heating hot water systems with variable flow designs or for condensing water serving only water cooled chillers.		

Purpose of the Test

All hydronic variable flow chilled water and water-loop heat pump systems with total circulating pump power larger than 5 hp shall vary system flow rate by modulating pump speed using either a variable frequency drive (VFD) or equivalent according to §140.4(k)6. Pump speed and flow must be controlled as a function of differential pressure, and pump motor demand must be no more than 30 percent design wattage at 50 percent design flow.

As the loads within the building fluctuate, control valves should modulate the amount of water passing through each coil and add or remove the desired amount of energy from the air stream to satisfy the load. In the case of water-loop heat pumps, each two-way control valve associated with a heat pump closes when not operating. The purpose of the test is to ensure that, as each control valve modulates, the pump variable frequency drive (VFD) responds accordingly to meet system water flow requirements.

Note that this is not required on heating hot water systems with variable flow designs or for condensing water serving only water cooled chillers.

The related acceptance tests for this systems is:

- NA7.5.7 Valve Leakage Test (if applicable)

Test Conditions

To perform the test, use the control system to manipulate system operation to achieve the desired control. At a minimum, control system programming for the operation of the central equipment, control valves, and pumps must include, but not be limited to:

- Equipment start-stop control,
- Installed and calibrated control sensors, and
- Tuned control loops.
- All systems must be installed and ready for system operation, including:
- Heat pumps, cooling towers, boilers, pumps, control valves, piping, etc.
- Control sensors (temperature, flow, pressure, etc.)

Verify all piping is pressure tested, flushed, cleaned, and filled with water. Verify electrical power supply to all equipment. Confirm start-up procedures for all pieces of equipment are complete, per manufacturer's recommendations.

Document the initial conditions before overrides or manipulation of the BAS. Return all systems to their initial condition after test.

Complex Equipment

Controls

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-11-A: Automatic Demand Shed Control

Related to:
NRCA-MCH-18-A

Simple and Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.2(h) §120.5(a)10	NA7.5.10	Chapter 13.14

Complex Equipment

Controls

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-13-A: FDD for Air Handling Units and Zone Terminal Units

Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)12	NA7.5.12	Chapter 13.16

An FDD system that does not pass this test may still be installed, but no compliance credit will be given.

A minimum of 5% of the terminal boxes (VAV box) shall be tested.

Complex Equipment

NRCA-MCH-13-A: FDD for Air Handling Units and Zone Terminal Units

Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)12	NA7.5.12	Chapter 13.16

An FDD system that does not pass this test may still be installed, but no compliance credit will be given.

A minimum of 5% of the terminal boxes (VAV box) shall be tested.

Purpose of the Test

Fault detection and diagnostics can also be used to detect common faults with air handling units and zone terminal units. Many FDD tools are standalone software products that process trend data offline. Maintenance problems with built-up air handlers and variable air volume boxes are often not detected by energy management systems because the required data and analytical tools are not available. Performing the FDD analysis within the distributed unit controllers is more practical because of the large volume of data. The acceptance tests are designed to verify that the system detects common faults in air handling units and terminal units. FDD systems for air handling units and zone terminal units require DDC controls to the zone level. Successful completion of this test provides a compliance credit when using the performance approach. An FDD system that does not pass this test may still be installed, but no compliance credit will be given.

Instrumentation

FDD tests for air handling units and zone terminal units require no additional instrumentation for testing, since control algorithms are embedded in unit controllers.

Test Conditions

- The air handling unit should be installed and the heating, cooling and economizer modes of operation tested. To perform the test, use the building automation system (BAS) to manipulate system operation to achieve the desired control. BAS programming for the operation of the chillers, boilers, air handling units, and pumps must be complete.
- All equipment startup procedures must have been completed per manufacturer's instructions. All control sensors must be installed and control loops tuned.
- Document the initial conditions before any overrides to the building automation system.
- **Minimum of 5% of the VAV boxes are to be tested.**

Estimated Time to Complete

Acceptance tests will take 1-2 hours for each air handler. Time for acceptance testing for terminal units depends on the number of boxes to be tested.

Acceptance Criteria

- The system is able to detect common faults with air handling units, such as sensor failures, damper failures, actuator failures, or improper operating modes.
- The system is able to detect and report common faults with zone terminal units, such as damper failure, actuator failure, or a control tuning issue.

Potential Issues and Cautions

Difficulties could be encountered with manipulating the control system if not familiar with the programming language. Therefore, a controls contractor should be on-site to assist with the testing.

Complex Equipment

TES

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-15-A: Thermal Energy Storage (TES) System

Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§120.5(a)14	NA7.5.14	Chapter 13.18

Complex Equipment: TES

NRCA-MCH-15-A: Thermal Energy Storage (TES) System

Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
 ☐ TAB Technician ☒ BAS Technician ☐ HERS Rater	§120.5(a)14	NA7.5.14	Chapter 13.18

Instrumentation

TES acceptance tests require no additional instrumentation for testing.

Test Conditions

- The chiller, EMS, piping, and components should be installed and operational.
- The thermal storage tank should be without charge, or even partially charged (not fully charged), at the start of testing.
- The system should be configured with an on-peak cooling period (tank discharge) and an off-peak charging period.
- The cooling load can be met by storage if the tank has stored energy available or by compressor cooling if there is no stored energy available.

Estimated Time to Complete

- Construction Inspection: 0.5 hours
- Acceptance Tests: 2 hours

Acceptance Criteria

The TES system and the chilled water plant is controlled and monitored by an EMS.
Verify:

- The TES system stores energy in storage/charge mode.
- The storage charging stops when an end of charge signal is generated.
- The TES system starts discharging with the compressor(s) in discharge mode.
- The TES does not discharge and the cooling load is met by the compressor(s) in mechanical cooling only mode.
- The TES discharges with the chiller sharing the load during discharge and mechanical cooling mode.
- Storage does not discharge and all compressors are off during the off/storage-secure mode.
- When applicable, tanks can be charged while serving in active cooling mode during charge-plus cooling mode.

Potential Issues and Cautions

- Potential damage to the chiller, pumps, storage tanks, etc., by improper manipulation of the control system.
- Perform this test with the assistance of the controls vendor or facility operator.

• Perform this test with the assistance of the controls vendor or facility operator.

Complex Equipment

Controls

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-16-A: Supply Air Temperature Reset Controls

	Simple and Complex HVAC System	Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
		§140.4(f) §140.4(d) §120.5(a)15	NA7.5.15	Chapter 13.19
	[X] TAB Technician			
	[X] BAS Technician			
	[ ] HERS Rater			

Complex Equipment

Controls

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-17-A: Condenser Water Temperature Reset Controls

Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
Required if this control strategy is implemented.	NA7.5.16	Chapter 13.20

Complex Equipment: Controls

NRCA-MCH-17-A: Condenser Water Temperature Reset Controls

Complex HVAC System

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
Required if this control strategy is implemented.	NA7.5.16	Chapter 13.20

Potential Issues and Cautions

- Condenser water temperature reset is most effective on a moderately warm day. When testing during cold weather conditions, make sure that freeze protection controls are installed and functional to prevent equipment damage. Also ensure the conditioned spaces do not fall below safe temperatures, as this may cause discomfort or unsafe working conditions.
- If conducting this test during hot weather conditions, make sure the chiller load amps don't increase as the condenser water temperature **increases**. If so, you will need to conduct this test on a cooler day. Likewise, stop the test if the chiller begins to surge.
- This test does not require operation of the plant equipment across all operating stages, so it is not necessary, nor desirable, that the system experience peak load conditions. However, the system cooling load must be sufficiently high to run the test. If necessary, artificially increase the load to perform the functional tests, or wait until a time of stable chiller operation. If necessary, reverse Steps 1 & 2 in the functional test based on atmospheric conditions and building loads.
- If the system is designed to employ variable flow simultaneously with temperature reset, allow the system to operate as programmed but take care that the water flow rate stays within the minimum and maximum flow rate limits for the chiller(s) and cooling tower(s). Minimum flow through a cooling tower is important to provide even water distribution and full wetting of the fill to prevent scaling.
- Exemption: There is an important exemption associated with this functional test to provide flexibility given the range of chilled water plant operations, as follows: If the control sequence differs significantly from that implied by the tests, and / or has already been tested during the building commissioning process, attach a description of the control sequence, a description of the tests that were done to verify the system operates according to the sequence, the test results, and a plot of any associated trend data.

Test Conditions

To perform the test, it may be necessary to use the building automation system (BAS) to manipulate system operation to achieve the desired control. BAS programming for the operation of the chillers, cooling towers, air handling units, and pumps must be complete, including but not limited to:

- Chilled water and condenser water temperature control
- Equipment start-stop control
- All installed and calibrated control sensors
- Tuned Control loops

All systems must be installed and ready for system operation, including:

- Chillers, cooling towers, pumps, air handling units, valves, and piping.

Complex Equipment

Controls

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

NRCA-MCH-18-A: Energy Management Control System

Related to:
NRCA-MCH-11-A

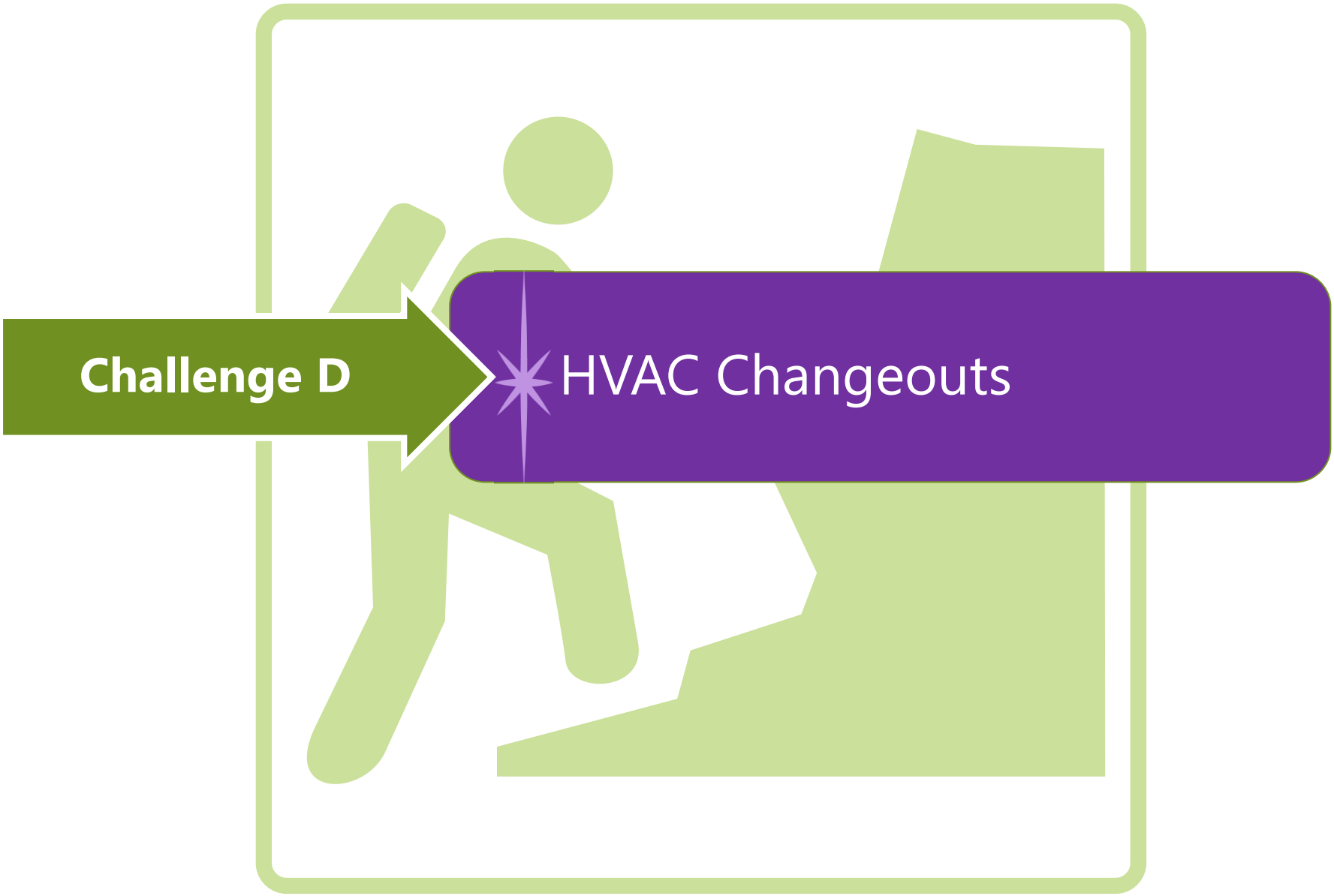
Simple and Complex HVAC System

(Ctrl)

- ☐ *TAB Technician*
- ☒ *BAS Technician*
- ☐ *HERS Rater*

Title 24 Part 6 Energy Standards Reference	Reference NR Appendix NA7	Nonresidential Manual Chapter 13
§110.2(e) §120.2(h) §120.5(a)17	No NA7 Guidance	Chapter 13.21
Lighting requirements may also apply		

Challenge D



2016 ENERGY CODE

Ace Resources | Title 24, Part 6 Triggers

Nonresidential

New HVAC: Simple and Complex Systems

HVAC Simple Systems

	Mandatory Requirements								Prescriptive Requirements			
Space Conditioning Equipment [A]	Zone Thermostat[F] §120.2(a), (b) Setback Capable[G]	DCV[H] §120.1(c)	Heat Pump Controls[I] §120.2(d)	Shutoff and Reset[J] §120.2(e)	Ventilation Dampers §120.2(f) Automatic close upon fan shutdown[L]	Isolation Devices[N] §120.2(g)	Demand Shedding[O] §120.2(h)	Economizer FDD[P] §120.2(i)	Zone Control[Q] §140.4(d)	Supply Temperature Reset[R] §140.4(f)	Economizer[P,S] §140.4(e)1- 5	Variable Flow Control[T] §140.4(k)6 §140.4(m)
Package Terminal Air Conditioner [B,C]	YES[D]	YES	no	YES[K]	YES	no	YES	YES	YES	YES	no	YES[U]
Unitary Air Conditioners and Condensing Units [D]	YES	YES	no	YES[K]	YES	no	no	YES	no	no	YES	YES[U]
Unitary Heat Pumps [E]	YES	YES	YES	YES[K]	YES	no	no	YES	no	no	YES	YES[U]
Applied Heat Pumps [E]	YES	YES	YES	YES[K]	YES	YES	YES	YES	YES	no	YES	YES[U]
Forced Air Furnace	YES	YES	no	YES[K]	YES[M]	no	YES	no	no	no	no	no
Unit Heater	YES	no	no	YES[K]	no	no	no	no	no	no	no	no

A Central Energy Management Control System (EMCS) should be installed at building site for optimal equipment operation and coordination.

B Configurations vary between availability of central plant in design or reliance on self-contained heating and cooling.

C Special application requirements for Hotels, High-rise Residential, and Perimeter Zoning. Setback capable terminal devices should be used except where zone is not on EMCS. In that case, capability of four programmable control periods per 24 hours is required (§110.2(c)).

D Stand-alone single room window units are exempt (See §110.2(c)).

E Air or water source configuration.

F An EMCS may perform the setback functions.

G Set back the zone temperature setpoints to 55°F or lower for heating and 85°F or higher for cooling. Where used to control both heating and cooling, and where changeover between heating and cooling modes is automatic, the thermostatic controls shall be capable of providing a temperature dead band of at least 5°F, within which heating and cooling are both shut off or minimized.

H Demand Control Ventilation. See §120.1(c) 3, 4 and 5 for additional CO2 concentration setpoint information and sensor location requirements.

I Heat pumps with supplementary electric resistance heat have control requirements.

J Must include automatic restart to maintain setback temperatures as necessary.

K Must include automatic time switch OR occupancy sensor OR 4-hour timer. 7-day programmable local control exemption.

L Assumes system has ventilation capacity at the terminal device. Damper is to reduce ventilation to zero during unoccupied periods. Exemptions for; gravity dampers, combustion air paths, 24-hour operation, or local law jurisdiction.

M Reference to combustion air requirements.

N For systems serving multiple zones totaling more than 25,000 ft². A zone need not be isolated if demonstrated that it must be heated or cooled continuously.

O Include settings capable of disabling, manually controlling, or automatically operating equipment. Applies to HVAC systems with DDC to the zone level.

P Fault detection and diagnostics (FDD) systems are commonly available for packaged HVAC units, and can be integrated directly by the manufacturer. These are required for all new air-cooled unitary direct-expansion systems with cooling capacity of 54 kBtu/h (4 ½ tons) or greater. Controls include economizer checks and refrigerant diagnostics. The systems can report failures or suboptimal conditions that impact efficiency. Required acceptance tests for these systems may be found in Reference Appendix NA7.5.11.

Q Simultaneous heat and cool prevention except for variable-air-volume and other system types listed in this section. Ambient conditions also provide lockout for seasonal operation only per §140.4(n).

R A reset strategy defined and applied to the supply air stream of the unit or terminal device.

S Exemptions apply where: (1) outside air conditions are undesirable, (2) high-rise residential, (3) adverse effects of other systems, like dehumidification, (4) high cooling efficiency systems [Table 140.1-A] (5) computer rooms served per §140.9(a).

T Air-side applications referred to in respective code language. Central EMCS necessary for remote system operation and ability to oversee all space-conditioning equipment and pumping needs.

U Variable Frequency Drive necessary to operate supply fan speed control at the unit.

Acceptance Tests: HVAC Simple Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-03-A Constant Volume, Single-zone, Unitary A/C and HP	NRCA-MCH04-A Air Distribution Duct Leakage	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-12-A Fault Detection and Diagnostic for DX Systems	NRCA-MCH-13-A Fault Detection and Diagnostic for AHUs	NRCA-MCH-16-A Supply Air Temp Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	YES	no	no	no	no	no	no	no	no	no	YES
DCV	YES	YES	no	YES	YES	YES	no	no	no	no	no	YES
Heat Pump Controls	no	YES	no	no	no	no	no	no	no	no	no	no
Shutoff and Reset	no	YES	no	no	no	no	no	YES	no	no	no	YES
Ventilation Dampers	YES	YES	YES	YES	no	YES	no	no	no	no	no	YES
Isolation Devices	no	YES	YES	no	no	no	YES	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	YES	no	no	YES	YES	no	YES
Zone Control	no	YES	no	no	no	no	YES	YES	no	no	no	YES
Supply Temp. Reset	no	no	no	no	no	no	no	no	no	no	YES	YES
Variable Flow Control	no	no	no	no	no	YES	YES	no	no	no	no	YES
Duct Systems	YES	no	YES	no	no	no	no	no	no	no	no	no

A Test is only applicable if an EMCS is present

HVAC Complex Systems

	Mandatory Requirements								Prescriptive Requirements				
Space Conditioning Equipment[A]	Zone Thermostat[C] §120.2(a), (b) Setback Capable[D]	DCV[E] §120.1(c)	Shutoff and Reset[F] §120.2(e)	VentilationDampers §120.2(f) Automatic close upon fan shutdown[H]	Isolation Devices[I] §120.2(g)	Demand Shedding[J] §120.2(h)	DDC §120.2(j)	Optimum Start Stop §120.2(k) (new in 2016)	Zone Control[K] §140.4(d)	Supply Temperature Reset §140.4(f) §140.4(k)4	Economizer[N] §140.4(e)1- 5	Variable Flow Control[O] §140.4(k)6 §140.4(m)	Isolation §140.4(k)2 §140.4(k)3
Boiler	no	no	YES[G]	no	no	YES	YES	YES	YES	YES[L]	no	no	YES
Air-cooled Chiller	no	no	YES[G]	no	no	YES	YES	YES	YES	YES[M]	no	YES	YES
Water-cooled Chiller	no	no	YES[G]	no	no	YES	YES	YES	YES	YES[M]	no	YES	YES
Variable Refrigerant Flow (VRF)	YES	YES	YES[G]	no	YES	YES	no	no	YES	YES	YES	YES	no
Air Handling Systems & Zones[B]	YES	YES	YES[G]	YES	YES	YES	YES	YES	YES	YES	YES	YES	no
Zone Terminal Units or Fan Coils	YES	no	YES[G]	no	no	YES	YES	YES	YES	YES	no	YES	no

A Central Energy Management Control System (EMCS) should be installed at building site for optimal equipment operation and coordination.

B Applies to fan systems serving multiple thermostatically controlled zones, and to built-up air handler systems (non-unitary or nonpackaged HVAC equipment).

C An EMCS may perform the setback functions.

D Heating and cooling set point dead band of ±5°F should be implemented on all temperature set points. Applies only to equipment with heating AND cooling capability. Set back the zone temperature set points to 55°F or lower for heating and 85°F or higher for cooling.

E Demand Control Ventilation. See §120.1(c) 3, 4 and 5 for additional CO_2 concentration set point information and sensor location requirements.

F Must include automatic restart to maintain setback temperatures as necessary

G Must include automatic time switch OR occupancy sensor OR 4-hour timer 7-day programmable local control exemption.

H Reference to mechanical room ventilation fan where chillers are located.

I For systems serving multiple zones totaling more than 25,000 ft². A zone need not be isolated if demonstrated that it must be heated or cooled continuously.

J Include settings capable of disabling, manually controlling, or automatically operating equipment. Applies to HVAC systems with DDC to the zone level.

K Simultaneous heat and cool prevention except for variable-air-volume and other system types listed in this section. Ambient conditions also provide lockout for seasonal operation only.

L Referred to as "Hot Water Supply Temperature Reset".

M Referred to as "Chilled Water Supply Temperature Reset".

N Exemptions apply where: (1) outside air conditions are undesirable, (2) high-rise residential, (3) adverse effects of other systems, like dehumidification, (4) high cooling efficiency systems [Table 140.1-A] (5) computer rooms served per §140.9(a).

O Includes reference to both water and air-side applications referred to in respective code language. Central EMCS necessary for remote system operation and ability to oversee all space-conditioning equipment and pumping needs.

Acceptance Tests: HVAC Complex Systems

The measures below trigger these acceptance tests	NRCA-MCH-02-A Outdoor Air	NRCA-MCH-05-A Air Economizer Controls	NRCA-MCH-06-A Demand Control Ventilation	NRCA-MCH-07-A Supply Fan VFD	NRCA-MCH-08-A Valve Leakage	NRCA-MCH-09-A Supply Water Temperature Reset	NRCA-MCH-10-A Hydronic System Variable Flow	NRCA-MCH-11-A Automatic Demand Shed	NRCA-MCH-13-A AHUs and Zone Terminal Units	NRCA-MCH-14-A Distributed Energy Storage DX AC Systems	NRCA-MCH-15-A Thermal Energy Storage	NRCA-MCH-16-A SAT Reset Controls	NRCA-MCH-17-A Condenser Water Temperature Reset	NRCA-MCH-18-A[A] Energy Management Control System
Zone T-Stats	no	no	no	no	no	no	no	no	no	no	no	no	no	YES
DCV	YES	no	YES	YES	no	no	no	no	no	no	no	no	no	YES
Shutoff and Reset	no	no	no	no	no	no	YES	YES	no	no	no	no	no	YES
Ventilation Dampers	YES	YES	no	YES	no	no	no	no	YES	no	no	no	no	YES
Isolation Devices	no	no	no	no	YES	no	YES	no	no	no	no	no	no	YES
Demand Shedding	no	no	no	no	no	no	no	YES	no	no	no	no	no	YES
Economizer and/or FDD	YES	YES	no	YES	no	no	no	no	no	no	no	no	no	YES
Zone Control	no	no	no	no	YES	no	YES	YES	YES	no	no	YES	no	YES
Supply Temp. Reset	no	no	no	no	no	YES	no	no	no	no	no	YES	YES	YES
Variable Flow Control	no	no	no	YES	YES	no	YES	no	YES	no	no	no	no	YES
Distributed Energy Storage DX AC Systems	no	no	no	no	no	no	no	no	no	YES	no	no	no	no
Thermal Energy Storage Systems	no	no	no	no	no	no	no	no	no	no	YES	no	no	no

A Test is only applicable if an EMCS is present

For More Information

Primary Sources

- Energy Standards Section 110.2 – Mandatory Requirements for Space-Conditioning Equipment:
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1102mandatoryrequirementsforspaceconditioningequipment.htm
- Energy Standards Section 120.1 – Requirements for Ventilation:
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1201requirementsforventilation.htm
- Energy Standards Section 120.2 – Required Controls for Space-Conditioning Systems:
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1202requiredcontrolsforspaceconditioningsystems.htm
- Energy Standards Section 140.4 – Prescriptive Requirements for Space-Conditioning Systems:
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1404prescriptiverequirementsforspaceconditioningsystems.htm
- Energy Standards Section 140.9 – Prescriptive Requirements for Covered Processes:
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1409prescriptiverequirementsforcoveredprocesses.htm
- Energy Standards Reference Appendix NA7– Installation and Acceptance Requirements for Nonresidential Buildings and Covered Processes:
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/appendixna7installationandacceptancerequirementsfornonresidentia.htm

California Energy Commission Information & Services

- Energy Standards Hotline: 1-800-772-3300 (Free) or Title24@energy.ca.gov
- Online Resource Center:
  energy.ca.gov/title24/orc/
  - The Energy Commission's main web portal for Energy Standards, including information, documents, and historical information

Additional Resources

- Energy Code Ace:
  EnergyCodeAce.com
  - An online "one-stop-shop" providing free resources and training to help appliance and building industry professionals decode and comply with Title 24, Part 6 and Title 20. The site is administered by California's investor-owned utilities.
    Please register with the site and select an industry role for your profile in order to receive messages about all our free offerings!

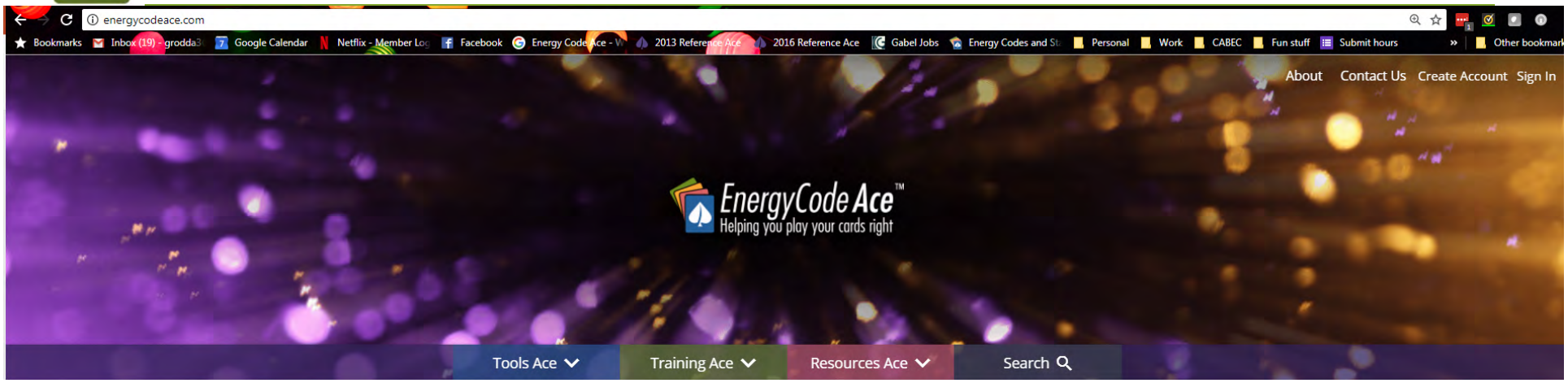
Next Steps

What's Next?

- Currently, installing contractor/technician provides the testing and documentation for mechanical acceptance testing.

- Wait until Energy Commission mandates "Certified" ATT's must be used….
  - What are we waiting for?
    - Quality assurance program to be established for the 2016 code cycle
  - 2019 addressing those hiccups
    - Maybe adopted early for 2016…MAYBE!

Other ECA Resources



Ace Resources Trigger Sheets

Quick reference component-by-component summaries of sections of Title 24, Part 6 "triggered" based on project scope.

Ace Resources Fact Sheets

Quick reference summaries of key requirements, forms, definitions and resources for implementing Title 24, Part 6 and Title 20

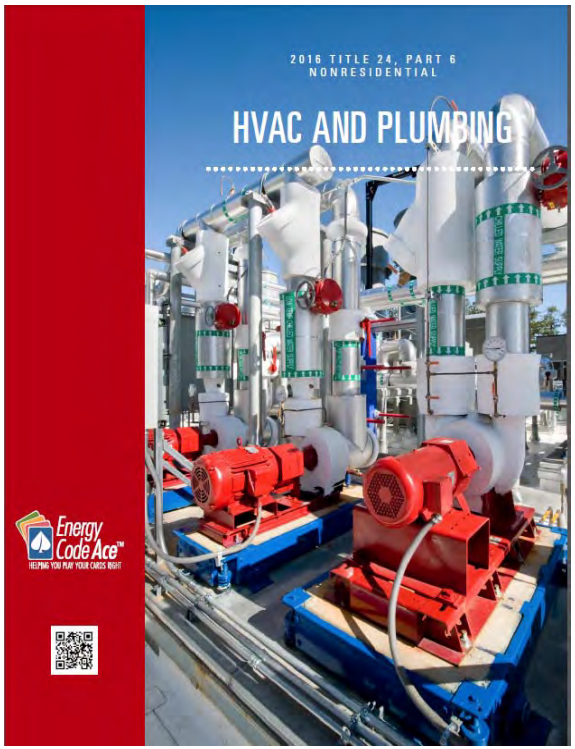
Ace Resources Checklists

Step-by-step guidance for plans checks and field inspections

Ace Resources Application Guides

Short manuals including compliance requirements and recommendations for implementing Title 24, Part 6 in new construction, addition and renovation projects.

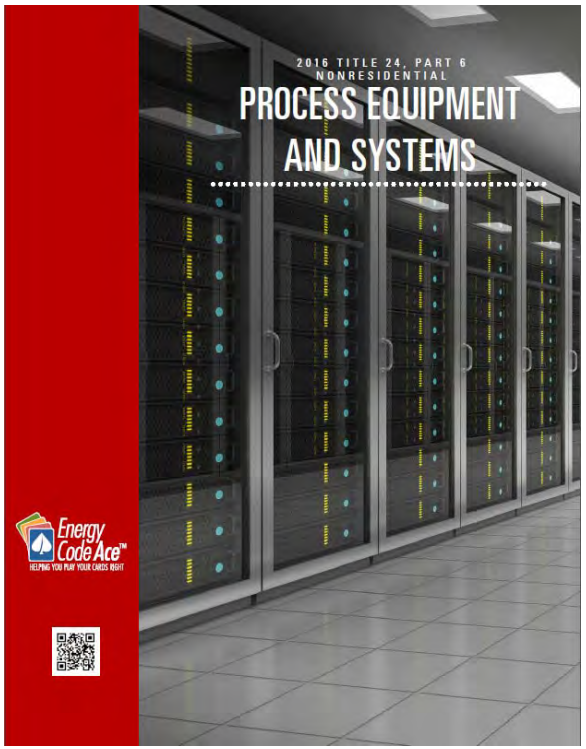
Ace Resources™



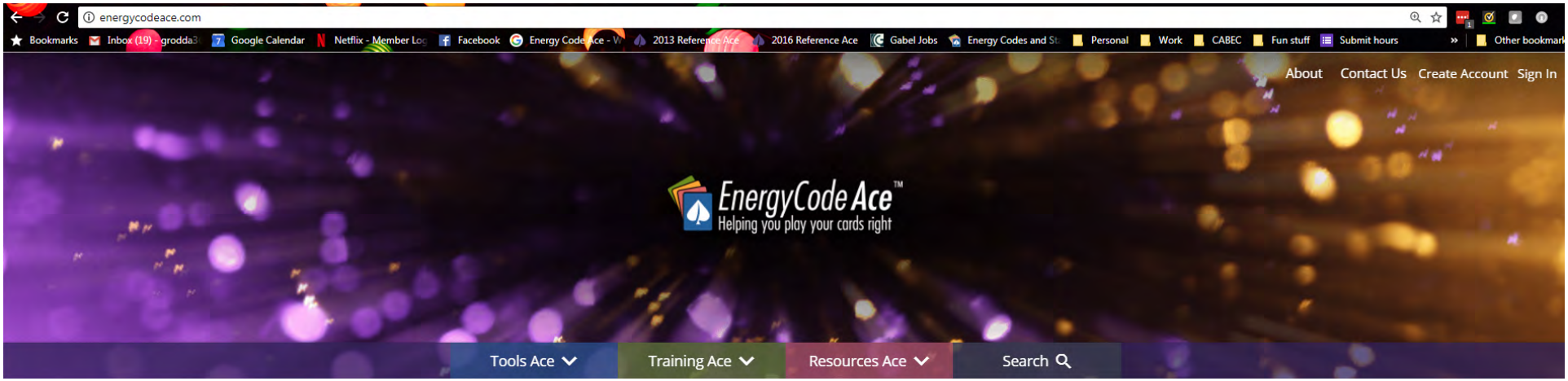
Application Guides:

Short manuals including compliance requirements and recommendations for implementing Title 24, Part 6 in new construction, addition and renovation projects.

Available through Amazon



Other ECA Resources



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December 2017

Review the NEW NRCC-LTO and NRCC-LTS

February 2018

Structure of the Energy Standards

w/Chris Olvera from the Energy Commission

Please Provide Your Feedback!

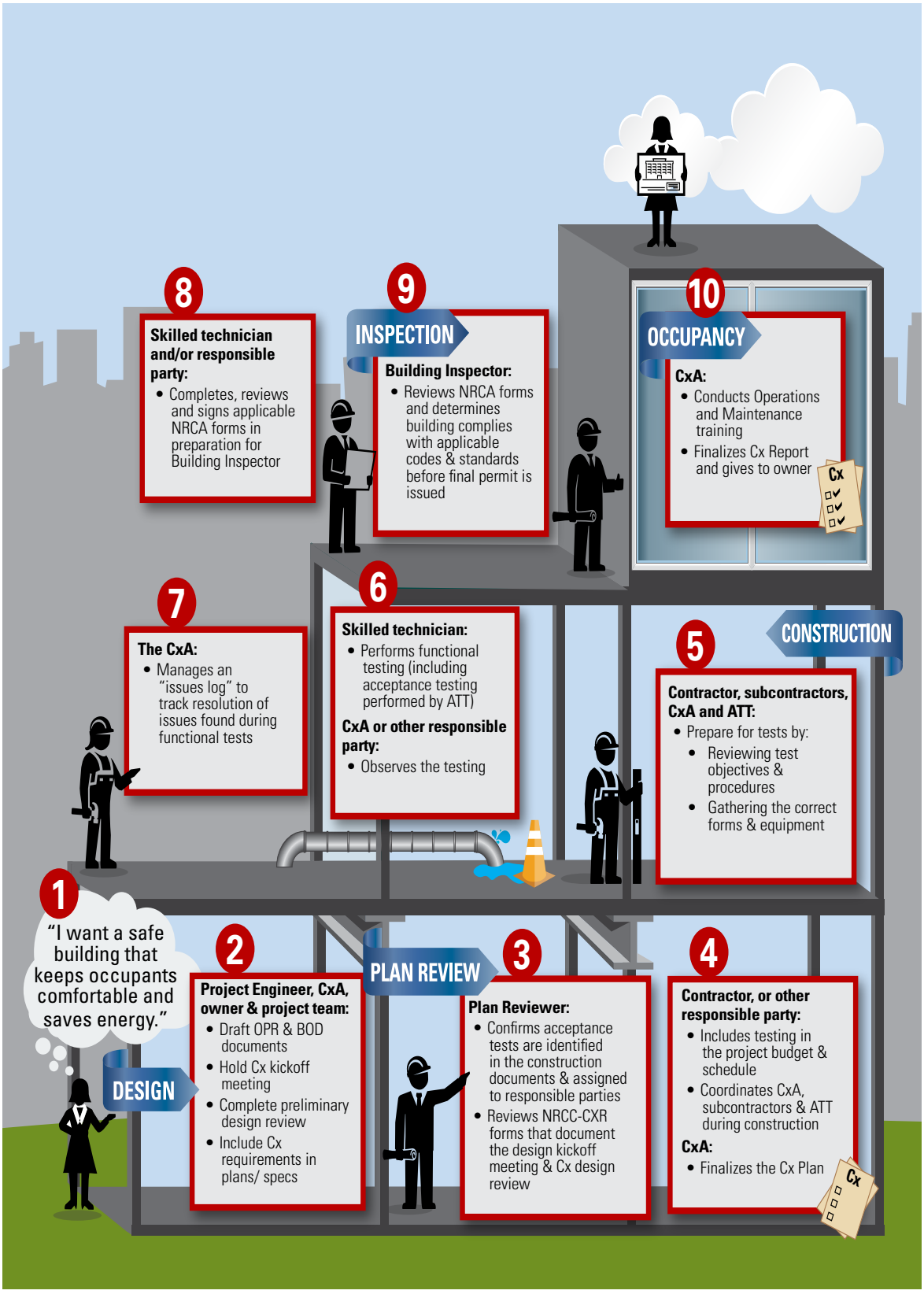
A survey will pop up on your screen before you leave us today.

- Focus our attentions on your input for further development of training, job aides, tools, etc.
- Fine tune future events
- Let California Statewide Codes & Standards team know how we can improve
- Make your voice heard!

This is how to get a copy of the slide deck

Wrap Up

Nonresidential Commissioning



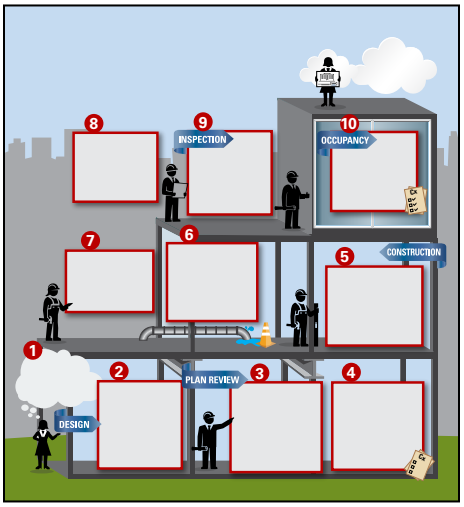
What is Commissioning?

California's Building Energy Efficiency Standards (Energy Standards), Title 24, Part 6 defines commissioning as "a systematic quality assurance process that spans the entire design and construction process, including verifying and documenting that building systems and components are planned, designed, installed, tested, operated and maintained to meet the owner's project requirements."

Closely related to acceptance testing, commissioning (also commonly referred to as Cx) involves functional testing during construction, but also includes activities during design that will ensure the building systems and associated controls will meet the owner's energy and operating efficiency goals.

Commissioning requirements for all newly constructed nonresidential buildings are included in the 2016 Energy Standards Title 24, Part 6. Many of these requirements were moved from Title 24, Part 11 (CalGreen), where commissioning was originally incorporated into state building code in 2008.

Why?: Commissioning is critical to realizing the energy savings during building operation that were intended by the building design.



A systematic quality assurance process that spans the entire design and construction process, including verifying and documenting that building systems and components are planned, designed, installed, tested, operated and maintained to meet the owner's project requirements.

Relevant Code Sections

2016 California Building Energy Efficiency Standards, Title 24, Part 6:

- Section 120.8 – Nonresidential Building Commissioning

Relevant Compliance Forms

- NRCC-CXR-01-E: for Design Review Kickoff
- NRCC-CXR-02-E: Construction Documents Design Review Checklist
- NRCC-CXR-03-E: for "simple" HVAC systems
- NRCC-CXR-04-E: for "complex" HVAC systems
- NRCC-CXR-05-E: Design Review Signature Page

Roles and Responsibilities

Because commissioning spans the entire building delivery process from pre-design through occupancy, many parties are involved, making communication and coordination paramount. Understanding and assigning roles early in the commissioning process is key to success. Below is a list of who may need to participate in the commissioning process.

- Owner, owner's representative or facility operator
- Designers (architect and MEP)
- Design Reviewer
- Plans Examiner
- General Contractor*
- Key Subcontractors (HVAC, controls, TAB, etc.)*
- Acceptance Test Technician (ATT)*
- Commissioning Authority (CxA)*
- Building Inspector*

** These parties are generally only involved in the commissioning process for buildings with nonresidential conditioned floor area 10,000ft² or greater when §120.8(f)- §120.8(i) are required.*

The most appropriate person to fill each of these roles depends on the experience and expertise of the project team. The Energy Standards do not specify who must function as the Commissioning Authority. However, there are restrictions on who may act as the Design Reviewer.

Building Size	<10,000 ft²	10,000 - 50,000 ft²	>50,000ft²	Complex systems in BIdgs >10,000 ft²
Allowed Design Reviewer	A licensed professional engineer, architect or contractor, including the engineer or architect of record	A qualified engineer or architect in-house to the design firm but not associated with the project, a third-party engineer, architect, or contractor	A third-party engineer, architect or contractor	A third-party engineer, architect or contractor

Table 1. Design Reviewer Specifications, per §120.8(d) (references 10-103(a)1 in Title 24, Part 1)

Commissioning Requirements

Commissioning requirements are included in Section 120.8 of the Energy Standards and apply to all newly constructed nonresidential buildings, though the extent of the requirements depends on the size of the conditioned floor area. Commissioning requirements for nonresidential spaces within high-rise residential and hotel/motel buildings are based on the conditioned floor area (CFA) of nonresidential spaces only (excluding all residential living spaces and guestrooms).

Table 2 illustrates which requirements apply based on conditioned floor area.

Commissioning Requirements	Conditioned Floor Area		When
	<10k ft²	≥10k ft²	
Owner's Project Requirements (OPR) (§120.8(b))		X	Pre-Design
Basis of Design (BOD) (§120.8(c))		X	Draft during Schematic Design, update as necessary
Design Review (§120.8(d))	X	X	Preliminary at 50% Design / Final at 90% Design
Commissioning specifications in Construction Docs (CD) (§120.8(e))	X	X	Draft at 50% Design / Final at 90% Design
Commissioning Plan (§120.8(f))		X	Draft at 90% Design / Final during Construction
Functional Performance Tests (§120.8(g))		X	Construction
Operation & Maintenance (O&M) Training (§120.8(h))		X	Occupancy
Commissioning Report (§120.8(i))		X	Draft during Construction / Final during Occupancy

Table 2. Commissioning Requirements in Title 24, Part 6

Don't Forget About CALGreen!

Title 24, Part 11 (CALGreen) also includes requirements for commissioning in Chapter 5 - Nonresidential Mandatory Measures. These requirements are complementary to the Energy Standards requirements, but be sure to read through them as additional systems such as renewable energy, landscape irrigation and water reuse systems are covered here.

Functional Performance Test Procedures

Per Section 120.8(g), functional testing performed to satisfy commissioning requirements must be performed in accordance with acceptance testing procedures outlined in other sections of the Energy Standards.

Why?: To demonstrate the correct installation and operation of each component, system and system-to-system interface.

Note that functional performance tests needed for commissioning are based on the systems documented in the Owner's Project Requirements (OPR) and Basis of Design (BOD) documents, and may be more comprehensive than the project's required acceptance tests. Not being included in the OPR/BOD does not exempt a system from acceptance test requirements outlined in other sections of the Energy Standards.

Forms: Which and When

During Schematic Design:

- NRCC-CXR-01-E: Records that the requirement to hold a design review kickoff meeting between the owner, architect, design engineer and design reviewer has been met and that the OPR and BOD were reviewed during the meeting
  - Signed by the Principal Designer (Responsible Person)

Why?: The Energy Standards dictate that the commissioning process starts in early design.

At 90% Construction Documents:

- NRCC-CXR-02-E: Records that applicable envelope, lighting/daylighting, water heating and general HVAC code elements are included and are well documented in the construction documents
  - Completed by the Designer and the Design Reviewer
  - Signed by the Documentation Author and the Principle Designer (Responsible Person)
- NRCC-CXR-03-E: Supplemental information for "simple" HVAC systems, **OR**
- NRCC-CXR-04-E: Supplemental information for "complex" HVAC systems (See Figure 1)
  - Completed by the Designer and the Design Reviewer
  - Signed by the Documentation Author and the Principle Designer (Responsible Person)
- NRCC-CXR-05-E: Records that the required construction documents design review has been completed for the project
  - Completed and signed by Owner/Owner's Representative, Design Architect/Engineer, the Design Reviewer **and** the Principle Designer (Responsible Person)

Why?: The Energy Standards dictate that all the completed, signed certificates are to be made available with the building permit(s) issued for the building, and to the enforcement agency for all applicable inspections.

Notes:

- All newly constructed nonresidential projects are required to complete the design review certificates of compliance, regardless of project size (See Table 1).
- Although there are no commissioning forms other than the certificates of compliance, the NRCA forms (certificates of acceptance) are used to document functional performance tests for the inspector to review.

"Simple" HVAC Systems include:
(a) Unitary or packaged equipment listed in Tables 110.2-A, 110.2-B, 110.2-C and 110.2-E that each serve one zone; **OR**
(b) Two-pipe, heating only systems serving one or more zones
"Complex" HVAC Systems include:
(a) Fan systems each serving multiple thermostatically controlled zones; **OR**
(b) Built-up air handler systems (non-unitary or non-packaged HVAC equipment); **OR**
(c) Hydronic or steam heating systems; **OR**
(d) Hydronic cooling systems

Figure 1. "Simple" vs. "Complex" HVAC Systems

For More Information

Commissioning Process

- Energy Design Resources e-news #96 ("Commissioning for Compliance"):
  energydesignresources.com/resources/e-news/e-news-96-commissioning.aspx
  - Includes tips and tricks and a handy graphic that shows when during project delivery the commissioning requirements should be implemented.

Roles and Responsibilities

- Building Commissioning Guide in Nonresidential Compliance Manual:
  energy.ca.gov/2015publications/CEC-400-2015-033/chapters/chapter_12_building_commissioning_guide.pdf
  - Section 12.1 of this guide outlines roles and information on how to find a qualified Commissioning Authority
- California Commissioning Collaborative:
  cacx.org/resources/provider_list.php
  - Provider List that may be valuable when searching for a Commissioning Authority
- Energy Standards Section 10-103(a)1:
  energycodeace.com/site/custom/public/referenceace-2016/index.html#!Documents/10103permitcertificateinformationalandenforcementrequirementsfor.htm#sect10_103_a1
  - Specifies who can act as the Design Reviewer
- California Energy Commission's Acceptance Test Technician Certification Provider webpage:
  energy.ca.gov/title24/attcp/
  - For information on becoming a certified ATT

Functional Performance Testing Requirements

- Chapter 13 Acceptance Requirements in the Nonresidential Compliance Manual:
  energy.ca.gov/2015publications/CEC-400-2015-033/chapters/chapter_13_acceptance_requirements.pdf
  - An overview of acceptance testing requirements, the process and the forms are further detailed in Chapter 13. Section 13.1 includes a list of certificate of acceptance forms by building component for new or modified tests.
- Nonresidential Reference Appendices NA7:
  energycodeace.com/site/custom/public/reference-ace-2016/Documents/appendixna7installationandacceptancerequirementsfornonresidentia.htm
  - This Section of the Nonresidential Appendices includes test procedures, roles and responsibilities and other details related to acceptance testing

Compliance Forms

- Energy Design Resources e-news #96 ("Commissioning for Compliance"):
  energydesignresources.com/resources/e-news/e-news-96-commissioning.aspx
  - Includes more detail on each compliance form, including when it should be completed
- Building Commissioning Guide in Nonresidential Compliance Manual:
  energy.ca.gov/2015publications/CEC-400-2015-033/chapters/chapter_12_building_commissioning_guide.pdf
  - Section 12.10 has detailed instructions on completing the compliance forms associated with commissioning
- NRCA forms:
  energy.ca.gov/2015publications/CEC-400-2015-033/appendices/forms/NRCA/
  - The certificates of acceptance themselves are useful to understand required documentation
- NRCC Forms:
  energy.ca.gov/2015publications/CEC-400-2015-033/appendices/forms/NRCC/
  - The cerfiticates of compliance themselves are useful to understand required documentation

California Energy Commission Information & Services

- Energy Standards Hotline: 1-800-772-3300 (Free) or Title24@energy.ca.gov
- Online Resource Center:
  energy.ca.gov/title24/orc/
  - The Energy Commission's main web portal for Energy Standards, including information, documents, and historical information

Additional Resources

- EnergyCodeAce.com
  An online "one-stop-shop" providing free resources and training to help appliance and building industry professionals decode and comply with Title 24, Part 6 and Title 20. The site is administered by California's investor-owned utilities.
  Please register with the site and select an industry role for your profile in order to receive messages about all our free offerings!

This program is funded by California utility customers under the auspices of the California Public Utilities Commission and in support of the California Energy Commission.