Nonresidential Appendix NA7

Appendix NA7 – Acceptance and Installation Requirements for Nonresidential Buildings and Covered Processes

NA7.1 Purpose and Scope

This appendix defines acceptance procedures that must be completed on certain controls and equipment before the installation is deemed to be in compliance with the Standards. These requirements apply to all newly installed equipment for which there are acceptance requirements in new and existing buildings. The procedures apply to nonresidential, high-rise residential, ~~and~~ hotel/motel buildings and covered processes as defined by the California Energy Commission's Energy Efficiency Standards for Nonresidential Buildings (Standards).

The purpose of the acceptance tests is to assure:

1. The presence of equipment or building components according to the specifications in the compliance documents.
2. Installation quality and proper functioning of the controls and equipment to meet the intent of the design and the Standards.

NA7.2 Introduction

Acceptance requirements are defined as implementation of targeted inspection checks and functional and performance testing to determine whether specific building components, equipment, systems, and interfaces between systems conform to the criteria set forth in the Standards and to related construction documents (plans or specifications). Acceptance requirements improve code compliance effectiveness and help meet the expected level of performance.

Prior to signing a Certificate of Acceptance the installing contractor, engineer of record or owners agent shall be responsible for reviewing the plans and specifications to assure they conform to the acceptance requirements. Persons eligible to sign the Certificate of Acceptance are those responsible for its preparation; and licensed in the State of California as a civil engineer, mechanical engineer, licensed architect or a licensed contractor performing the applicable work or a person managing work on a structure or type of work described pursuant to Business and Professions Code sections 5537, 5538, and 6737.1.

NA7.3 Responsible Party

The installing responsible party shall certify compliance with the acceptance requirements. They shall be responsible for performing data analysis, calculation of performance indices, and crosschecking results with the requirements of the Standards. They shall be responsible for issuing a Certificate of Acceptance as well as copies of all measurement and monitoring results for individual test procedures to the enforcement agency. The enforcement agency shall not release a final Certificate of Occupancy until a Certificate of Acceptance, and all applicable acceptance requirements for code compliance forms, are approved and submitted by the responsible party. A responsible party who is licensed shall record their State of California contractor's license number or their State of California professional registration license number on each Certificate of Acceptance that they issue.

NA7.4 Building Envelope Acceptance Tests

NA7.4.1 Fenestration

- Each fenestration product shall have either an NFRC Label Certificate or the Commission's Fenestration Certificate, FC-1 ~~or FC-2~~, to identify the thermal performance (e.g. U-factor, SHGC) of each fenestration product being installed. The labels shall be located at the job site for verification by the enforcement agency. In addition, the responsible party shall fill out the Fenestration Acceptance Certificate. The responsible party shall verify the thermal performance of each specified fenestration product being installed and shall ensure that it matches the label certificate, energy compliance documentation and building plans. A copy of the certificate shall be given to the building owner and the enforcement agency for their records.

NA7.4.1.1 Elements Requiring Verification:

The responsible party shall verify the following:

1. The thermal performance for each fenestration product matches the building plans, energy compliance documentation, and the label certificate,
2. The delivery receipt or purchase order matches the delivered fenestration product(s).
3. Verify the NFRC Label Certificate is filled out and includes an NFRC's Certified Product Directory (CPD) number or that the FC-1 ~~or FC-2~~ matches the purchase order or detailed receipt.
4. The Certificate of Acceptance form is completed and signed.

NA7.4.1.2 Required Documentation

- NFRC Product Label Certificate:
    - The label can list a single or multiple fenestration products, each with its own CPD number. The CPD number for each fenestration product" can be verified for authenticity by accessing www.NFRC.org, Certified Product Database; or
- Commission's Fenestration Label Certificate:
    - The FC-1 ~~and FC-2~~ are used to document products not certified by NFRC by using the Commission's Default Table values in §110.6. ~~or the Alternate Default Fenestration Thermal Performance method as described in Appendix NA6.~~
    - FC-1 is used for vertical fenestration ~~10,000 ft² or greater~~ and is only limited to the Energy Commission's Default Values found in Standards Table 110.6-A and Table 110.6-B or;
    - ~~FC-2 is used for vertical fenestration less than 10,000 ft² and may use either the Energy Commission's Default Table Values found in Standards Table 116-A and Table 116-B or may use the Alternate Default Fenestration Thermal Performance procedures described in Appendix NA6.~~
- Purchase Order or Receipt:
    - A copy of the purchase order or a detailed payment receipt shall be used to cross reference with the NFRC Product Label Certificate CPD number or the FC-1 or FC-2 values; and
    - The purchase order or a detailed payment receipt should match the energy compliance documentation and the building plans.
- Fenestration Building Plans:
    - The building plans shall list in a schedule each fenestration product to be installed in the building.

- Certificate of Acceptance Form:
    - The acceptance form ~~must~~shall be filled out by the responsible party and signed.
    - The signed Certificate of Acceptance shall be submitted to enforcement agency or field inspector.
    - A copy of the Certificate of Acceptance shall be given to the building owner.

NA7.5 Mechanical Systems Acceptance Tests

NA7.5.1 Outdoor Air

NA7.5.1.1 Variable Air Volume Systems Outdoor Air Acceptance

NA7.5.1.1.1 Construction Inspection

Prior to functional testing, verify and document the following:

- Sensor used to control outdoor air flow is either factory calibrated or field calibrated.
- Attach calibration certification or results.
- Dynamic damper control is being used to control outside air.
- Specify the type of dynamic control being utilized to control outside air.
- Specify the method of delivering outside air to the unit.
- Pre-occupancy purge has been programmed for the 1-hour period immediately before the building is normally occupied.
- ~~F~~System controlling outside airflow was calibrated either in the field or factory.

NA7.5.1.1.2 ~~F~~unctional Testing

Step 1: If the system has an outdoor air economizer, force the economizer high limit to disable economizer control (e.g. for a fixed drybulb high limit, lower the setpoint below the current outdoor air temperature)

Step 2: Adjust supply airflow to achieve design airflow or maximum airflow at full cooling~~either the sum of the minimum zone airflows or 30 percent of the total design airflow~~. Verify and document the following:

- Measured outside airflow reading is within 10 percent of the total ventilation air called for in the Certificate of Compliance.
- Outside air damper position ~~OSA controls~~ stabilizes within 5 minutes.

Step 3: Adjust supply airflow to either the sum of the minimum zone airflows, full heating, or 30 percent of the total design airflow. ~~achieve design airflow.~~ Verify and document the following:

- Measured outside airflow reading is within 10 percent of the total ventilation air called for in the Certificate of Compliance.
- Outside air damper position ~~OSA controls~~ stabilizes within 5 minutes.

Step 4: Restore system to “as-found” operating conditions

NA7.5.1.2 Constant Volume System Outdoor Air Acceptance

NA7.5.1.2.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- System is designed to provide a fixed minimum OSA when the unit is on.
- Specify the method of delivering outside air to the unit.
- Pre-occupancy purge has been programmed for the 1-hour period immediately before the building is normally occupied.
  - Minimum position is marked on the outside air damper.
  - The system has means of maintaining the minimum outdoor air damper position.

NA7.5.1.2.2 Functional Testing

Step 1: If the system has an outdoor air economizer, force the economizer to the minimum position and stop outside air damper modulation (e.g. for a fixed drybulb high limit, lower the setpoint below the current outdoor air temperature)

- Measured outside airflow reading is within 10 percent of the total ventilation air called for in the Certificate of Compliance.

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

NA7.5.2.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

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

NA7.5.2.2 Functional Testing

Step 1: Disable economizer and demand control ventilation systems (if applicable).

Step 2: Simulate a heating demand during the occupied condition. Verify and document the following:

- Supply fan operates continually.
- The unit provides heating.
- No cooling is provided by the unit.
- Outside air damper is at minimum position.

Step 3: Simulate operation in the dead band during occupied condition. Verify and document the following:

- Supply fan operates continually.
- Neither heating nor cooling is provided by the unit.
- Outside air damper is at minimum position.

Step 4: Simulate cooling demand during occupied condition. Lock out economizer (if applicable). Verify and document the following:

- Supply fan operates continually.
- The unit provides cooling.
- No heating is provided by the unit.
- Outside air damper is at minimum position.

Step 5: Simulate operation in the dead band during unoccupied mode. Verify and document the following:

- Supply fan is off.
- Outside air damper is fully closed.
- Neither heating nor cooling is provided by the unit.

Step 6: Simulate heating demand during unoccupied conditions. Verify and document the following:

- Supply fan is on (either continuously or cycling).
- Heating is provided by the unit.
- No cooling is provided by the unit.
- Outside air damper is either closed or at minimum position.

Step 7: Simulate cooling demand during unoccupied condition. Lock out economizer (if applicable). Verify and document the following:

- Supply fan is on (either continuously or cycling).
- Cooling is provided by the unit.
- No heating is provided by the unit.
- Outside air damper is either closed or at minimum position.

Step 8: Simulate manual override during unoccupied condition. Verify and document the following:

- System operates in "occupied" mode.
- System reverts to "unoccupied" mode when manual override time period expires.

Step 9: Restore economizer and demand control ventilation systems (if applicable), and remove all system overrides initiated during the test.

NA7.5.3 Air Distribution Systems

NA7.5.3.1 Construction Inspection

Prior to Functional Testing on new duct systems, verify and document the following:

- Duct connections meet the requirements of Standards §120.4.
- Specify choice of drawbands.
- Flexible ducts are not ~~compressed~~constricted in any way.
- ~~Ducts are fully accessible for testing.~~
- Joints and seams are properly sealed according to the requirements of Standards §120.4.
- Joints and seams are not sealed with cloth back rubber adhesive tape unless used in combination with Mastic and drawbands. Cloth backed tape may be used if tape has been approved by the CEC. Ducts are fully accessible for testing.
- Insulation R-Values meet the minimum requirements of Standards §150.1~~2~~0(f)10.~~4~~(a).
- Insulation is protected from damage and suitable for outdoor service if applicable per Standards §120.4(f).
- A sticker has been affixed to the exterior surface of the air handler access door.

Prior to Functional Testing on all new and existing duct systems, visually inspect to verify that the following locations have been sealed:

- Connections to plenums and other connections to the forced air unit
- Refrigerant line and other penetrations into the forced air unit
- Air handler door panel (do not use permanent sealing material, metal tape is acceptable)
- Register boots sealed to surrounding material
- Connections between lengths of duct, as well as connections to takeoffs, wyes, tees, and splitter boxes

Prior to Functional Testing on all new and existing duct systems, visually inspect to verify that portions of the duct system that are excessively damaged have been replaced. Ducts that are considered to be excessively damaged are:

- Flex ducts with the vapor barrier split or cracked with a total linear split or crack length greater than 12 inches
- Crushed ducts where cross-sectional area is reduced by 30 percent or more
- Metal ducts with rust or corrosion resulting in leaks greater than 2 inches in any dimension
- Ducts that have been subject to animal infestation resulting in leaks greater than 2 inches in any dimension

NA7.5.3.2 Functional Testing

Step 1: Perform duct leakage test per Reference Nonresidential Appendix NA2. Certify the following:

- Duct leakage conforms to the requirements of Standards §140.4(k) and Standards §140.9(b)1D.

Step 2: Obtain HERS Rater field verification as required by Reference Nonresidential Appendix NA1.

NA7.5.4 Air Economizer Controls

NA7.5.4.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Economizer lockout setpoint complies with Table 140.4(e)-C of Section§140.4(e)3.
- If the high-limit control is fixed dry-bulb, it shall have an adjustable setpoint.
- Economizer lockout control sensor is located to prevent false readings.
- Sensor performance curve is provided by factory with economizer instruction material.
- Sensor output value measured during sensor calibration is plotted on the performance curve.
- Primary damper control temperature sensor located after the cooling coil to maintain comfort.
- Economizer damper moves freely without binding.
- Unitary systems with an economizer have control systems, including two-stage or electronic thermostats, that cycle compressors off when economizers can provide partial cooling
- Economizer reliability features are present per Standards Section 140.4(e)4.
- System is designed to provide up to 100 percent outside air without over-pressurizing the building.
- For systems with DDC controls lockout sensor(s) are either factory calibrated or field calibrated.
- For systems with non-DDC controls, manufacturer's startup and testing procedures have been applied
- For direct expansion systems 65,000 Btu/hr and less, thermostats (e.g. two stage or electronic) and control system has capacity to modulate compressor or cycle compressor off during periods where economizer cooling can partially meet the cooling load as per Section 140.4(e)2.B.i.

- For direct expansion systems, equipment submittal specifies compressor capacity steps and/or compressor capacity modulation complying with the stages or modulation required in Section 140.4(e)2.B.ii.
- Provide an economizer specification sheet proving capability of at least 100,000 actuations.
- Provide a product specification sheet proving compliance with AMCA Standard 500 damper leakage at 10 cfm/sf.
- Unit has a direct drive modulating actuator with gear driven interconnections.

NA7.5.4.2 Functional Testing

Step 1: Disable demand control ventilation systems (if applicable)

Step 2: Enable the economizer and simulate a cooling demand large enough to drive the economizer fully open. Verify and document the following:

- Economizer damper is 100 percent open and return air damper is 100 percent closed.
- For systems that meet the criteria of §140.4(e)2.B.i, verify that the economizer is 100 percent open part of the time and the compressor cycles on and off when the cooling demand can no longer be met by the economizer alone.
- For systems that meet the criteria of §140.4(e)2.b.ii~~1~~, verify that the economizer provides partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load~~remains 100 percent open when the cooling demand can no longer be met by the economizer alone~~.
- All applicable fans and dampers operate as intended to maintain building pressure.
- The unit heating is disabled (if unit has heating capability).

Step 3: Disable the economizer and simulate a cooling demand. Verify and document the following:

- Economizer damper closes to its minimum position.
- All applicable fans and dampers operate as intended to maintain building pressure.
- The unit heating is disabled (if unit has heating capability).

Step 4: If unit has heating capability, ~~S~~simulate a heating demand and set the economizer so that it is capable of operating (i.e. actual outdoor air conditions are below lockout setpoint). Verify the following:

- The economizer is at minimum position

Return air damper opens

Step 5: Turn off the unit. Verify and document the following:

- Economizer damper closes completely.

Step ~~6~~5: Restore demand control ventilation systems (if applicable) and remove all system overrides initiated during the test.

NA7.5.5 Demand Control Ventilation (DCV) Systems

NA7.5.5.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Carbon dioxide control sensor is factory calibrated or field-calibrated per §120.1(c)4.
- The sensor is located in the high density space between 3 ft and 6 ft above the floor or at the anticipated level of the occupants' heads.

- DCV control setpoint is at or below the CO_2 concentration permitted by §120.1(c)4.C.

NA7.5.5.2 Functional Testing

Step 1: Disable economizer controls

Step 2: Simulate a signal at or slightly above the CO_2 concentration setpoint required by §120.1(c)4.C. Verify and document the following:

- For single zone units, outdoor air damper modulates open to satisfy the total ventilation air called for in the Certificate of Compliance.
- For multiple zone units, either outdoor air damper or zone damper modulate open to satisfy the zone ventilation requirements.

Step 3: Simulate signal well below the CO_2 setpoint. Verify and document the following:

- For single zone units, outdoor air damper modulates to the design minimum value.
- For multiple zone units, either outdoor air damper or zone damper modulate to satisfy the reduced zone ventilation requirements.

Step 4: Restore economizer controls and remove all system overrides initiated during the test.

Step 5: With all controls restored, apply CO_2 calibration gas at a concentration slightly above the setpoint to the sensor. Verify that the outdoor air damper modulates open to satisfy the total ventilation air called for in the Certificate of Compliance.

NA7.5.6 Supply Fan Variable Flow Controls

NA7.5.6.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Supply fan includes device(s) for modulating airflow, such as variable speed drive or electrically commutated motor.
  - For multiple zone systems:
    - Discharge static pressure sensors are either factory calibrated or field-calibrated.
    - The static pressure location, setpoint, and reset control meets the requirements of §140.4(c)2.B~~C~~ and §140.4(c)2.C~~D~~.

NA7.5.6.2 Functional Testing

Step 1: Simulate demand for full design airflow. Verify and document the following:

- Supply fan controls modulate to increase capacity.
- For multiple zone systems, s~~S~~upply fan maintains discharge static pressure within +/-10 percent of the current operating set point.
- Supply fan controls stabilize within a 5 minute period.

Step 2: Simulate demand for reduced or minimum airflow. Verify and document the following:

- Supply fan controls modulate to decrease capacity.
- Current operating setpoint has decreased (for systems with DDC to the zone level).
- For multiple zone systems, ~~S~~supply fan maintains discharge static pressure within +/-10 percent of the current operating setpoint.

- Supply fan controls stabilize within a 5 minute period.

Step 3: Restore system to correct operating conditions

NA7.5.7 Valve Leakage Test

NA7.5.7.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Valve and piping arrangements were installed per the design drawings.

NA7.5.7.2 Functional Testing

Step 1: For each of the pumps serving the distribution system, dead head the pumps using the discharge isolation valves at the pumps. Document the following:

- Record the differential pressure across the pumps
- Verify that this is within 5 percent of the submittal data for the pump

Step 2: Reopen the pump discharge isolation valves. Automatically close all valves on the systems being tested. If 3-way valves are present, close off the bypass line. Verify and document the following:

- The valves automatically close.
- Record the pressure differential across the pump
- Verify that the pressure differential is within 5 percent of the reading from Step 1 for the pump that is operating during the valve test.

Step 3: Restore system to correct operating conditions

NA7.5.8 Supply Water Temperature Reset Controls

NA7.5.8.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Supply water temperature sensors have been either factory or field calibrated.

NA7.5.8.2 Functional Testing

Step 1: Change reset control variable to its maximum value. Verify and document the following:

- Chilled or hot water temperature setpoint is reset to appropriate value.
- ~~Actual supply temperature changes to meet setpoint.~~
- Verify that actual supply temperature changes to~~is~~ within 2 percent of the ~~control~~ new setpoint.

Step 2: Change reset control variable to its minimum value. Verify and document the following:

- Chilled or hot water temperature setpoint is reset to appropriate value.
- ~~Actual supply temperature changes to meet setpoint.~~
- Verify that actual supply temperature ~~is~~ changes to within 2 percent of the ~~control~~ new setpoint.

Step 3: Restore reset control variable to automatic control. Verify and document the following:

- Chilled or hot water temperature set-point is reset to appropriate value.
- ~~Actual supply temperature changes to meet setpoint.~~

- Verify that actual supply temperature ~~is~~ changes to within 2 percent of the ~~control~~ newl setpoint.

NA7.5.9 Hydronic System Variable Flow Controls

NA7.5.9.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- The static pressure location, setpoint, and reset control meets the requirements of the Standards Section 140.4(k)6B.
- Pressure sensors are either factory or field calibrated.

NA7.5.9.2 Functional Testing

Step 1: Modulate control valves to reduce water flow to 50 percent of the design flow or less, but not lower than the pump minimum flow. Verify and document the following:

- Pump operating speed decreases (for systems with DDC to the zone level).
- Current operating setpoint has not increased (for all other systems that are not DDC).
- System pressure is within 5 percent of current operating setpoint.
- System operation stabilizes within 5 minutes after test procedures are initiated.

Step 2~~1~~: Open control valves to increase water flow to a minimum of 90 percent design flow. Verify and document the following:

- Pump speed increases
- Pumps are operating at 100 percent speed.
- System pressure is greater than the setpoint in Step 1.
- System pressure is either within ±5 percent of current operating setpoint. ~~or the pressure is below the setpoint and the pumps are operating at 100 percent speed.~~
- System operation stabilizes within 5 minutes after test procedures are initiated.

~~Step 2: Modulate control valves to reduce water flow to 50 percent of the design flow or less, but not lower than the pump minimum flow. Verify and document the following:~~

- ~~Pump speed decreases.~~
- ~~Current operating setpoint has decreased (for systems with DDC to the zone level).~~
- ~~Current operating setpoint has not increased (for all other systems).~~
- ~~System pressure is within 5 percent of current operating setpoint.~~
- ~~System operation stabilizes within 5 minutes after test procedures are initiated.~~

Step 3: Restore system to correct operating conditions.

NA7.5.10 Automatic Demand Shed Control Acceptance

NA7.5.10.1 Construction Inspection

Prior to Acceptance Testing, verify and document the following:

- That the EMCS interface enables activation of the central demand shed controls.

NA7.5.10.2 Functional Testing

Step 1: Engage the global demand shed system. Verify and document the following:

- That the cooling setpoint in non-critical spaces increases by the proper amount.
- That the cooling setpoint in critical spaces do not change.

Step 2: Disengage the global demand shed system. Verify and document the following:

- That the cooling setpoint in non-critical spaces return to their original values.
- That the cooling setpoint in critical spaces do not change.

NA7.5.11 Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion Units

NA7.5.11.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Verify fault detection and diagnostics (FDD) hardware is installed on HVAC unit.
- Verify the FDD system matches the make and model reported on the design drawings.
- Verify the following air temperature sensors are permanently installed:
    - outside air
    - supply air
    - return air
- Verify the controller has the capability of displaying the value of the following parameters:
    - Air temperatures: outside air, supply air, return air.
    - Refrigerant pressure and temperature sensors (if present, their output should be made available).
- Verify the controller provides system status by indicating the following conditions:
    - Free cooling available
    - Economizer enabled
    - Compressor enabled
    - Heating enabled
    - Mixed air low limit cycle active

~~Verify FDD hardware is installed on equipment by the manufacturer and that equipment make and model include factory-installed FDD hardware that match the information indicated on copies of the manufacturer's cut sheets and on the plans and specifications.~~

~~**Eligibility Criteria**~~

~~A fault detection and diagnostics (FDD) system for direct-expansion packaged units shall contain the following features to be eligible for credit in the performance calculation method:~~

~~1. The unit shall include a factory-installed economizer and shall limit the economizer deadband to no more than 2°F.~~

~~2. The unit shall include direct-drive actuators on outside air and return air dampers.~~

~~3. The unit shall include an integrated economizer with either differential dry-bulb or differential enthalpy control.~~

~~4. The unit shall include a low temperature lockout on the compressor to prevent coil freeze-up or comfort problems.~~

~~5. Outside air and return air dampers shall have maximum leakage rates conforming to ASHRAE 90.1-2004.~~

~~6. The unit shall have an adjustable expansion control device such as a thermostatic expansion valve (TXV).~~

~~7. To improve the ability to troubleshoot charge and compressor operation, a high-pressure refrigerant port will be located on the liquid line. A low-pressure refrigerant port will be located on the suction line.~~

~~8. The following sensors should be permanently installed to monitor system operation and the controller should have the capability of displaying the value of each parameter:~~

- ~~Refrigerant suction pressure~~
- ~~Refrigerant suction temperature~~
- ~~Liquid line pressure~~
- ~~Liquid line temperature~~
- ~~Outside air temperature~~
- ~~Outside air relative humidity• Return air temperature~~
- ~~Return air relative humidity~~
- ~~Supply air temperature~~
- ~~Supply air relative humidity.~~

~~The controller will provide system status by indicating the following conditions:~~

- ~~Compressor enabled~~
- ~~Economizer enabled~~
- ~~Free cooling available~~
- ~~Mixed air low limit cycle active~~
- ~~Heating enabled.~~

~~The unit controller shall have the capability to manually initiate each operating mode so that the operation of compressors, economizers, fans, and heating system can be independently tested and verified.~~

NA7.5.11.2 Functional Testing

For each HVAC unit to be tested, complete the following:

NA7.5.11.2.1 Functional Testing for Air Temperature Sensor Failure/Fault

Step 1: Verify the FDD system indicates normal operation.

Step 2: Disconnect outside air temperature sensor from unit controller. Verify and document the following:

- FDD system reports a fault.

Step 3: Connect outside air temperature sensor to unit controller. Verify and document the following:

- FDD system indicates normal operation.

NA7.5.11.2.2 Functional Testing for Excess Outside Air

Step 1: Coordinate this test with NA7.5.1 Outdoor Air

- If NA7.5.1 Outdoor Air passes, verify FDD system indicates normal operation.

NA7.5.11.2.3 Functional Testing for Economizer Operation

Step 1: Interfere with normal unit operation so test NA7.5.4 Air Economizer Controls fails by immobilizing the outdoor air economizer damper according to manufacturer's instructions

- After NA7.5.4 Air Economizer Controls fails, verify FDD system reports a fault.

Step 2: Successfully complete and pass NA7.5.4 Air Economizer Controls

- After NA7.5.4 Air Economizer Controls passes, verify FDD system reports normal operation.

NA7.5.11.2.4 Functional Testing for Refrigerant Diagnostic Sensors

Step 1: During normal cooling operation, record refrigerant temperatures and pressures, and saturated discharge temperature and saturated suction temperature, if displayed by the unit controller.

Step 2: During same operating conditions as Step 1, install calibrated refrigerant gauge with an accuracy of plus or minus 3% shall be used to determine and record saturated discharge temperature and saturated suction temperatures. If either temperature determined is more than 5 F different than recorded in Step 1, test has failed. Otherwise, test passes.

- Refrigeration gauges shall be calibrated according to the manufacturer's calibration procedure to conform to the accuracy requirement specified. All testers performing diagnostic tests shall obtain evidence from the manufacturer that the equipment meets the accuracy specifications. The evidence shall include equipment model, serial number, the name and signature of the person of the test laboratory verifying the accuracy, and the instrument accuracy. All diagnostic testing equipment is subject to re-calibration when the period of the manufacturer's guaranteed accuracy expires.

~~Test low airflow condition by replacing the existing filter with a dirty filter or appropriate obstruction.~~

~~1. Verify that the fault detection and diagnostics system reports the fault.~~

~~2. Verify that the system is able to verify the correct refrigerant charge.~~

~~3. Calibrate outside air, return air, and supply air temperature sensors.~~

NA7.5.12 Automatic Ffault Ddetection and Ddiagnostics (FDD) for Aair Hhandling Uunits and Zzone Tterminal Uunits.

NA7.5.12.1 Functional Testing for Air Handling Units

Testing of each AHU with FDD controls shall include the following tests.

1. Sensor drift/failure:

Step 1: Disconnect outside air temperature sensor from unit controller.

Step 2: Verify that the FDD system reports a fault.

Step 3: Connect OAT sensor to the unit controller.

Step 4: Verify that FDD indicates normal system operation.

2. Damper/actuator fault:

Step 1: From the control system workstation, command the mixing box dampers to full open (100 percent outdoor air).

Step 2: Disconnect power to the actuator and verify that a fault is reported at the control workstation.

Step 3: Reconnect power to the actuator and command the mixing box dampers to full open.

Step 4: Verify that the control system does not report a fault.

Step 5: From the control system workstation, command the mixing box dampers to a full-closed position (0 percent outdoor air),

Step 6: Disconnect power to the actuator and verify that a fault is reported at the control workstation.

Step 7: Reconnect power to the actuator and command the dampers closed.

Step 8: Verify that the control system does not report a fault during normal operation.

3. Valve/actuator fault:

Step 1: From the control system workstation, command the heating and cooling coil valves to full open or closed, then disconnect power to the actuator and verify that a fault is reported at the control workstation.

4. Inappropriate simultaneous heating, mechanical cooling, and/or economizing:

Step 1: From the control system workstation, override the heating coil valve and verify that a fault is reported at the control workstation.

Step 2: From the control system workstation, override the cooling coil valve and verify that a fault is reported at the control workstation.

Step 3: From the control system workstation, override the mixing box dampers and verify that a fault is reported at the control workstation.

NA7.5.12.2 Functional Testing for Zone Terminal Units

Testing shall be performed on one of each type of terminal unit (VAV box) in the project. A minimum of 5 percent of the terminal boxes shall be tested.

1. Sensor drift/failure:

Step 1: Disconnect the tubing to the differential pressure sensor of the VAV box.

Step 2: Verify that control system detects and reports the fault.

Step 3: Reconnect the sensor and verify proper sensor operation.

Step 4: Verify that the control system does not report a fault.

2. Damper/actuator fault:

(a) Damper stuck open.

Step 1: Command the damper to be fully open (room temperature above setpoint).

Step 2: Disconnect the actuator to the damper.

Step 3: Adjust the cooling setpoint so that the room temperature is below the cooling setpoint to command the damper to the minimum position. Verify that the control system reports a fault.

Step 4: Reconnect the actuator and restore to normal operation.

(b) Damper stuck closed.

Step 1: Set the damper to the minimum position.

Step 2: Disconnect the actuator to the damper.

Step 3: Set the cooling setpoint below the room temperature to simulate a call for cooling. Verify that the control system reports a fault.

Step 4: Reconnect the actuator and restore to normal operation.

3. Valve/actuator fault (For systems with hydronic reheat):

Step 1: Command the reheat coil valve to (full) open.

Step 2: Disconnect power to the actuator. Set the heating setpoint temperature to be lower than the current space temperature, to command the valve closed. Verify that the fault is reported at the control workstation.

Step 3: Reconnect the actuator and restore normal operation.

4. Feedback loop tuning fault (unstable airflow):

Step 1: Set the integral coefficient of the box controller to a value 50 times the current value.

Step 2: The damper cycles continuously and airflow is unstable. Verify that the control system detects and reports the fault.

Step 3: Reset the integral coefficient of the controller to the original value to restore normal operation.

5. Disconnected inlet duct:

Step 1: From the control system workstation, commands the damper to full closed, then disconnect power to the actuator and verify that a fault is reported at the control workstation.

6. Discharge air temperature sensor:

Step 1: Adjust zone setpoints to drive the box from dead band to full heating.

Step 2: Verify that in heating, the supply air temperature resets up to the maximum setpoint while the airflow is maintained at the dead band flow rate.

Step 3: Verify that after the supply air temperature is reset up to the maximum setpoint, the airflow rate then increases up to the heating maximum flow rate in order to meet the heating load.

NA7.5.13 Distributed Energy Storage DX AC Systems Acceptance Tests[1]

These acceptance requirements apply only to constant or variable volume, direct expansion (DX) systems with distributed energy storage (DES/DXAC). These acceptance requirements are in addition to those for other systems or equipment such as economizers, packaged equipment, etc.

NA7.5.13.1 Construction Inspection

Prior to Performance Testing, verify and document the following:

- The water tank is filled to the proper level.
- The water tank is sitting on a foundation with adequate structural strength.
- The water tank is insulated and the top cover is in place.
- The DES/DXAC is installed correctly (refrigerant piping, etc.).
- Verify that the correct model number is installed and configured.

NA7.5.13.2 Equipment Testing

Step 1: Simulate cooling load during daytime period (e.g. by setting time schedule to include actual time and placing thermostat cooling set-point below actual temperature). Verify and document the following:

- Supply fan operates continually.
- If the DES/DXAC has cooling capacity, DES/DXAC runs to meet the cooling demand (in ice melt mode).
- If the DES/DXAC has no ice and there is a call for cooling, the DES/DXAC runs in direct cooling mode.

Step 2: Simulate no cooling load during daytime condition. Verify and document the following:

- Supply fan operates as per the facility thermostat or control system.
- The DES/DXAC and the condensing unit do not run.

Step 3: Simulate no cooling load during morning shoulder time period. Verify and document the following:

- The DES/DXAC is idle.

Step 4: Simulate a cooling load during morning shoulder time period. Verify and document the following:

- The DES/DXAC runs in direct cooling mode.

NA7.5.13.3 Calibrating Controls

Set the proper time and date, as per manufacturer's installation manual for approved installers.

NA7.5.14 Thermal Energy Storage (TES) Systems

The following acceptance tests apply to thermal energy storage systems that are used in conjunction with chilled water air conditioning systems.

NA7.5.14.1 Eligibility Criteria

The following types of TES systems are eligible for compliance credit:

- Chilled Water Storage
- Ice-on-Coil
- Ice Harvester
- Brine
- Ice-Slurry
- Eutectic Salt
- Clathrate Hydrate Slurry (CHS)

The following Certificate of Compliance information for both the chiller and the storage tank shall be provided on the plans to document the key TES System parameters and allow plan check comparison to the inputs used in the DOE-2 simulation. DOE-2 keywords are shown in ALL CAPITALS in parentheses.

Chiller:

- Brand and Model
- Type (Centrifugal, Reciprocating, Other)
- Capacity (tons) (SIZE)
- Starting Efficiency (kW/ton) at beginning of ice production (COMP - KW/TON - START)
- Ending Efficiency (kW/ton) at end of ice production (COMP - KW/TON/END)
- Capacity Reduction (% / °F) (PER – COMP - REDUCT/F)

Storage Tank:

- Storage Type (TES-TYPE)
- Number of Tanks (SIZE)
- Storage Capacity per Tank (ton-hours) (SIZE)

- Storage Rate (tons) (COOL – STORE - RATE)
- Discharge Rate (tons) (COOL – SUPPLY - RATE)
- Auxiliary Power (watts) (PUMPS + AUX - KW)
- Tank Area (CTANK – LOSS - COEFF)
- Tank Insulation (R - Value) (CTANK – LOSS - COEFF)

NA7.5.14.2 Functional Testing

Acceptance testing also shall be conducted and documented on the Certificate of Acceptance in two parts:

In the TES System Design Verification part, the installing contractor shall certify the following information, which verifies proper installation of the TES System consistent with system design expectations:

- The TES system is one of the above eligible systems.
- Initial charge rate of the storage tanks (tons).
- Final charge rate of the storage tank (tons).
- Initial discharge rate of the storage tanks (tons).
- Final discharge rate of the storage tank (tons).
- Charge test time (hrs).
- Discharge test time (hrs).
- Tank storage capacity after charge (ton-hrs).
- Tank storage capacity after discharge (ton-hrs).
- Tank standby storage losses (UA).
- Initial chiller efficiency (kW/ton) during charging.
- Final chiller efficiency (kW/ton) during charging.

In the TES System Controls and Operation Verification part, the installing contractor also shall complete the following acceptance testing to ensure the TES System is controlled and operates consistent with the compliance simulation. The installing contractor shall convey the results of the testing to the enforcement agency using the Certificate of Acceptance.

1. Verify that the TES system and the chilled water plant is controlled and monitored by an energy management system (EMS).
2. Force the time to be between 9:00 p.m. and 9:00 a.m. and simulate a partial or no charge of the tank and simulate no cooling load by setting the indoor temperature set point higher than the ambient temperature. Verify that the TES system starts charging (storing energy).
3. Force the time to be between 6:00 p.m. and 9:00 p.m. and simulate a partial charge on the tank and simulate a cooling load by setting the indoor temperature set point lower than the ambient temperature. Verify that the TES system starts discharging.
4. Force the time to be between noon and 6:00 p.m. and simulate a cooling load by lowering the indoor air temperature set point below the ambient temperature. Verify that the tank starts discharging and the compressor is off.
5. Force the time to be between 9:00 a.m. to noon, and simulate a cooling load by lowering the indoor air temperature set point below the ambient temperature. Verify that the tank does not discharge and the cooling load is met by the compressor only.

6. Force the time to be between 9:00 p.m. and 9:00 a.m. and simulate a full tank charge by changing the sensor that indicates tank capacity to the Energy Management System so that it indicates a full tank capacity. Verify that the tank charging is stopped.

7. Force the time to be between noon and 6:00 p.m. and simulate no cooling load by setting the indoor temperature set point above the ambient temperature. Verify that the tank does not discharge and the compressor is off.

NA7.5.15 Supply Air Temperature Reset Controls

The following acceptance tests apply to supply air temperature reset controls.

NA7.5.15.1 Construction Inspection

Prior to functional testing, verify and document the following:

- Reset controls have been installed per Standards §144(f)(2).
- Reset schedule, including high and low setpoint limits and equipment lockout temperatures, is available and documented in the building plans. Reset schedule resets temperature by at least 25% of the difference between the design supply air temperature and design room air temperature.
- Sensors used to control supply air temperature have been calibrated, or read accurately against a calibrated temperature standard. Attach a copy of the calibration certificate or field verification results.
- If applicable, duct static pressure reset controls are disabled during testing to prevent any unwanted interaction.
- Controls for outside air damper or economizer operation are disabled during testing to prevent any unwanted interaction.
- Document current supply air temperature.

NA7.5.15.2 Functional Testing

- If system is single-duct, or has zone-level reheat, Steps 1-3 are performed once at the main supply fan. If system is dual-duct, Steps 1-3 are performed for each duct or "deck" downstream of the main supply fan.
- Check to make sure that chilled/hot water coils, if used, are not already fully open and calling for maximum cooling/heating. If this is the case, reverse Steps 1 and 2 as necessary to allow system to operate within its bounds of operation and not be forced to meet an impossible setpoint.
- If zone feedback is used to reset, identify any zones with unusually high loads ("rogue zones") prior to and during performing the test. If possible, exclude those zones from the reset sequence.

Step 1: Override reset control variable to its maximum value to drive supply temperature downward (for example, temporarily replace outside temperature signal with a high fixed temperature value for outside air temperature, or temporarily override zone damper signals to imitate all zones calling for maximum cooling). If the reset control variable input cannot be modified, then change the limit of the variable around the currently occurring value (for example, modify the reset schedule to create an outside air setpoint high limit below the current outside air temperature).Verify and document the following:

- Supply air temperature setpoint is reset to meet the appropriate value.
- Actual supply air temperature changes to meet setpoint.
- Verify that supply air temperature is within +/-2 degree F of the control setpoint.

Step2: Override reset control variable to its minimum value to drive supply temperature upward. If the reset control variable input cannot be modified, then change the limit of the variable around the currently occurring value. Verify and document the following:

- Supply air temperature setpoint is reset to meet the appropriate value.
- Actual supply air temperature changes to meet setpoint.
- Verify that supply air temperature is within +/-2 degree F of the control setpoint.

Step 3: Restore reset control variable to automatic control, and/or restore the high and low limits of the reset control variable. Remove all system overrides initiated during test. Verify and document the following:

- Supply air temperature setpoint is reset to meet the appropriate value.
- Actual supply air temperature changes to meet setpoint.

NA7.5.16 Condenser Water Supply Temperature Reset Controls

The following acceptance tests apply to supply air temperature reset controls.

NA7.5.16.1 Construction Inspection

Prior to functional testing, verify and document the following:

- Condenser water supply temperature control sequence, including condenser water supply high and low limits, is available and documented in the building documents.
- Cooling tower fan control sequence, including tower design wetbulb temperature and approach, is available and documented in the building documents.
- Temperature, pressure, and flow gauges and sensors are installed where appropriate.
- All ambient dry bulb temperature, relative humidity, and pressure sensors used by controller have been calibrated, or read accurately against a standard calibrated sensor. Attach a copy of calibration certificate or field verification results.
- All cooling tower fan motors are operational.
- All cooling tower fan speed controls (e.g. VSDs) are installed, operational, and connected to cooling tower fan motors.
- Document current outdoor ambient air dry bulb and wet bulb temperatures, entering condenser water supply temperature, and leaving chilled water temperature readings from the control system.

NA7.5.16.2 Functional Testing

- The system cooling load must be sufficiently high to run the test. If necessary, artificially increase the evaporator load to perform the functional tests, or wait until a time of stable chiller operation. If necessary, reverse Steps 1 & 2 in the test based on atmospheric conditions and buildings loads.
- If testing in cold ambient conditions, ensure that freeze protection controls are installed and functional to prevent equipment damage.
- If the actual control sequence differs significantly from that implied by the tests, attach a description of the control sequence, a description of the tests that were done to verify the system operates according to the sequence, and the test results.

Step 1: Using the desired reset strategy, change the reset control variable to its minimum value to drive condenser water supply temperature downward towards lower limit (for example, temporarily replace signal of outdoor air wetbulb temperature to a low fixed value). If the reset control variable input cannot be modified, then change the limit of the variable around the currently occurring value (for example, adjust the sequence to set the maximum outdoor air wetbulb temperature to below the current temperature). Allow time for the system to stabilize. Verify and document the following:

- Condenser water supply temperature setpoint changes to meet appropriate value.

- Actual condenser water supply temperature changes to meet setpoint.
- Cooling tower fan(s) stage properly and/or adjust speed according to fan schedule, to meet lower condenser water supply setpoint.

Step 2: Using the desired reset strategy, override reset control variable towards its maximum value to drive condenser water supply temperature upward to high limit. If the reset control variable input cannot be modified, then change the limit of the variable around the currently occurring value. Allow time for the system to stabilize. Verify and document the following:

- Condenser water supply temperature setpoint changes to meet appropriate value.
- Actual condenser water supply temperature changes to meet setpoint.
- Cooling tower fan(s) stage properly and/or adjust speed according to fan schedule, to meet higher condenser water supply setpoint.

Step 3: Restore all controls and equipment to original settings, and/or restore the high and low limits of the reset control variable. Remove all system overrides initiated during test. Verify and document the following:

- Condenser water supply temperature setpoint is reset to the appropriate value.

~~7.~~• Cooling tower fan(s) and chiller(s) return to normal operation.

NA7.6 ~~Indoor~~ Lighting Control ~~Systems~~Acceptance Requirements

Lighting control acceptance testing ~~is~~ shall be performed on:

- ~~Manual daylighting controls.~~
- ~~Automatic daylighting controls.~~
- ~~Occupancy sensors.~~
- ~~Automatic time-switch control~~
- Automatic Daylighting Controls complying with Section 130.1(d)
- Shut-off Controls complying with Section 130.1(c)
- Demand Responsive Controls in accordance with Section 130.1(e).

~~NA7.6.1 Automatic Daylighting Controls Acceptance~~

~~NA7.6.2~~NA7.6.1 Acceptance tests for Automatic Daylighting Controls complying with Section 130.1(d)

~~NA7.6.2.1~~NA7.6.1.1 Construction Inspection

~~Prior to Functional testing, verify and document the following:~~

~~All control devices (photocontrols) have been properly located, field-calibrated and set for appropriate set points and threshold light levels.~~

~~Installer has provided documentation of setpoints, setting and programming for each device.~~

~~Luminaires located in primary or secondary sidelit zone(s) or in skylit area(s) are controlled separately from non-daylit areas. Compare location of daylighting controlled luminaires against description of sidelit and skylit zones on the building plans.~~

~~Luminaires located in primary or secondary sidelit zone(s) are controlled separately from skylit area(s)~~

~~The location where calibration adjustments are made is remote from photosensor.~~

Verify that automatic daylighting controls qualify as one of the required control types, are installed, and fully functional in accordance with Section 130.1(d), or that there is a specific Excepted from Section 130.1(d); as follows:

- Luminaires in the primary and secondary sidelit zone in parking garages are controlled by automatic daylighting controls as described in Section 130.1(d)3. are controlled independently by fully functional automatic daylighting controls that meet the applicable requirements of Section 110.9, and the applicable requirements below:
    - Parking garage area with combined total of 36 square feet or more of glazing or opening, luminaires providing general lighting that are in the combined primary and secondary sidelit daylit zones are controlled independently by automatic daylighting control devices.
    - If the daylighting controls control lighting outside of the daylight zones including those behind obstructions as described in Section 130.1(d)1, the control system is not compliant
    - In parking garages, when primary sidelit zones receive illuminance levels greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power consumption is zero, or the application meets one of the exceptions. List any exceptions.
    - Photo sensors are located so that they are not readily accessible to unauthorized personnel.
    - The location where calibration adjustments are made to an automatic daylighting control device are readily accessible and accessible only to authorized personnel.

- In indoor spaces other than parking garages, luminaires providing general lighting in or partially in the Skylit Daylit Zones and the Primary Sidelit Daylit Zones are controlled independently by fully functional automatic daylighting controls that meet the applicable requirements of Section 110.9, and the applicable requirements below:
    - All Skylit Daylit Zones and Primary Sidelit Daylit Zones are shown on the plans.
    - Luminaires in the Skylit Daylit Zone are controlled separately from those in the Primary Sidelit Daylit Zones
    - Luminaires that fall in both a Skylit and Primary Sidelit Daylit Zone are controlled as part of the Skylit Daylit Zone
    - Secondary Sidelit Daylit Zones are shown on plan,
    - Luminaires in the Secondary Sidelit Daylit Zones are controlled separately from those in the Primary Sidelit Daylit Zones and Skylit Daylit Zones,
    - Luminaires that fall in a Skylit and Secondary Sidelit Daylit Zone are controlled as part of the Skylit Daylit Zone.
    - If the daylighting controls control lighting outside of the daylight zones including those behind obstructions as described in Section 130.1(d)1, the control system is not compliant
    - Photo sensors are located so that they are not readily accessible to unauthorized personnel.
    - The location where calibration adjustments are made to an automatic daylighting control device are readily accessible and accessible only to authorized personnel.
    - Automatic daylighting controls provide functional multi-level lighting, including continuous dimming, and have at least the number of control steps specified in Table 130.1-A, or meet one of the exceptions. List any exceptions
    - For each space, the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available

- In areas served by lighting that is daylight controlled, when the illuminance received from the daylight is greater than 150 percent of the illuminance received from the general lighting system, the general lighting power in that daylight zone is reduced by a minimum of 65 percent, or the application meets one of the exceptions. List any exceptions.

~~NA7.6.2.2~~NA7.6.1.2 Functional testing

All photocontrols serving more than 5,000 ft² of daylit area shall undergo functional testing. Photocontrols that are serving smaller spaces may be sampled as follows:

For buildings with up to five (5) photocontrols, all photocontrols shall be tested. For buildings with more than five (5) photocontrols, sampling may be done on spaces with similar sensors and cardinal orientations of glazing. If the first photocontrol in the sample group passes the functional test, the remaining building spaces in the sample group also pass. If the first photocontrol in the sample group fails the functional test, the rest of the photocontrols in the group shall be tested. If any tested photocontrol fails the functional test, it shall be repaired, replaced or adjusted until it passes the test.

For each photocontrol to be tested do the following:

Test each group of lights controlled separately by the photocontrol according to the following protocol. In all interior spaces other than parking garages, a separate test shall be conducted for daylighting control of the primary sidelit zone separate from the secondary sidelit zone.

Continuous Dimming Control Systems

This requirement is for systems that have more than 10 levels of controlled light output in a given zone.

Step 1: Identify the minimum daylighting location in the controlled zone (Reference Location). This can be identified using either the illuminance method or the distance method.

Illuminance Method

Turn OFF controlled lighting and measure daylight illuminance within zones illuminated by controlled luminaires.

Identify the Reference Location; this is the task location with lowest daylight illuminance in the zone illuminated by controlled luminaires. This location will be used for illuminance measurements in subsequent tests.

~~Turn controlled lights back ON~~.

Distance Method

Identify the task location within the zone illuminated by controlled luminaires that is farthest away from daylight sources. This is the Reference Location and will be used for illuminance measurements in subsequent tests.

Step 2: No daylight test. Simulate or provide conditions without daylight. Verify and document the following:

Automatic daylight control system provides appropriate control so that electric lighting system is providing full light output unless otherwise specified by design documents.

Document the reference illuminance, which is the electric lighting illuminance level at the reference location identified in Step 1.

Light output is stable with no discernable flicker.

Step 3: Full daylight test. Simulate or provide bright conditions. Verify and document the following:

Lighting power reduction is at least 65 percent under fully dimmed conditions and light output is stable with no discernable flicker.

Only luminaires in daylit zones are affected by daylight control. . If the daylighting controls control lighting outside of the daylight zones including those behind obstructions as described in Section 130.1(d)1, the control system is not compliant

Step 4: Partial daylight test. Simulate or provide ~~bright~~ daylight conditions where illuminance (fc) from daylight only at the Reference Location is between 60 and 95 percent of Reference Illuminance (fc) documented in Step 2. Verify and document the following:

Measure that the combined illuminance of daylight and controlled electric lighting (fc) at the reference location is no less than the electric lighting illuminance (fc) at this location during the no daylight test documented in Step 2.

Measure that the combined illuminance of daylight and controlled electric lighting (fc) at the Reference Location is no greater than 150 percent of the reference illuminance (fc) documented in Step 2.

Light output is stable with no discernable flicker.

Stepped Switching or Stepped Dimming Control Systems

This requirement is for systems that have no more than 10 discrete steps of control of light output.

If the control has 3 steps of control or less, conduct the following tests for all steps of control. If the control has more than 3 steps of control, testing 3 steps of control is sufficient for showing compliance.

Step 1: Identify the minimum daylighting location(s) in the controlled zone. (Reference Location). This can be identified using either the illuminance method or the distance method.

~~If lighting controls are staged so that one stage is closer to the daylight source, identify a minimum daylighting location for each stage of control. If all stages of control are equally close to the daylight source, select a single minimum daylighting location representing all stages of the control. This minimum daylighting location for each stage of control is designated as the reference location for that stage of control and will be used for illuminance measurements in subsequent tests. The reference location can be identified using either the illuminance method or the distance method.~~

Illuminance Method

Turn OFF controlled lighting and measure daylight illuminances within a zone illuminated by controlled luminaires.

Identify the reference location; this is the task location with lowest daylight illuminance in the zone illuminated by controlled luminaires. This location will be used for illuminance measurements in subsequent tests.

Turn controlled lights back ON.

Distance Method

Identify the task location within the zone illuminated by controlled luminaires that is farthest away from daylight sources. This is the reference location and will be used for illuminance measurements in subsequent tests.

Step 2: No daylight test. Simulate or provide conditions without daylight for a stepped switching or stepped dimming control system. Verify and document the following:

If the control is manually adjusted (not self commissioning), make note of the time delay and override time delay or set time delay to minimum setting. This condition shall be in effect through step 4.

Automatic daylight control system turns ON all stages of controlled lights unless it is documented that multi-level luminaires have been "tuned" to less than full output and providing design illuminance (fc) levels

Stepped dimming control system provides reduced flicker over the entire operating range per §1110.9~~(f)2~~.

Document the reference illuminance which is the electric lighting illuminance level measured at the reference location identified in Step 1.

Step 3: Full daylight test. Simulate or provide bright conditions. Verify and document the following:

Lighting power reduction of controlled luminaires is at least 65 percent

Only luminaires in daylit zones (toplit zone, primary sidelit zone and secondary sidelit zone) are affected by daylight control. If the daylighting controls control lighting outside of the daylight zones including those behind obstructions as described in Section 130.1(d)1, the control system is not compliant

Step 4: Partial daylight test. For each control stage that is tested in this step, the control stages with lower setpoints than the stage tested are left ON and those stages of control with higher setpoints are dimmed or controlled off. Simulate or provide conditions so that each control stage turns on and off or dims. Verify and document the following for each control stage:

~~The measured illuminance contribution from the control stage tested at its corresponding reference location.~~

~~The~~ Document the total daylight and electric lighting illuminance level measured at its reference location just after the stage of control dims or shuts off a stage of lighting:

1. The total measured illumination shall be no less than the reference illuminance measured at this location during the no daylight test documented in Step 2.
2. The total measured illumination shall be no greater than 150 percent of the reference illuminance.

The control stage shall not cycle on and off or cycle between dim and undimmed while daylight illuminance remains constant.

Only luminaires in daylit zones (toplit zone, primary sidelit zone, and secondary sidelit zone) are affected by daylight control.

Step 5: Verify time delay.

Verify that time delay automatically resets to normal mode within 60 minutes.

Set normal mode time delay to at least three minutes.

Confirm that there is a time delay of at least 3 minutes between the time when illuminance exceeds the setpoint for a given dimming stage and when the control dims or switches off the controlled lights.

NA7.6.2 Acceptance tests for Shut-off Controls complying with Section 130.1(c)

NA7.6.2.1 Construction Inspection and Acceptance Tests

- Verify that the shut-off control qualifies as one of the required control types, is installed, and is fully functional in accordance with Section 130.1(c), or that the application meets one of the exceptions. List the exceptions.

~~NA7.6.3 Occupancy Sensor Acceptance~~

~~NA7.6.3.1~~NA7.6.2.2 Occupancy Sensing Lighting Control ***Construction Inspection***

Prior to Functional testing, verify and document the following:

Occupancy sensor has been located to minimize false signals:

No closer than four (4) feet from a HVAC diffuser.

PIR sensor pattern does not enter into adjacent zones.

Occupancy sensors do not encounter any obstructions that could adversely affect desired performance.

Ultrasonic occupancy sensors do not emit audible sound.

~~NA7.6.3.2~~NA7.6.2.3 Occupancy Sensing Lighting Control Functional testing

For buildings with up to seven (7) occupancy sensors, all occupancy sensors shall be tested. For buildings with more than seven (7) occupancy sensors, sampling may be done on spaces with similar sensors and space geometries. If the first occupancy sensor in the sample group passes the acceptance test, the remaining building spaces in the sample group also pass. If the first occupancy sensor in the sample group fails the acceptance test the rest of the occupancy sensors in that group must be tested. If any tested occupancy sensor fails it shall be repaired, replaced or adjusted until it passes the test.

For each sensor to be tested do the following:

Step 1: For a representative sample of building spaces, simulate an unoccupied condition. Verify and document the following:

Lights controlled by occupancy sensors turn off within a maximum of 30 minutes from the start of an unoccupied condition per §119(d).

The occupant sensor does not trigger a false “on” from movement in an area adjacent to the space containing the controlled luminaires or from HVAC operation.

Signal sensitivity is adequate to achieve desired control.

Step 2: For a representative sample of building spaces, simulate an occupied condition. Verify and document the following:

Status indicator or annunciator operates correctly.

Lights controlled by occupancy sensors turn on immediately upon an occupied condition, OR sensor indicates space is “occupied” and lights are turned on manually (automatic OFF and manual ON control strategy).

~~NA7.6.4 Manual Daylighting Controls Acceptance~~

~~NA7.6.4.1 Construction Inspection~~

~~Prior to Functional testing, verify and document the following:~~

~~If dimming ballasts are specified for light fixtures within the primary sidelit zone or skylit zone, make sure they meet all the Standards requirements, including “reduced flicker operation” for manual dimming control systems.~~

~~NA7.6.4.2 Functional testing~~

~~Step 1: Perform manual switching control. Verify and document the following:~~

~~Only lights in the primary sidelit zone or the skylit zone as defined in §131(c) are controlled. Compare daylighting controlled luminaires against description of the primary sidelit and skylit zones on the building plans.~~

~~Manual switching or dimming achieves a lighting power reduction of at least 50 percent.~~

~~The amount of light delivered to the space is uniformly reduced.~~

~~NA7.6.5 Automatic Time Switch Control Acceptance~~

~~NA7.6.5.1~~NA7.6.2.4 Automatic Time Switch Lighting Control Construction Inspection

Prior to Functional testing, verify and document the following:

Automatic time switch control is programmed with acceptable weekday, weekend, and holiday (if applicable) schedules.

Document for the owner automatic time switch programming including weekday, weekend, holiday schedules as well as all set-up and preference program settings.

Verify the correct time and date is properly set in the time switch.

Verify the battery back-up (if applicable) is installed and energized.

Override time limit is set to no more than 2 hours.

Override switches remote from area with controlled luminaires have annunciator lights.

~~*NA7.6.5.2*~~*NA7.6.2.5 Automatic Time Switch Lighting Control* ***Functional testing***

Step 1: Simulate occupied condition. Verify and document the following:

All lights can be turned on and off by their respective area control switch.

Verify the switch only operates lighting in the enclosed space (ceiling-height partitioned area) in which the switch is located.

Step 2: Simulate unoccupied condition. Verify and document the following:

All non-exempt lighting turn off per §131(d)1.

Manual override switch allows only the lights in the enclosed space (ceiling height partitioned) where the override switch is located to turn on or remain on until the next scheduled shut off occurs.

NA7.6.3 Acceptance tests for Demand Responsive Controls in accordance with Section 130.1(e).

NA7.6.3.1 Construction Inspection and Acceptance Tests

Verify that demand responsive lighting controls qualify as one of the required control types, are installed, and are fully functional in accordance with Section 130.1(e)

NA7.7 Lighting Control Installation Requirements

Lighting control installation inspection shall be performed on:

1. Lighting control systems installed to comply with Section 110.9(b).
2. Energy Management Control System installed to comply with Section 130.5(f)1
3. All line-voltage track lighting integral current limiters in accordance with Section 110.9 and Section 130.0
4. All dedicated line-voltage track lighting supplementary overcurrent protection panels in accordance with Section 110.9 and Section 130.0
5. Shutoff control installed to comply with Section 130.1(c)
6. Automatic daylighting controls installed to comply with Section 130.1(d)
7. Demand responsive controls installed to comply with Section 130.1(e)
8. Interlocked lighting systems serving an area in accordance with Section 140.6(a)1
9. Lighting controls installed to earn a Power Adjustment Factor (PAF) in accordance with Section 140.6(a)2
10. Lighting for a Videoconferencing Studio in Accordance with Exception to Section 140.6(a)3T
11. Outdoor lighting systems installed to comply with Section 130.2(c)

NA7.7.1 Lighting Control Systems Installed to Comply with Section 110.9(b)

NA7.7.1.1 Installation Inspection

If a lighting control required by Title 24, Part 6 is a field assembled system consisting of two or more components, verify the system components meet all of the requirements for each lighting control type, in

accordance with Section 110.9, On the approved installation compliance form, identify, list, and verify each type of lighting control system as follows:

- Separately identify and list each type of lighting control system. When there are identical lighting control systems in a single building, identical lighting control system may be listed together.
- Identify and list all requirements for the type of self-contained lighting control device for which the lighting control system is installed to function as, in accordance with Section 110.9 and in accordance with the Title 20 Appliance Efficiency Regulations.
- Verify the lighting control system complies with all of the applicable requirement as listed
- If the lighting control system does not meet all applicable requirements, the installation fails.

NA7.7.2 Energy Management Control System (EMCS) Installed in Accordance with Section 130.1(f)

NA7.7.2.1 Installation Requirements

- The EMCS shall be separately tested for each respective lighting control system for which it is installed to function as.
- List and verify functional compliance with all applicable requirements in accordance with Sections 130.1 through 130.5.
- If applicable, list and verify functional compliance with all applicable requirements for all applications for which the EMCS is installed to function as, in accordance with Section 140.6.
- If applicable, list and verify functional compliance with all applicable requirements for all applications for which the EMCS is installed to function as, in accordance with Section 140.7.
- If applicable, list and verify functional compliance with all applicable requirements for all applications for which the EMCS is installed to function as, in accordance with Section 150(k)

NA7.7.3 Track Lighting Integral Current Limiter

NA7.7.3.1 Certification requirements

- Verify that the track lighting integral current limiter is certified to the Energy Commission in accordance with Section 110.9 by checking the Energy Commission database. If the track current limiter has not been certified to the Energy Commission, this method for determining installed lighting power shall not be used for compliance with Title 24, Part 6, and the installation test shall be terminated.

NA7.7.3.2 Installation Inspection

Verify and document the following on the approved installation compliance form:

- The track current limiter is used exclusively on the same manufacturer's track for which it is designed
- The track current limiter is designed and installed so that the track current limiter housing is permanently attached to the track so that the system will be irreparably damaged if the integral track current limiter housing were to be removed after installation into the track. Methods of attachment may include but are not limited to one-way barbs, rivets, and one-way screws
- The track current limiter has identical volt-ampere (VA) rating of the track current limiter, as installed and rated for compliance with Title 24, Part 6, clearly marked as follows:
    - So that it is visible for the building officials' field inspection without opening cover-plates, fixtures, or panels

- Permanently marked on the circuit breaker
- On a factory-printed label that is permanently affixed to a non-removable base-plate inside the wiring compartment

- The track current limiter employs tamper resistant fasteners for the cover to the wiring compartment
- The track current limiter has a conspicuous factory installed label permanently affixed to the inside of the wiring compartment warning against removing, tampering with, rewiring, or bypassing the device.
- Each electrical panel from which track lighting integral current limiters are connected has a factory printed label permanently affixed and prominently located, with the following information: "NOTICE: Current limiting devices installed in track lighting integral current limiters connected to this panel shall only be replaced with the same or lower amperage. Adding track or replacement of existing current limiters with higher continuous ampere rating will void the track lighting integral current limiter certification, and will require re-submittal and re-certification of California Title 24, Part 6 compliance documentation."
- For installations where a total of five or less track current limiters are installed in a single building, all integral track current limiters shall be inspected. For installations where a total of more than five track current limiters are installed in a single building, no less than five track current limiters shall be inspected, up to five inspections for each 20 installed track current limiters.
- If any of the above requirements fail, the track current limiter fails the installation test, and this method for determining installed lighting power shall not be used for compliance with Title 24.

NA7.7.4 Line-Voltage Track Lighting Supplementary Overcurrent Protection Panel

NA7.7.4.1 Construction Inspection

Verify and document the following on the approved compliance form:

- The supplementary overcurrent protection panel is Listed, as defined in Section 100.1
- The supplementary overcurrent protection panel is used only for line voltage track lighting. No other lighting or building power is connected to a track-lighting supplementary overcurrent protection panel
- No overcurrent protection panel has been used to determine installed wattage for any lighting system other than line-voltage track lighting.
- The supplementary overcurrent protection panel is installed in an electrical equipment room, or permanently installed adjacent to the lighting panel board providing supplementary overcurrent protection for the track lighting circuits served by the supplementary over current protection pane
- There is a prominently labeled permanently attached to the panel by the manufacturer with the following information: "NOTICE: This Panel for Track Lighting Energy Code Compliance Only. The overcurrent protection devices in this panel shall only be replaced with the same or lower amperage. No other overcurrent protective device shall be added to this panel. Adding to, or replacement of existing overcurrent protective device(s) with higher continuous ampere rating, will void the panel listing and require re-submittal and re-certification of California Title 24, Part 6 compliance documentation."
- If any of the above requirements fail, the supplementary overcurrent protection panel fails the Installation test, and this method for determining installed lighting power shall not be used for compliance with Title 24.

NA7.7.5 Interlocked Lighting Systems Serving an Area in Accordance with Section 140.6(a)1

NA7.7.5.1 Installation Inspection

Verify and document the following:

- The space qualifies only as one or more the following types: Auditorium, convention center, conference room, multipurpose room, or theater, in accordance with the definitions of those space types in Section 100.1,
- There are no more than two interlocked lighting systems serving the space.
- The two lighting systems are interlocked with a non-programmable double throw switch to prevent simultaneous operation.
- If all of the above in not true, the installation fails, and all connected lighting in the space shall be counted as part of the total installed lighting power.

NA7.7.6 Lighting Controls Installed to Earn a Power Adjustment Factor (PAF) in Accordance with Section 140.6(a)2

NA7.7.6.1 Construction Inspection

Verify and document the following:

- Separately list all requirements for each PAF that is claimed in accordance with Sections 110.9, and 140.6(a)2, and Table 140.6-A
- Verify the installation complies with all applicable requirements in accordance with Sections 110.9, and 140.6(a)2, and Table 140.6-A
- If all of the above in not true, the installation fails, and the PAF cannot be used.

NA7.7.7 Lighting for a Videoconferencing Studio in Accordance with Exception to Section 140.6(a)3T

NA7.7.7.1 Installation Inspection

Verify and document the following:

- The videoconferencing studio is using only the Area Category Method for compliance. The extra lighting allowance shall not be taken when using the Complete Building Method or Tailored Method of compliance.
- The Videoconferencing Studio is a room with permanently installed videoconferencing cameras, audio equipment, and playback equipment for both audio-based and video-based two-way communication between local and remote sites.
- General lighting is switched in accordance with Table 130.1-A
- Wall wash lighting is separately switched from the general lighting system.
- All of the lighting is controlled by a multiscene programmable control system (scene preset control system);
- If all of the above is not true, the installation fails, and the extra wattage for videoconferencing studio lighting cannot be used.

~~NA7.7~~NA7.8 ~~Outdoor Lighting Acceptance Tests~~ Outdoor Lighting Controls Installed to Comply with Section 130.2(c)

~~NA7.7.1 Outdoor Motion Sensor Acceptance~~

NA7.8.1.1 Construction inspection and installation requirements

Verify that outdoor lighting controls qualify as one of the required control types, are installed, and are fully functional in accordance with Section 130.1(e); as follows:

- All installed outdoor lighting is controlled by a photocontrol or astronomical time lighting control that automatically turns off the outdoor lighting when daylight is available, or it the application meets one of the exceptions. List any exceptions.
- All installed outdoor lighting is circuited and controlled to turn off independently from other electrical loads.
- All installed outdoor lighting where the bottom of the luminaire is mounted 24 feet or less above the ground, is controlled with motion sensors. The motion sensor is capable of automatically reducing the lighting power of each luminaire by at least 40 percent but not exceeding 80 percent, or provide continuous dimming through a range that includes 40 percent through 80 percent, and employs auto-on functionality. No more than 1,500 watts of lighting power is controlled together, or the application meets one of the exceptions. List any exceptions.
- Outdoor Sales Frontage, Outdoor Sales Lots, and Outdoor Sales Canopies lighting, an automatic lighting control is installed that meets the requirements in Section 130.2.
- Building Facade, Ornamental Hardscape and Outdoor Dining lighting, an automatic lighting control is installed that meets one or more of the following requirements in Section 130.2, or the application meets the exception. List the exception.

NA7.8.1.2 Outdoor Motion Sensor Acceptance

~~NA7.7.1.1~~NA7.8.1.3 Construction Inspection

Prior to Functional testing, verify and document the following:

- Motion sensor has been located to minimize false signals.
- Sensor is not triggered by motion outside of adjacent area.
- Desired motion sensor coverage is not blocked by obstructions that could adversely affect performance.

~~NA7.7.1.2~~NA7.8.1.4 Functional testing

Step 1: Simulate motion in area under lights controlled by the motion sensor. Verify and document the following:

- Status indicator operates correctly.
- Lights controlled by motion sensors turn on immediately upon entry into the area lit by the controlled lights near the motion sensor.
- Signal sensitivity is adequate to achieve desired control.

Step 2: Simulate no motion in area with lighting controlled by the ~~sensor but with motion adjacent to this area~~. Verify and document the following:

- Lights controlled by motion sensors ~~turn off~~ reduce light output within a maximum of 30 minutes from the start of an unoccupied condition per §110.9(d).

- The occupant sensor does not trigger a false "on" from movement outside of the controlled area
- Signal sensitivity is adequate to achieve desired control.

~~NA7.7.2~~NA7.8.2 Outdoor Lighting Shut-off Controls

~~*NA7.7.2.1*~~*NA7.8.2.1 Construction Inspection*

Prior to Functional testing, verify and document the following:

- Controls to turn off lights during daytime hours are installed.
- Astronomical and standard time switch control is programmed with acceptable weekday, weekend, and holiday (if applicable) schedules.
- Demonstrate and document for the owner time switch programming including weekday, weekend, holiday schedules as well as all set-up and preference program settings.
- ~~Lighting systems that meet the criteria of §130.2(c)2 shall have a scheduling control (time switch) installed which is able to schedule separately:~~
  - ~~o Aa reduction in outdoor lighting power by 50 to 80 percent~~
  - ~~o turningTurns off all outdoor lighting covered by §130.2(c)2~~
- ~~Verify that the correct time and date is properly set in the standard and astronomical time switch.~~
- ~~Verify that the correct latitude, longitude and time zone are set in the astronomical time switch.~~
- ~~Verify the battery back-up (if applicable) is installed and energized in the standard and astronomical time switch.~~

~~*NA7.7.2.2 Outdoor Photocontrol Functional testing*~~

~~Note photocontrol mustshall be used in conjunction with time switch or motion sensor to meet the requirements of §130.2(c)2.~~

~~Step 1: Nighttime test. Simulate or provide conditions without daylight. Verify and document:~~

- ~~Controlled lights turn on.~~

~~Step 2: Sunrise test: Provide between 10 and 30 horizontal footcandles (fc) to photosensor. Verify and document the following:~~

- ~~Controlled lights turn off.~~

~~*NA7.7.2.3 Astronomical Time Switch Functional testing*~~

~~Step 1: Power off test. Program control with location information, local date, time and schedules. Disconnect control from power source for at least 1 hour. Verify and document:~~

- ~~Control retains all programmed settings and local date and time~~

~~Step 2: Night schedule ON test. Simulate or provide times when the sun has set and lights are scheduled to be ON. Verify and document:~~

- ~~Controlled lights turn on~~

~~Step 3: Night schedule OFF test. Simulate or provide times when the sun has set and lights are scheduled to be OFF. Verify and document:~~

- ~~Controlled lights turn off~~

~~Step 4: Sunrise test: Simulate or provide the programmed offset time after the time of local sunrise.~~

- ~~Controlled lights turn off~~

~~NA7.7.2.4 Standard (non-astronomical) Time Switch Functional Testing~~

~~Note: this control shall be used in conjunction with a photocontrol to meet requirements of §132(c).~~

~~Step 1: Power off test. Program control with local date, time and schedules. Disconnect control from power source for at least 1 hour. Verify and document:~~

- ~~Control retains all programmed schedules and local date and time~~

~~Step 2: On schedule test. Simulate or provide times when lights are scheduled to be ON. Verify and document:~~

- ~~Controlled lights turn on~~

~~Step 3: Schedule test. Simulate or provide times when the sun has set and lights are scheduled to be OFF. Verify and document:~~

- ~~Controlled lights turn off~~

~~NA7.8~~NA7.9 Sign Lighting Acceptance Tests

Reserved For Future Use

NA7.10 Refrigerated Warehouse Refrigeration System Acceptance Tests

The measurement devices used to verify the refrigerated warehouse refrigeration system components shall be calibrated once every two years using a NIST traceable reference. The calibrated measurement devices to be used in these acceptance tests shall have the following measurement tolerances: The temperature measurement devices shall be calibrated to +/- 0.7°F between -30°F and 200°F. The pressure measurement devices shall be calibrated to +/- 2.5 psi between 0 and 500 psig. The relative humidity (RH) measurement devices shall be calibrated to +/- 1% between 5% and 90% RH.

NA7.10.1 Electric Resistance Underslab Heating System

NA7.10.1.1 Construction Inspection

Prior to functional testing, verify and document the following for all electric resistance underslab heating systems:

- Verify that summer on-peak period is programmed into all underslab heater controls to meet the requirements of Section 126(b).

NA7.10.1.2 Functional Testing

Step 1: Using the control system, lower slab temperature set point. Verify and document the following using an electrical test meter:

- The underslab electric resistance heater is off.

Step 2: Using the control system, raise the slab temperature set point. Verify and document the following using an electrical test meter:

- The underslab electric resistance heater is on.

Step 3: Using the control system, change the control system's time and date corresponding to the local utility's summer on-peak period. If control system only accounts for time, set system time corresponding to the local utility's summer on-peak period. Verify and document the following using an electrical test meter:

- The underslab electric resistance heater is off.

Step 4: Restore system to correct schedule and control set points.

NA7.10.2 Evaporators and Evaporator Fan Motor Variable Speed Control

NA7.10.2.1 Construction Inspection

Prior to functional testing, document the following on all evaporators:

- All refrigerated space temperature sensors used for control are verified to read accurately (or provide an appropriate offset) using a temperature standard.
- All refrigerated space humidity sensors used for control are verified to read accurately (or provide an appropriate offset) using a humidity standard.
- All refrigerated space temperature and humidity sensors are verified to be mounted in a location away from direct evaporator discharge air draft.
- Verify that all fans motors are operational and rotating in the correct direction.
- Verify that fan speed control is operational and connected to evaporator fan motors.
- Verify that all speed controls are in “auto” mode.

NA7.10.2.2 Functional Testing

Conduct and document the following functional tests on all evaporators.

Step 1: Measure current space temperature or humidity. Program this temperature or humidity as the test temperature or humidity set point into the control system for the functional test steps. Allow 5 minutes for system to normalize.

Step 2: Using the control system, lower test temperature or humidity set point in 1 degree or 1% RH increments below any control dead band range until:

- Evaporator fan controls modulate to increase fan motor speed.
- Evaporator fan motor speed increases in response to controls.
- Verify and document the above.

Step 3: Using the control system, raise the test temperature or humidity set point in 1 degree or 1% RH increments above any control dead band range until fans go to minimum speed. Verify and document the following:

- Evaporator fan controls modulate to decrease fan motor speed.
- Evaporator fan motor speed decreases in response to controls.
- Minimum fan motor control speed (rpm or percent of full speed).

Step 4: Restore control system to correct control set points.

NA7.10.3 Condensers and Condenser Fan Motor Variable Speed Control

NA7.10.3.1 Evaporative Condensers and Condenser Fan Motor Variable Speed Control

NA7.10.3.1.1 Construction Inspection

Prior to functional testing, document the following:

- Verify the minimum condensing temperature control set point is at or below 70°F.

- Verify the master system controller saturated condensing temperature input is the temperature equivalent reading of the condenser pressure sensor.
- Verify all drain leg pressure regulator valves are set below the minimum condensing temperature/pressure set point.
- Verify all receiver pressurization valves, such as the outlet pressure regulator (OPR), are set lower than the drain leg pressure regulator valve setting.
- Verify all condenser inlet and outlet pressure sensors read accurately (or provide an appropriate offset) using a pressure standard.
- Verify all ambient dry bulb temperature sensors used by controller read accurately (or provide an appropriate offset) using a temperature standard.
- Verify all relative humidity sensor used by controller read accurately (or provide an appropriate offset) using RH standard.
- Verify all temperature sensors used by the controller are mounted in a location that is not exposed to direct sunlight.
- Verify that all sensor readings used by the condenser controller convert or calculate to the correct conversion units at the controller (e.g., saturated pressure reading is correctly converted to appropriate saturated temperature; dry bulb and relative humidity sensor readings are correctly converted to wet bulb temperature, etc.)
- Verify that all fan motors are operational and rotating in the correct direction.
- Verify that all condenser fan speed controls are operational and connected to condenser fan motors to operate in unison the fans serving a common condenser loop.
- Verify that all speed controls are in “auto” mode.

NA7.10.3.1.2 Functional Testing

Note: The system cooling load must be sufficiently high to run the test. Artificially increase evaporator loads or decrease compressor capacity (manually turn off compressors, etc.) as may be required to perform the Functional Testing.

Step 1: Override any heat reclaim, floating suction pressure, floating head pressure and defrost functionality before performing functional tests.

Step 2:

- Document current outdoor ambient air dry bulb and wet bulb temperatures, relative humidity and refrigeration system condensing temperature/condensing pressure readings from the control system.
- Calculate and document the temperature difference (TD), defined as the difference between the wet bulb temperature and the refrigeration system saturated condensing temperature (SCT).
- Document current head pressure control set point.

Step 3: Using the desired condenser fan motor cycling or head pressure control strategy, program into the control system a set point equal to the reading or calculation obtained in Step 2. This will be referred to as the “test set point.” Allow 5 minutes for condenser fan speed to normalize.

Step 4: Using the control system, raise the test set point in 1 degree (or 3 psi) increments until the condenser fan control modulates to minimum fan motor speed. Verify and document the following:

- Fan motor speed decreases.
- All condenser fan motors serving common condenser loop decrease speed in unison in response to controller output.
- Minimum fan motor control speed (rpm or percent of full speed).

- If the refrigeration system is already operating at minimum saturated condensing temperature/head pressure, reverse Steps #4 and 5.

Step 5: Using the control system, lower the test set point in 1 degree (or 3 psi) increments until the condenser fan control modulates to increase fan motor speed. Verify and document the following:

- Fan motor speed increases.
- All condenser fan motors serving common condenser loop increase speed in unison in response to controller output.

Step 6: Document the current minimum condensing temperature set point. Using the control system, change the minimum condensing temperature set point to a value greater than the current operating condensing temperature. Verify and document the following:

- Condenser fan controls modulate to decrease capacity.
- All condenser fans serving common condenser loop modulate in unison.
- Condenser fan controls stabilize within a 5 minute period.

Step 7: Using the control system, reset the system head pressure controls, fan motor controls and minimum condensing temperature control set point to original settings documented in Steps #3 and 6.

Step 8: Restore any heat reclaim, floating suction pressure, floating head pressure and defrost functionality. Reset the minimum condensing temperature set point to the value documented in Step #6.

NA7.10.3.2 Air-Cooled Condensers and Condenser Fan Motor Variable Speed Control

Conduct and document the following functional tests on all air-cooled condensers.

NA7.10.3.2.1 Construction Inspection

Prior to functional testing, document the following:

- Verify that the minimum condensing temperature control set point is at or below 70°F.
- Verify that the master system controller saturated condensing temperature input is the temperature equivalent reading of the condenser pressure sensor.
- Verify all drain leg pressure regulator valves are set below the minimum condensing temperature/pressure set point.
- Verify all receiver pressurization valves, such as the outlet pressure regulator (OPR), are set lower than the drain leg pressure regulator valve setting.
- Verify all condenser inlet and outlet pressure sensors read accurately (or provide an appropriate offset) using a pressure standard.
- Verify all ambient dry bulb temperature sensors used by controller read accurately (or provide an appropriate offset) using temperature standard.
- Verify all temperature sensors used by the controller are mounted in a location that is not exposed to direct sunlight.
- Verify that all sensor readings used by the condenser controller convert or calculate to the correct conversion units at the controller (e.g., saturated pressure reading is correctly converted to appropriate saturated temperature, etc.)
- Verify that all fan motors are operational and rotating in the correct direction.
- Verify that all condenser fan speed controls are operational and connected to condenser fan motors to operate in unison the fans serving a common condenser loop.
- Verify that all speed controls are in “auto” mode.

NA7.10.3.2.2 Functional Testing

Note: The system cooling load must be sufficiently high to run the test. Artificially increase evaporator loads or decrease compressor capacity (manually turn off compressors, etc.) as may be required to perform the Functional Testing.

Step 1: Override any heat reclaim, floating suction pressure, floating head pressure and defrost functionality before performing functional tests.

Step 2:

- Document current outdoor ambient air dry bulb temperature and refrigeration system condensing temperature/condensing pressure readings from the control system.
- Calculate and document the temperature difference (TD), defined as the difference between the dry bulb temperature and the refrigeration system saturated condensing temperature (SCT).
- Document current head pressure control set point.

Step 3: Using the desired condenser fan motor cycling or head pressure control strategy, program into the control system a set point equal to the reading or calculation obtained in Step 2.

- This will be referred to as the "test set point." Allow 5 minutes for condenser fan speed to normalize.

Step 4: Using the control system, raise the test set point in 1 degree (or 3 psi) increments until the condenser fan control modulates to minimum fan motor speed. Verify and document the following:

- Fan motor speed decreases.
- All condenser fan motors serving common condenser loop decrease speed in unison in response to controller output.
- Minimum fan motor control speed (rpm or percent of full speed).
- If the refrigeration system is already operating at minimum saturated condensing temperature/head pressure, reverse Steps #4 and 5.

Step 5: Using the control system, lower the test set point in 1 degree (or 3 psi) increments until the condenser fan control modulates to increase fan motor speed. Verify and document the following:

- Fan motor speed increases.
- All condenser fan motors serving common condenser loop increase speed in unison in response to controller output.

Step 6: Document current minimum condensing temperature set point. Using the control system change the minimum condensing temperature set point to a value greater than the current operating condensing temperature. Verify and document the following:

- Condenser fan controls modulate to decrease capacity.
- All condenser fans serving common condenser loop modulate in unison.
- Condenser fan controls stabilize within a 5 minute period.

Step 7: Using the control system, reset the system head pressure controls, fan motor controls and minimum condensing temperature control set point to original settings documented in Steps #3 and 6.

Step 8: Restore any heat reclaim, floating suction pressure, floating head pressure and defrost functionality. Reset the minimum condensing temperature set point to the value documented in Step #6.

NA7.10.4 Variable Speed Screw Compressors

Conduct and document the following functional tests on all variable-speed screw compressors.

NA7.10.4.1 Construction Inspection

Prior to functional testing, document the following:

- Verify all single open-drive screw compressors dedicated to a suction group have variable speed control.
- Verify all compressor suction and discharge pressure sensors read accurately (or provide an appropriate offset) using a standard.
- Verify all input or control temperature sensors used by controller read accurately (or provide an appropriate offset) using temperature standard.
- Verify that all sensor readings used by the compressor controller convert or calculate to the correct conversion units at the controller (e.g., saturated pressure reading is correctly converted to appropriate saturated temperature, etc.)
- Verify that all compressor speed controls are operational and connected to compressor motors.
- Verify that all speed controls are in “auto” mode.
- Verify that compressor panel control readings for “RPMs”, “% speed”, “kW”, and “amps” match the readings from the PLC or other control systems.
- Verify that compressor nameplate data is correctly entered into the PLC or other control system.

NA7.10.4.2 Functional Testing

Note: The system cooling load must be sufficiently high to run the test. Artificially increase or decrease evaporator loads (add or shut off zone loads, change set points, etc.) as may be required to perform the Functional Testing.

Step 1: Override any heat reclaim, floating suction pressure, floating head pressure and defrost functionality before performing functional tests.

Step 2: Measure and document the current compressor operating suction pressure and saturated suction temperature.

Step 3: Document the suction pressure/saturated suction temperature set point. Program into the control system a target set point equal to the current operating condition measured in Step #2. Allow 5 minutes for system to normalize. This will be referred to as the “test suction pressure/saturated suction temperature set point”.

Step 4: Using the control system, raise the test suction set point in 1 psi increments until the compressor controller modulates to decrease compressor speed. Verify and document the following:

- Compressor speed decreases.
- Compressor speed continues to decrease to minimum speed.
- Any slide valve or other unloading means does not unload until after the compressor has reached its minimum speed (RPM).

Step 5: Using the control system, lower the test suction set point in 1 psi increments until the compressor controller modulates to increase compressor speed. Verify and document the following:

- Any slide valve or other unloading means first goes to 100 percent before compressor speed increases from minimum.
- Compressor begins to increase speed.
- Compressor speed continues to increase to 100 percent.

Step 6: Using the control system, program the suction target set points back to original settings as documented in Step #3.

Step 7: Restore any heat reclaim, floating suction pressure, floating head pressure and defrost functionality.

NA7.11 Commercial Kitchen Exhaust System Acceptance Tests

NA7.11.1 Kitchen Exhaust Systems with Type I Hood Systems

The following acceptance tests apply to commercial kitchen exhaust systems with Type I exhaust hoods. All Type I exhaust hoods used in commercial kitchens shall be tested.

NA7.11.1.1 Construction Inspection

Step 1: Verify exhaust and replacement air systems are installed, power is installed and control systems such as demand control ventilation are calibrated

Step 2: For kitchen/dining facilities having total Type 1 and Type II kitchen hood exhaust airflow rates greater than 5,000 cfm, calculate the maximum allowable exhaust rate for each Type 1 hood per Table ~~140.9~~141.0(b)-A.

NA7.11.1.2 Functional Testing at Full Load Conditions

The following acceptance test applies to systems with and without demand control ventilation exhaust systems. These tests shall be conducted at full load conditions.

Step 1: Operate all sources of outdoor air providing replacement air for the hoods

Step 2: Operate all sources of recirculated air providing conditioning for the space in which the hoods are located

Step 3: Operate all appliances under the hoods at operating temperatures

Step 4: Verify that the thermal plume and smoke is completely captured and contained within each hood at full load conditions by observing smoke or steam produced by actual cooking operation and/or by visually seeding the thermal plume using devices such as smoke candles or smoke puffers. Smoke bombs shall not be used (note: smoke bombs typically create a large volume of effluent from a point source and do not necessarily confirm whether the cooking effluent is being captured). For some appliances (e.g., broilers, griddles, fryers), actual cooking at the normal production rate is a reliable method of generating smoke). Other appliances that typically generate hot moist air without smoke (e.g., ovens, steamers) need seeding of the thermal plume with artificial smoke to verify capture and containment.

Step 5: Verify that space pressurization is appropriate (e.g. kitchen is slightly negative relative to adjacent spaces and all doors open/close properly).

Step 6: Verify that each Type 1 hood has an exhaust rate that is below the maximum allowed.

Step 7: Make adjustments as necessary until full capture and containment and adequate space pressurization are achieved and maximum allowable exhaust rates are not exceeded. Adjustments may include:

- Adjust exhaust hood airflow rates
- Add hood side panels
- Add rear seal (back plate)
- Increase hood overhang by pushing equipment back
- Relocate supply outlets to improve the capture and containment performance

Step 8: Measure and record final exhaust airflow rate per Type 1 hood.

NA7.11.1.3 Functional Testing for Exhaust Systems with Demand Control Ventilation

The following additional acceptance test shall be performed on all exhaust hoods with demand control ventilation exhaust systems.

Step 1: Turn off all kitchen hoods, makeup air and transfer systems

Step 2: Turn on one of the appliances on the line and bring to operating temperature. Confirm that:

- DCV system automatically switches from off to the minimum flow setpoint.
- The minimum flow setpoint does not exceed the larger of

  a. 50% of the design flow, or

  b. the ventilation rate required per Section 120.1.
- The makeup air and transfer air system flow rates modulate as appropriate to match the exhaust rate
- Appropriate space pressurization is maintained.

Step 3: Operate all appliances at typical conditions. Apply sample cooking products and/or utilize smoke puffers as appropriate. Confirm that:

- DCV system automatically ramps to full speed.
- Hood maintains full capture and containment during ramping to and at full-speed
- Appropriate space pressurization is maintained.

NA7.12 Parking Garage Ventilation System Acceptance Tests

NA7.12.1 Construction Inspection

Verify and document the following tests prior to the functional testing:

- Carbon monoxide control sensor is factory-calibrated per Section 120.6(c).
- The sensor is located in the highest expected concentration location in its zone per Section 120.6(c).
- Control setpoint is at or below the CO concentration permitted by Section 120.6(c).

NA7.12.2 Functional Testing

Conduct the following tests with garage ventilation system operating in occupied mode and with actual garage CO concentration well below setpoint.

Step 1: With all sensors active and all sensors reading below 25 ppm, observe that fans are at minimum speed and fan motor demand is no more than 30 percent of design wattage

Step 2: Apply CO span gas with a concentration of 30 ppm, and a concentration accuracy of +/- 2%, one by one to 50% of the sensors but no more than 10 sensors per garage and to at least one sensor per proximity zone. For each sensor tested observe:

- CO reading is between 25 and 35 ppm
- Ventilation system ramps to full speed when span gas is applied
- Ventilation system ramps to minimum speed when span gas is removed.

Step 3: Temporarily override the programmed sensor calibration/replacement period to 5 minutes.

- Wait 5 minutes and observe that fans ramp to full speed and an alarm is received by the facility operators. Restore calibration/replacement period.

Step 4: Temporarily place the system in unoccupied mode and override the programmed unoccupied sensor alarm differential from 30% for 4 hours to 1% for 5 minutes. Wait 5 minutes and observe that fans ramp to full speed and an alarm is received by the facility operators. Restore programming.

Step 5: Temporarily override the programmed occupied sensor proximity zone alarm differential from 30% for 4 hours to 1% for 5 minutes. Wait 5 minutes and observe that fans ramp to full speed and an alarm is received by the facility operators. Restore programming.

NA7.13 Compressed Air System Acceptance Tests

NA7.13.1 Construction Inspection

Prior to functional testing, compressed air system with 2 or more air compressors must verify and document the following:

- Size, rated capacity, and type of each air compressor
- Total system capacity (the sum of the individual capacities)
- System operating pressure
- Compressor(s) designated as trim compressors
- Method and tools for observing and recording the states of each compressor in the system, which shall include at least the following states:
  - Off
  - Unloaded
  - Partially loaded
  - Fully loaded
  - Short cycling (loading and unloading more often than once per minute)
  - Blow off (venting compressed air at the compressor itself)
- Method and tools for measuring the current air demand as a percentage of the total system capacity, including any necessary calibrations.

NA7.13.2 Functional Testing

Step 1: Per the test methods outlined in the Construction Inspection, verify that these methods have been employed, so that the states of the compressors and the current air demand can be observed and recorded during testing.

Step 2: Run the system steadily (at as close to a constant load as can be practically implemented) at a mid-range point, between 50% and 85% of total system capacity, for a duration of at least 10 minutes.

Step 3: Observe and record the states of each compressor and the current air demand during the test.

Step 4: Confirm that the combinations of compressors states meet the following criteria:

- No compressor exhibits short-cycling.
- No compressor exhibits blowoff.
- For new systems, the trim compressors shall be the only compressors partially loaded, while the base compressors will either be fully loaded or off by the end of the test.

[1] From AEC, Distributed Energy Storage for Direct-Expansion Air Conditioners, January 27, 2005.