Title 24

Mechanical Acceptance Testing

California State Pipe Trades Council

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Sacramento, California

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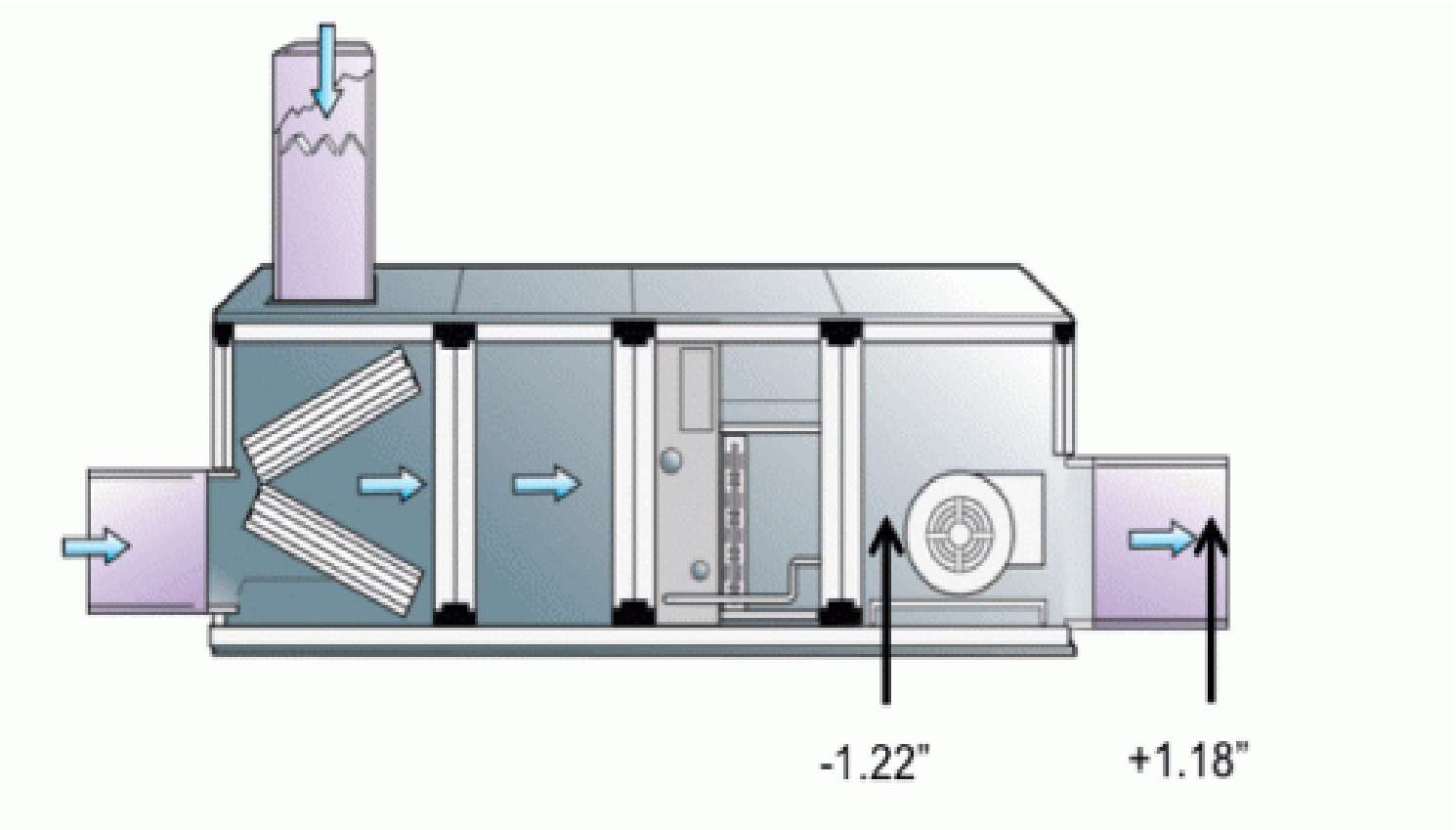
What is Mechanical Acceptance Testing?



CALIFORNIA ENERGY COMMISSION

The acceptance testing requirements specify targeted inspection procedures and functional performance test procedures that serve to determine whether specific equipment, systems, and interfaces between systems conform to the criteria set forth in the Energy Standards.

It is important to note that Acceptance testing is not intended to take the place of commissioning or test and balance procedures that a building owner might incorporate into a building project. It is a process focusing only on demonstrating compliance with the Energy Standards.

When are Acceptance Tests Required?

In general the Acceptance Tests apply to new equipment and systems installed in either new construction or retrofit applications, and must be submitted to the enforcement agency before a final occupancy permit can be granted.

Who can perform Mechanical Acceptance Testing?

With the exception of the NRCA-MCH-4A Air Distribution Duct Leakage Test, at least at this time, these tests can be performed by a qualified, experienced technician.

However, as soon as the state meets the threshold of 300 Certified Mechanical Acceptance Test Technicians you will be required to be certified to perform the commissioning acceptance testing, and must be employed by a Certified Acceptance Test Employer or ATE.

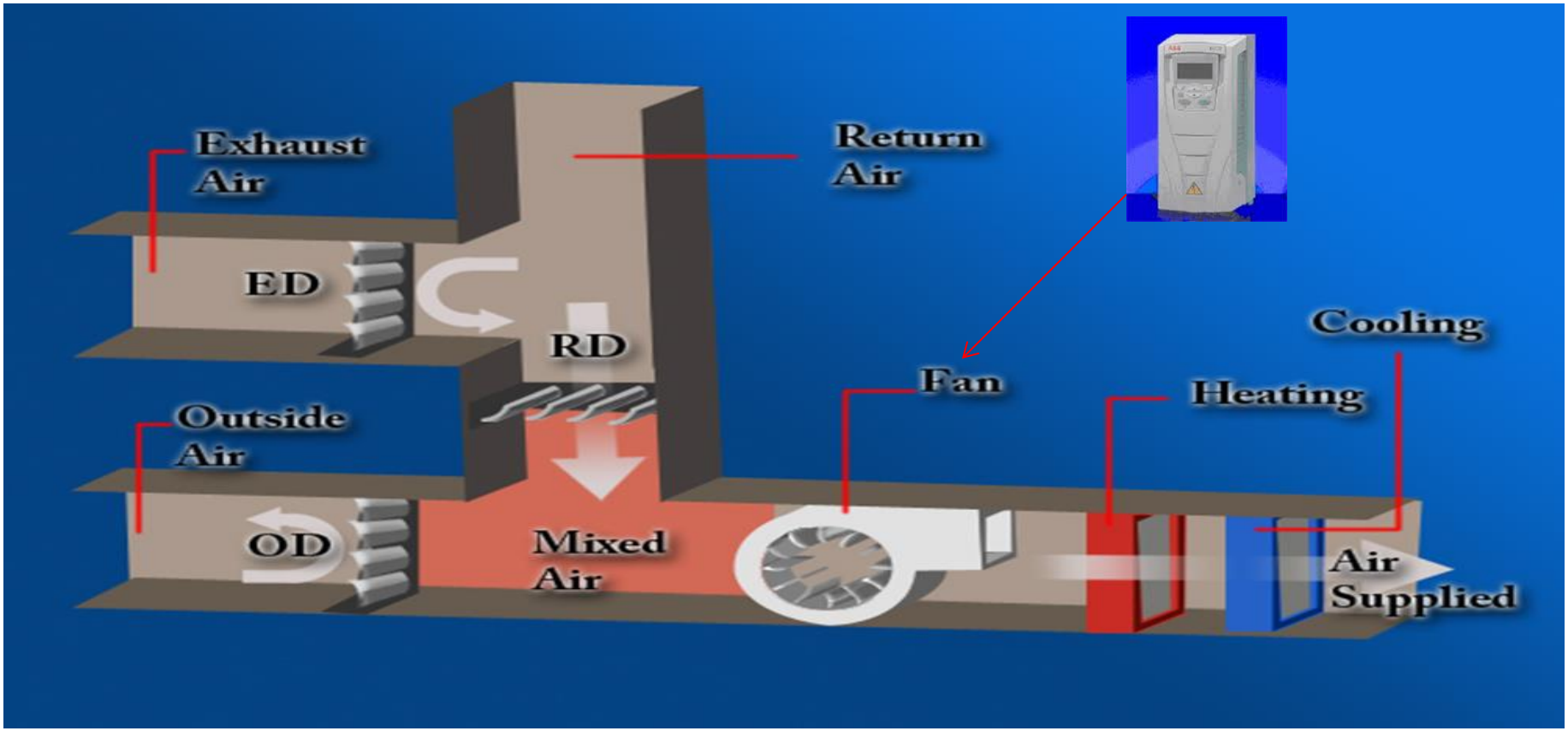
How many Acceptance Tests are there?

There are a total of 17 different Mechanical Acceptance Tests which are required for the 2016 Code Cycle.

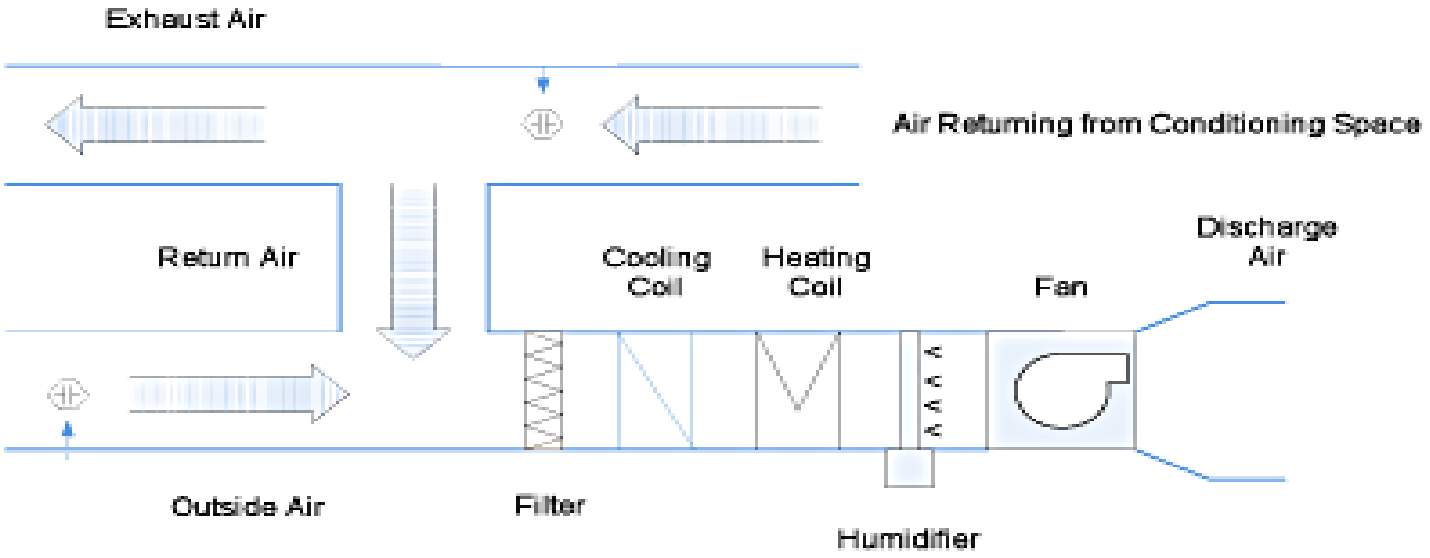
They range from the NRCA-MCH-2A through the NRCA-MCH-18A

Lets take a look at the Mechanical Acceptance Tests

NRCA-MCH-2A
OSA Ventilation Acceptance VAV



The test verifies that the minimum volume of outdoor air, as required per Subsection 120.1(b)2, is introduced to the air handling unit and is **within ±10%** of the required volume when the system is in occupied mode at these two conditions of supply airflow. The test consists of measuring outdoor air values at maximum flow, and at near minimum flow.*(And at any position in between these two positions).*



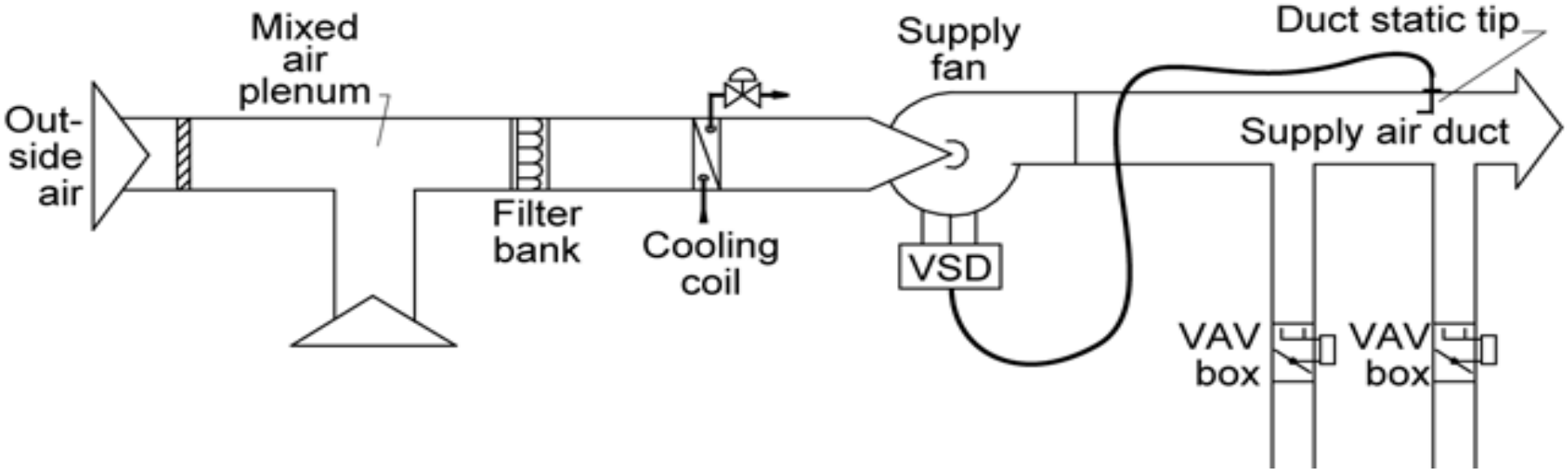
Outside Air Measurement

The choice of instrumentation will vary from Rotating Vane Anemometers, Hot Wire Anemometers, Velocity Grids (Vel Grid), Micro Manometers, Pitot Tube, etc.

Acceptance Criteria -

The sensor used to control outdoor air flow must be calibrated in the field or at the factory, with documentation attached.

The measured outdoor airflow reading is within ±10% of the total value found on the Standards Mechanical Plan Check document NRCC-MCH-03-E, Column M or Column I



This shows a typical VAV system. In standard practice, the TAB contractor sets the minimum position setting for the outdoor air damper during construction. It is set under the conditions of design airflow for the system, and remains in the same position throughout the full range of system operation. Does this meet code? The answer is NO!. As the system airflow drops, so will the pressure which will produce a varying outdoor airflow.

NRCA-MCH-2A
OSA Ventilation Acceptance CAV

* CAV units ≤54,000 Btu/Hr are not required to have an economizer, but they are required to provide the minimum Outside Side Air per §120.1(c)4E when ever the space is occupied.

OSA inlet with a barometric damper

Acceptance Criteria -

The sensor used to control outdoor air flow must be calibrated in the field or at the factory, with documentation attached.

The measured outdoor airflow reading is within ±10% of the total value found on the Standards Mechanical Plan Check document NRCC-MCH-03-E, Column M or Column I

Estimated Time to Complete –
(time given is an estimate given by the CEC and should not be used as the required time to perform this test).

Construction Inspection: 0.5 hours to 2 hours (This time may vary depending on complexity and difficulty in calibrating the "system" controlling outdoor airflow)

Functional Testing: 1 to 3 hours (This time may vary depending on the type of zone control and the number of zones)

NRCA-MCH-3A

Constant Volume, Single-zone, Unitary Air Conditioner and Heat Pumps Systems Acceptance

The functional testing of the thermostat confirms that the controller functions as designed and that it has been programmed as per the requirements of the Energy Standards.

Thermostat meets the temperature adjustment and dead band requirements of §120.2(b): The thermostat shall allow a heating setpoint of 55°F or lower and a cooling setpoint of 85°F or higher. The deadband shall be at least 5°F, where heating and cooling is shut off. Occupied, unoccupied, and holiday schedules have been programmed per the facility's schedule

Pre-occupancy purge has been programmed to meet the requirements of §120.1(c)2. This is typically accomplished by scheduling the unit to start one hour prior to actual occupancy. Check the method used to determine pre-occupancy purge:

- The lesser of 15 cfm per person, or the conditioned floor area times the ventilation rate from the Building Energy Efficiency Standards Table 120.1 A. This is typically .15 CFM per square foot for offices.

- Three complete building air changes (ACH)

- **Occupied heating mode operation:** The supply fan operates continuously, all heating stages operate, cooling is not enabled, and the outdoor air damper is at minimum position.

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

- **Occupied cooling mode operation:** The supply fan operates continuously, all cooling stages operate, heating is not enabled, and outside damper is at minimum position.

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

4.2.5 Thermostats

§110.2(c) and §120.2(b)4

When a central energy management control system (EMCS) is not included in the design of the HVAC system, then a thermostat with setback capabilities must be installed. The requirement is for all unitary heating or cooling systems to have a thermostat that is capable of at least 4 set points in a 24 hour period.

In addition, per §120.2(b)4, the thermostats on all unitary single zone, air conditioners, heat pumps must comply with the requirements of Reference Joint Appendix JA5, also known as the **Occupant Controlled Smart Thermostats**, which are capable of receiving demand response signals in the event of grid congestion and power shortages during high electrical demand periods.

Estimated Time to Complete –
(time given is an estimate given by the CEC and should not be used as the required time to perform this test).

Construction inspection: 0.5 to 1 hour (depending on complexity and familiarity with thermostat programming)

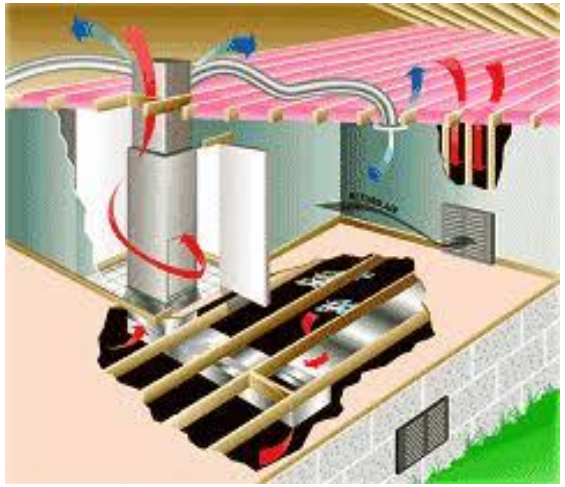
Equipment test: 1 to 2 hours (This test typically requires two technicians, one to manipulate the control as the other confirms its operation).

NRCA-MCH-4A
Air Distribution Systems Acceptance

As detailed in the Standards, this test is required only for single-zone units **serving less than 5,000 ft²** of floor area where **25 percent or more** of the duct surface area is in one of the following spaces:
Duct systems shall be sealed to a leakage rate **not to exceed 6%** per the conditions. (applies only to new constructed buildings)

The purpose of this test is to verify all duct work associated with all non-exempt constant volume, single-zone HVAC units (i.e. air conditioners, heat pumps, and furnaces) meet the material, installation, and insulation R-values, and leakage requirements of the Standard.

Complete the Visual Inspection as specified in NA2.1.4.2.4.

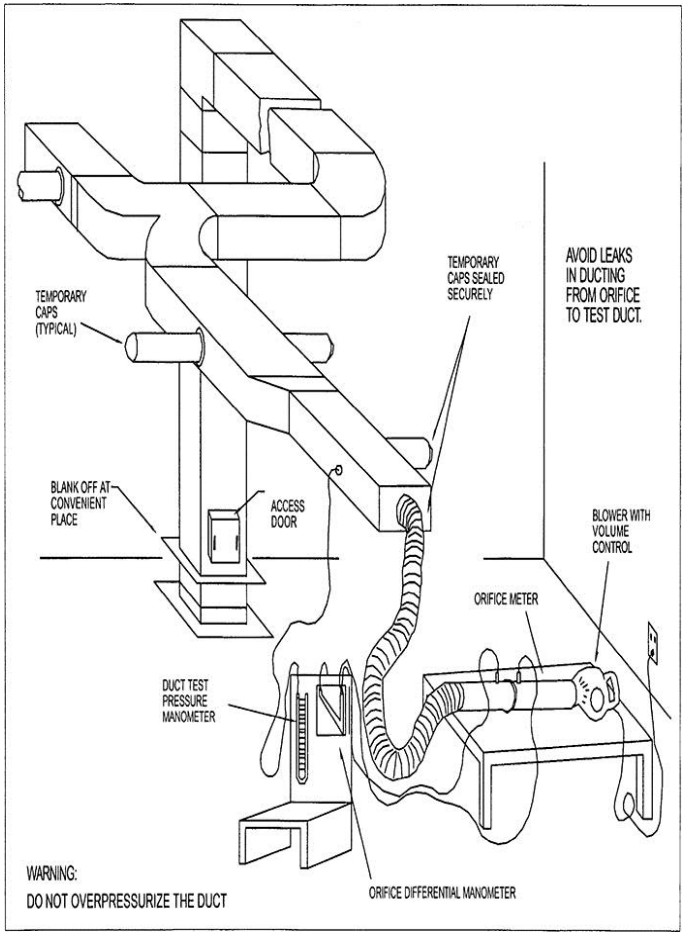


After sealing is complete use the same procedure to measure the leakage after duct sealing.

For **existing duct systems** that are having additional ducts added or are having major repairs or replacement of equipment connected to the ducts, the leakage rate of the existing duct system should be tested first before any alterations proceed.

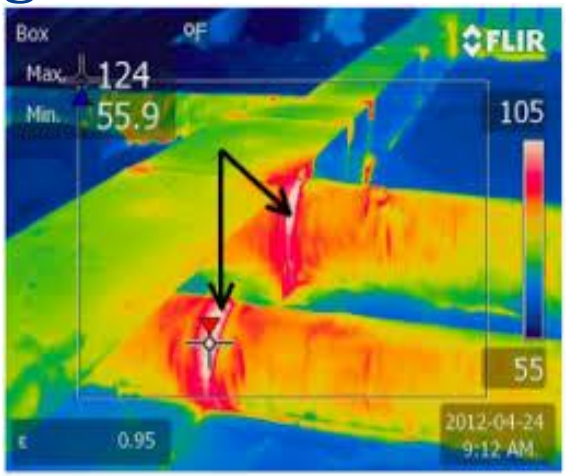
If this leakage percentage **is less than or equal to 15%,** the system passes. If the system does not pass, then the installer should locate and seal any accessible leaks/gaps.

Within this criteria, this test applies to both new duct systems and to existing duct systems which are either being extended or the space conditioning system is altered by the installation of replacement of space conditioning equipment.



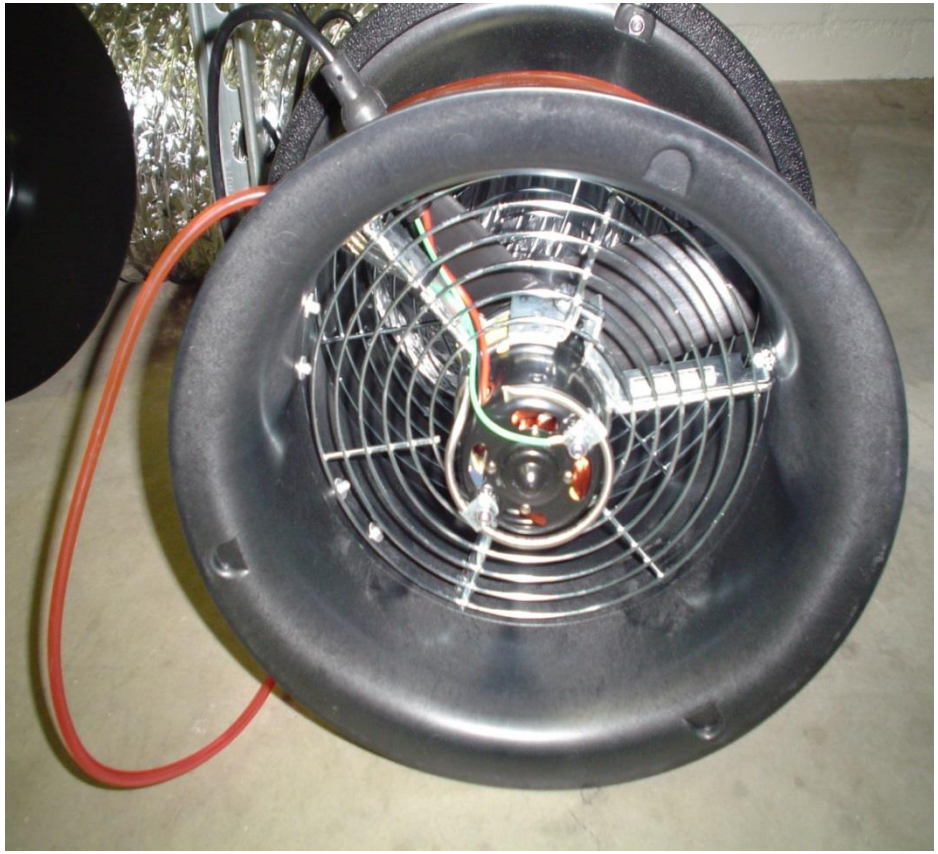
Complete the Smoke Test as specified in NA2.1.4.2.3

Inject either theatrical or other non-toxic smoke into a fan pressurization device that is maintaining a duct pressure difference of 25 PA (0.1 inches water) relative to duct surroundings, with all grilles and registers in the duct system sealed.



Duct Blaster Pressurization Fan

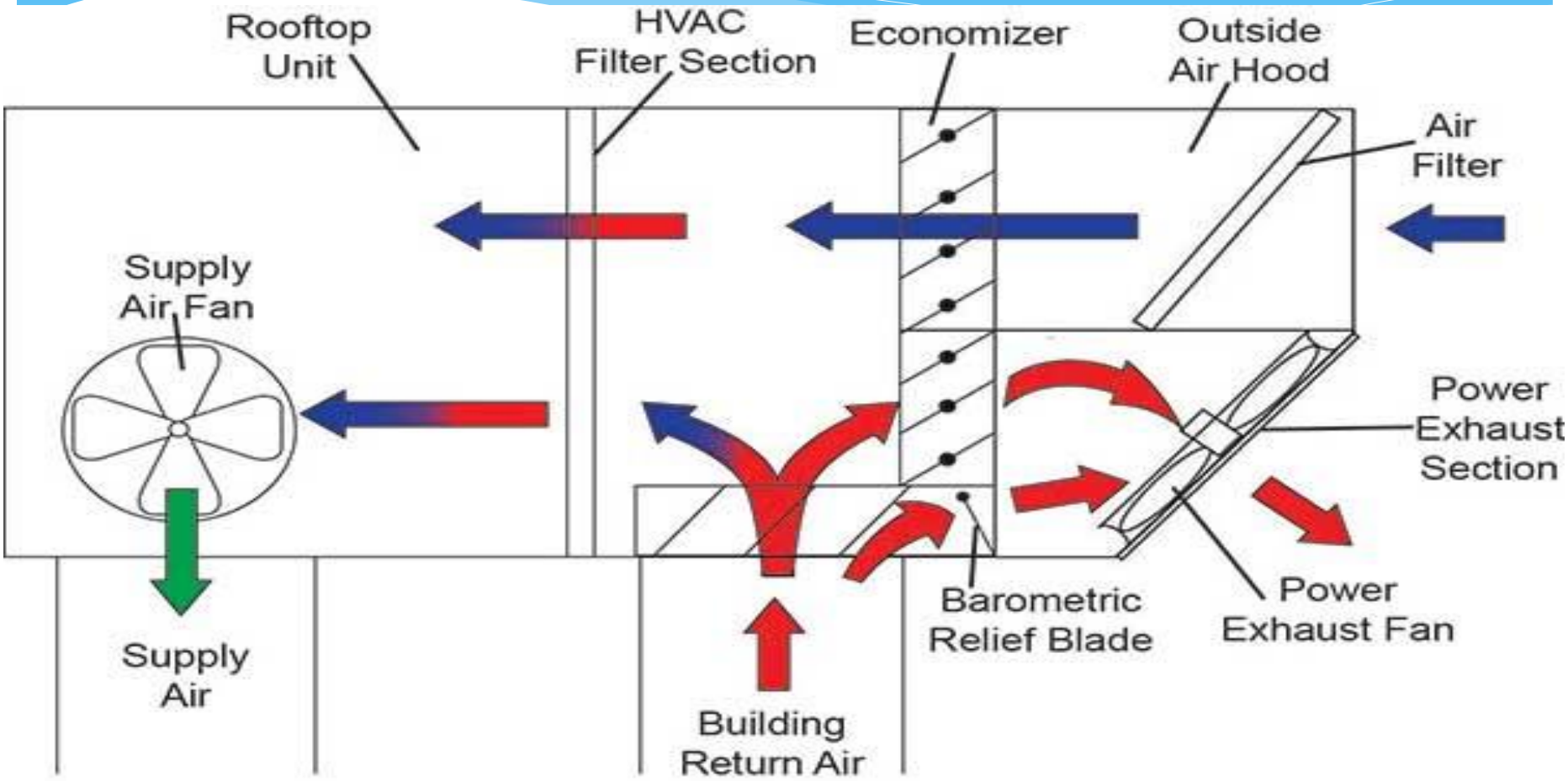
All instrumentation used for duct leakage diagnostic measurements shall be calibrated according to the manufacturer's calibration procedure to conform to the accuracy requirement specified NA2



Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

- **Construction Inspection:** 0.5 to 2 hours
- **Functional testing:** 3 to 6 hours

NRCA-MCH-5A
Air Economizer Controls Acceptance



The purpose of functionally testing of an air economizer system is to verify that an HVAC system uses outdoor air to satisfy space cooling loads when the outdoor air conditions are acceptable.

Packaged HVAC systems > **54,000** Btu/hr must have an economizer. Air economizers must be capable of providing 100% of the design supply air with outside air.

(For units with economizers that are factory installed and certified by the manufacturer to the California Energy Commission, and meet the economizer quality control requirements, the in-field economizer functional tests do not have to be conducted).


ENERGYGUIDE

Acceptance Criteria:

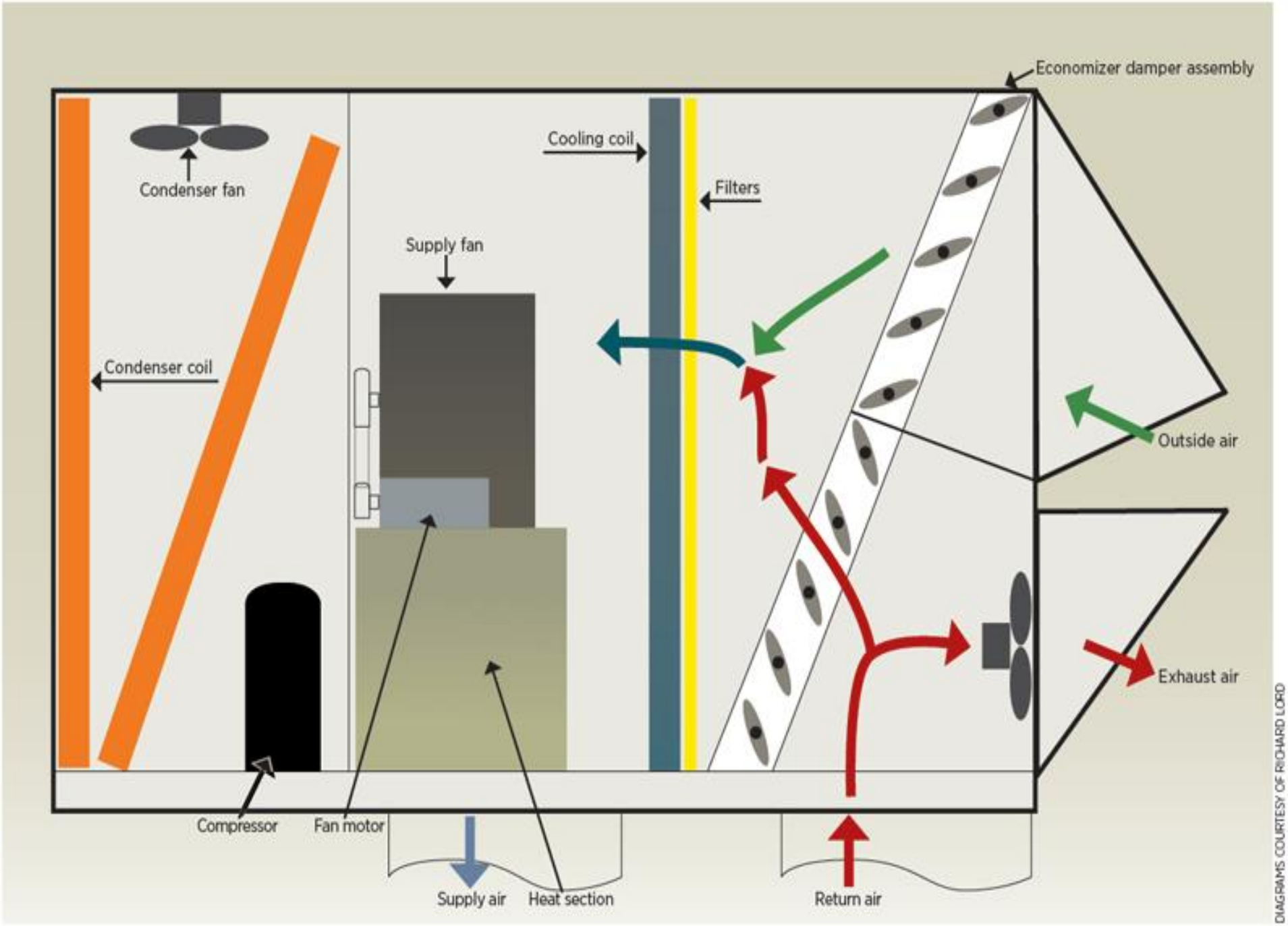
If the economizer is factory installed and certified, a valid factory certificate is required for acceptance. No additional equipment tests are necessary.

Check to ensure that the air economizer lockout setpoint complies with Standards Table 140.4-B per §140.4(e)3.

Ensure that the outside sensor location accurately reads true outdoor air temperature and is not affected by exhaust air or other heat sources.

All sensors are installed and located appropriately to achieve the desired control.

TYPICAL ECONOMIZER PACKAGE



DIAGRAMS COURTESY OF RICHARD LORD

The six basic steps of the Functional Testing of the Air Economizer Controls are ~

Disable demand control ventilation systems.

Enable the economizer and simulate a cooling demand large enough to drive the economizer fully open.

Disable the economizer and simulate a cooling demand.

If the unit is equipped with heating, simulate a heating demand and enable the economizer.

Turn off the unit and verify the following (economizer damper closes completely)

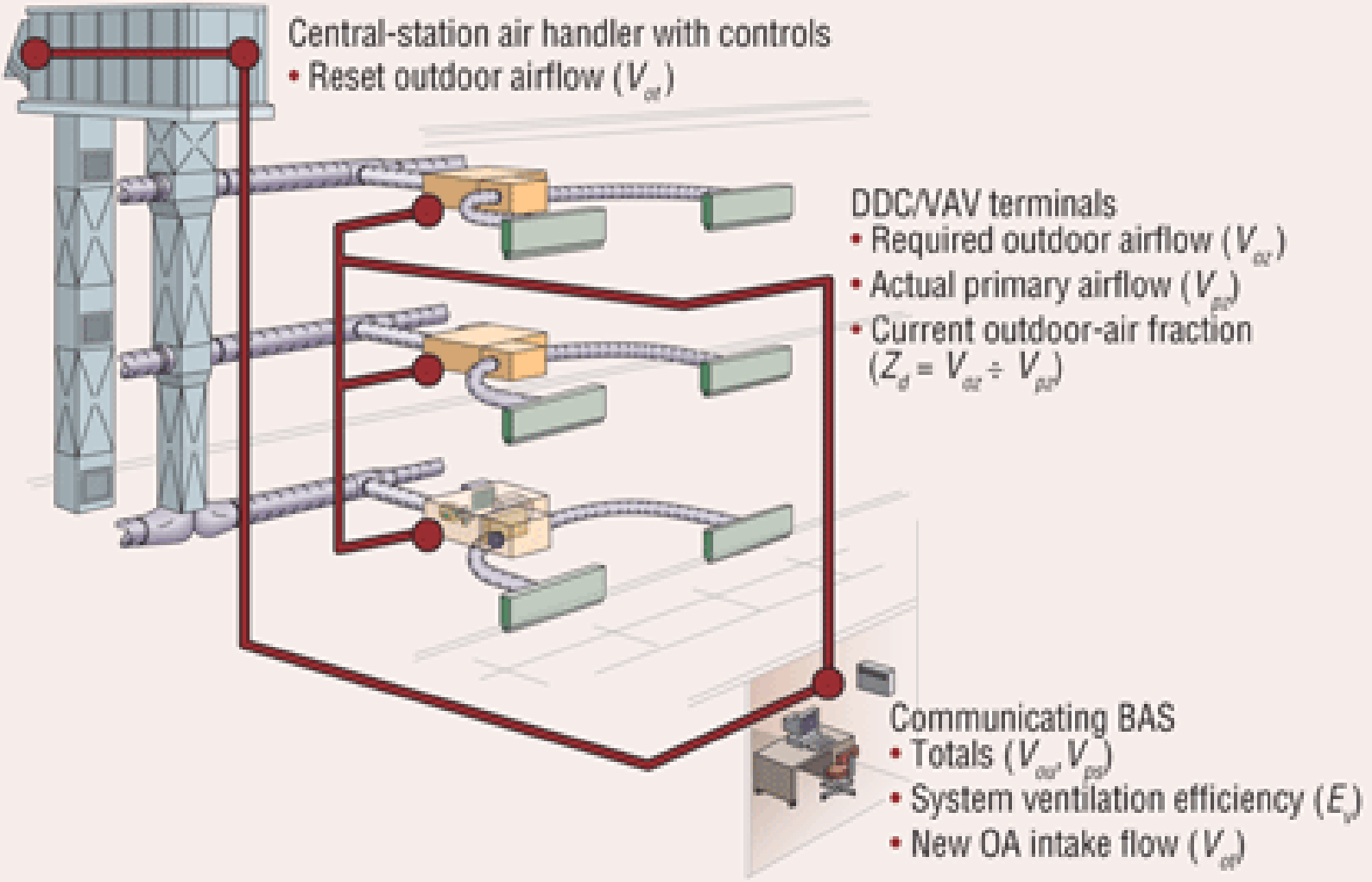
System returned to initial operating conditions.

Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

- **Construction Inspection:** 0.5 to 1 hours (depending on familiarity with the controls)

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

NRCA-MCH-6A
Demand Controlled Ventilation Acceptance


Central-station air handler with controls
• Reset outdoor airflow (V_{ot})
DDC/VAV terminals
• Required outdoor airflow (V_{oz})
• Actual primary airflow (V_{pz})
• Current outdoor-air fraction ($Z_d = V_{oz} \div V_{pz}$)
Communicating BAS
• Totals (V_{ot}, V_{pz})
• System ventilation efficiency (E_v)
• New OA intake flow (V_{ot})

Purpose of the Test:

The purpose of the test is to verify that systems required to employ demand controlled ventilation (refer to §120.1(c)3) can vary outside ventilation flow rates based on maintaining interior carbon dioxide (CO2) concentration setpoints.

CO2 is a good indicator of occupancy load and is the basis used for modulating ventilation flow rates.

(**Note:** Minimum OSA shall always be provided during the buildings scheduled occupancy per §120.1(c)4E regardless of space CO2 reading!)


CO_2 Calibration
BAPI
Sensors for HVAC/R
Driver Version 6.5
Software and Driver Installation
www.bapihvac.com
BAPI

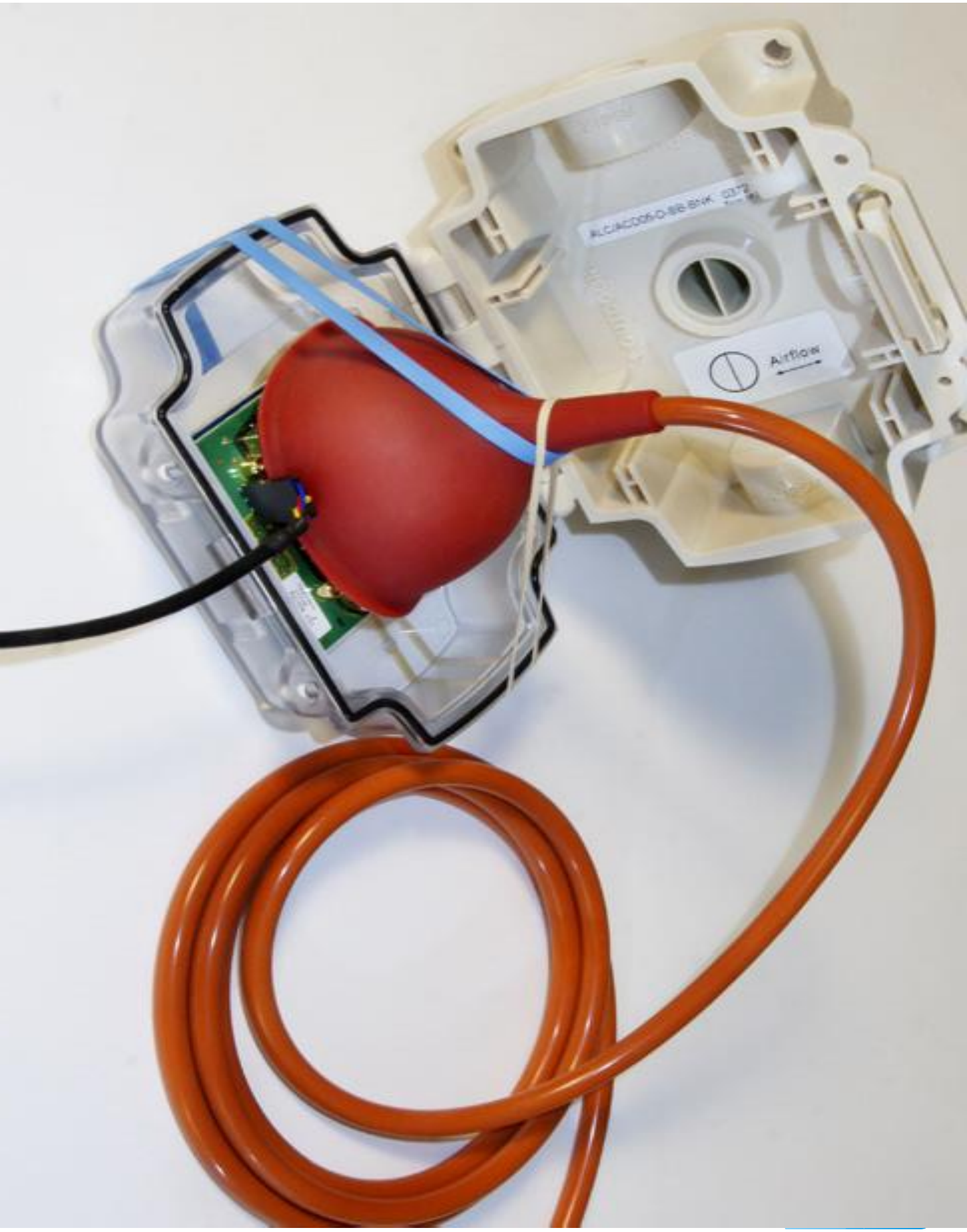
Acceptance Criteria

Each CO2 sensor is factory calibrated (with calibration certificate) or field calibrated.

Each CO2 sensor is wired correctly to the controls to ensure proper control operation of the outdoor air damper.

Each CO2 sensor is located correctly within the space 3 to 6 ft. above the floor.

Interior CO2 concentration setpoint is ≤600 ppm plus outdoor air CO2 value (typically about 400 ppm) if dynamically measured or an indoor setpoint of ≤1000 ppm if no OSA sensor is provided.


Airflow

The four basic steps to perform the Demand Control Ventilation Acceptance Test NRCA-MCH-06-A are -

Step 1 Prepare for functional Testing

a. Disable economizer controls

b. Outside air CO2 concentration (measured dynamically using CO2 sensor)

c. Interior CO2 concentration setpoint (Outside CO2 concentration + 600 ppm)

Step 2 Simulate a signal at or slightly above the CO2 setpoint or follow the manufacturers recommended testing procedures.

a. For single zone units, outdoor air damper modulates open to satisfy the total ventilation air called for in the Certificate of Compliance.

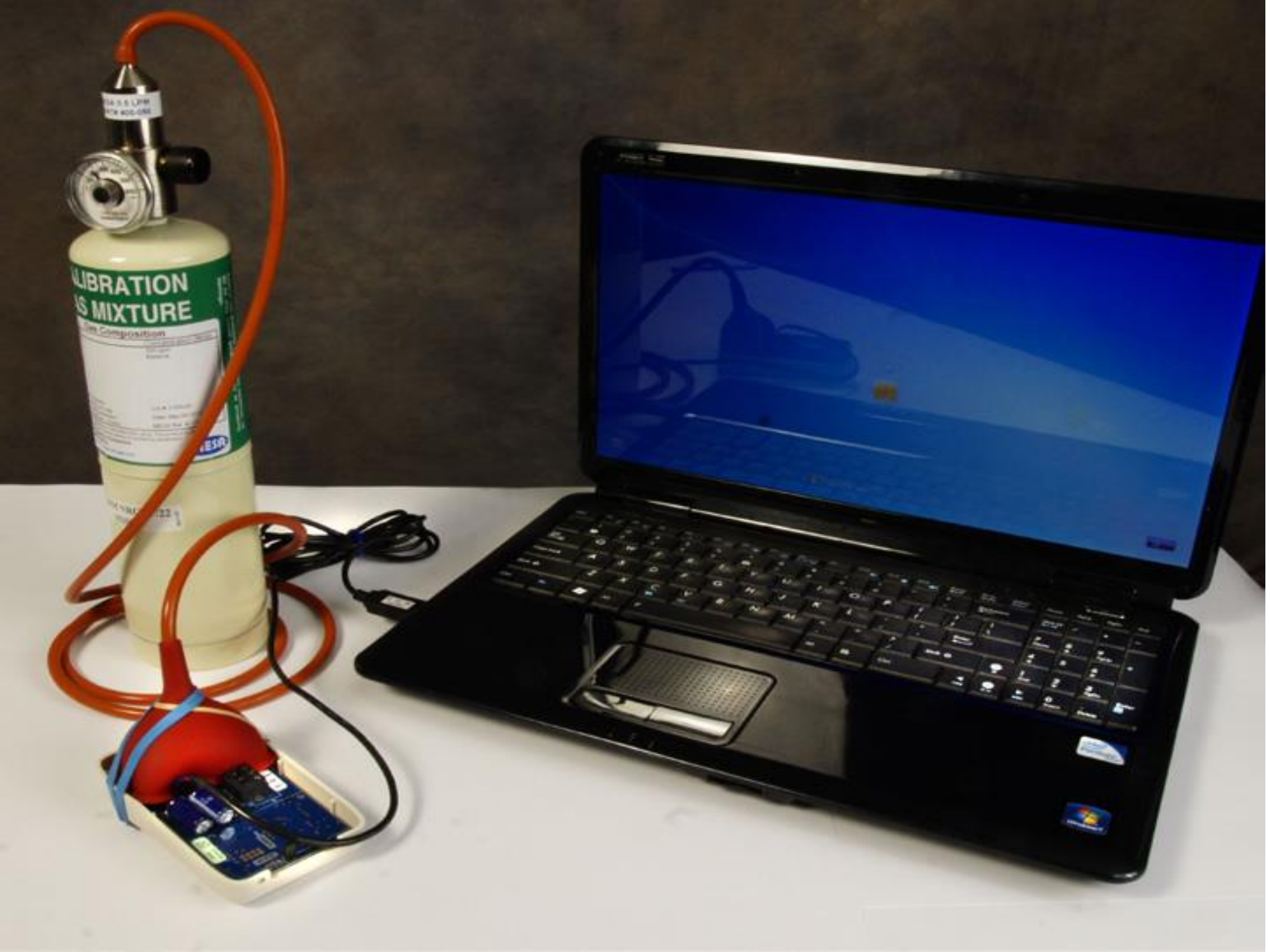
b. For multiple zone units, either outdoor air damper or zone damper modulate open to satisfy the zone ventilation requirements.

Step 3 Simulate a signal well below the CO2 setpoint or follow the manufacturers recommended procedures.

a. For single zone units, outdoor air damper modulates to the design minimum value.

b. For multiple zone units, either outdoor air damper or zone damper modulate to satisfy the reduced zone ventilation requirements.

Step 4 System returned to initial operating conditions.


LIBRATION
S MIXTURE

Estimated Time to Complete –
(time given is an estimate given by the CEC and should not be used as the required time to perform this test).

Construction inspection: 0.5 to 1 hours (depending on CO2 sensor calibration)

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

NRCA-MCH-7A
Supply Fan Variable Flow Controls Acceptance

Purpose of the Test:

The purpose of the test is to ensure that the supply fan in a variable air volume modulates to meet system airflow demand.

Airflow is typically controlled using a variable frequency drive (VFD) to modulate supply fan speed and vary system airflow.

The most common strategy for controlling the VFD is to measure and maintain static pressure within the duct.


-0.001
SP1
SP2
ALLO
ALHI
SP/AL
MENU
E
RST

Functional Testing

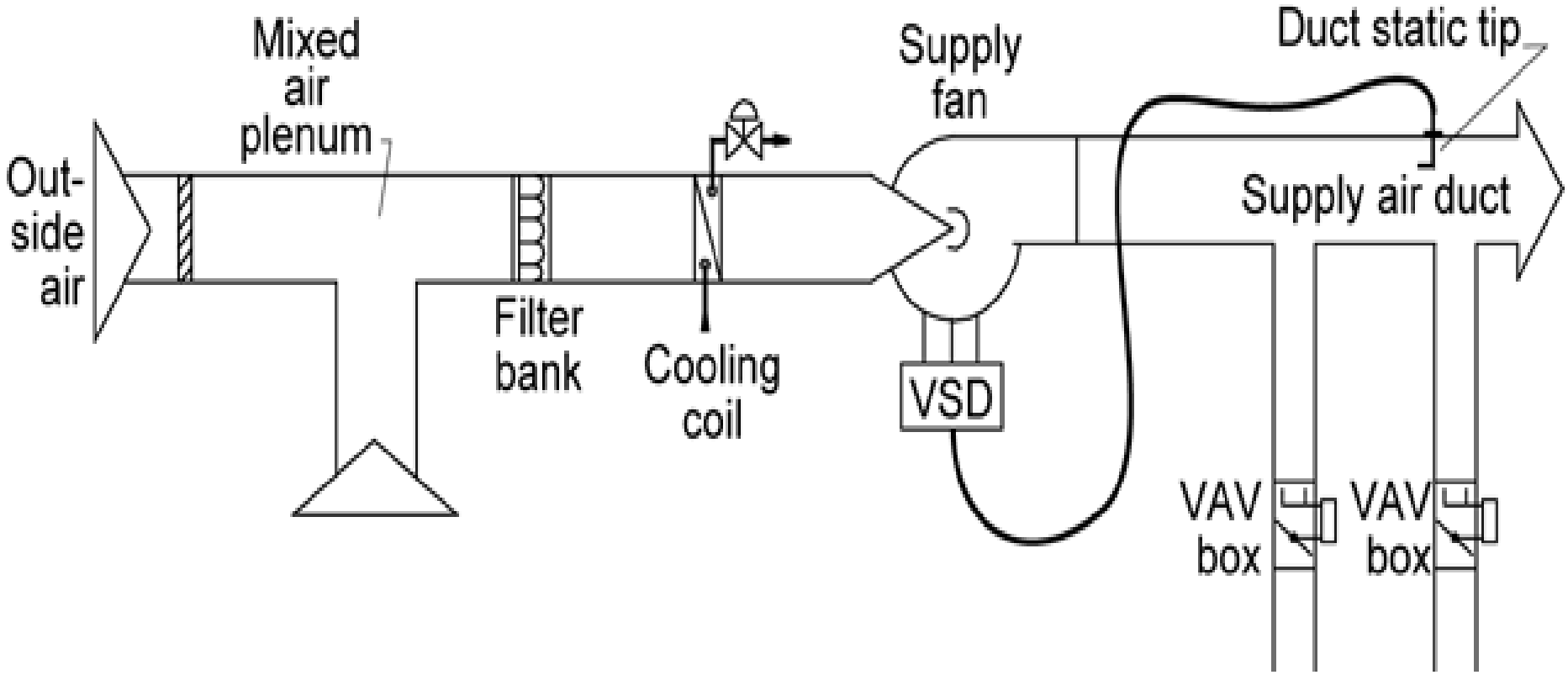
Supply air temperature reset should be disabled during testing to prevent any unwanted interaction.

Step 1: Drive all VAV boxes to achieve full design airflow.
Step 2: Drive all VAV boxes to a low airflow condition.

The intent is to verify and confirm proper supply fan operation when the system is at or near minimum flow conditions. This typically occurs when all of the VAV boxes are operating at minimum cooling flow rate.

Step 3: Return the system back to normal operating condition.

Ensure all schedules, setpoints, operating conditions, and control parameters are placed back to their initial conditions.


Out-
side
air
Mixed
air
plenum
Filter
bank
Cooling
coil
Supply
fan
VSD
Duct static tip
Supply air duct
VAV
box
VAV
box

Verify and Document

- That the supply fan speed decreases to meet flow conditions. Record fan VFD frequency (Hz).

- For systems with DDC to the zone level, check that current operating static pressure setpoint has decreased.

- For multi-zone systems, check that supply fan maintains discharge static pressure setpoint within **± 10 percent** of the current operating set point.

- Verification can be accomplished by simply reading the value measured by calibrated pressure sensor and comparing it to setpoint.

- System operation and supply fan control **stabilizes within 5 minutes.**

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eBay

SYXTHSENSE SDC GRAPHICS SERIES

MAIN PLANT AHU

-40 °C

-40 °C

SUPPLY SETPOINT 20.80 °C

-40 °C

DAMPER POSITION

32 %

HEATING VALVE

11.5%

COOLING VALVE

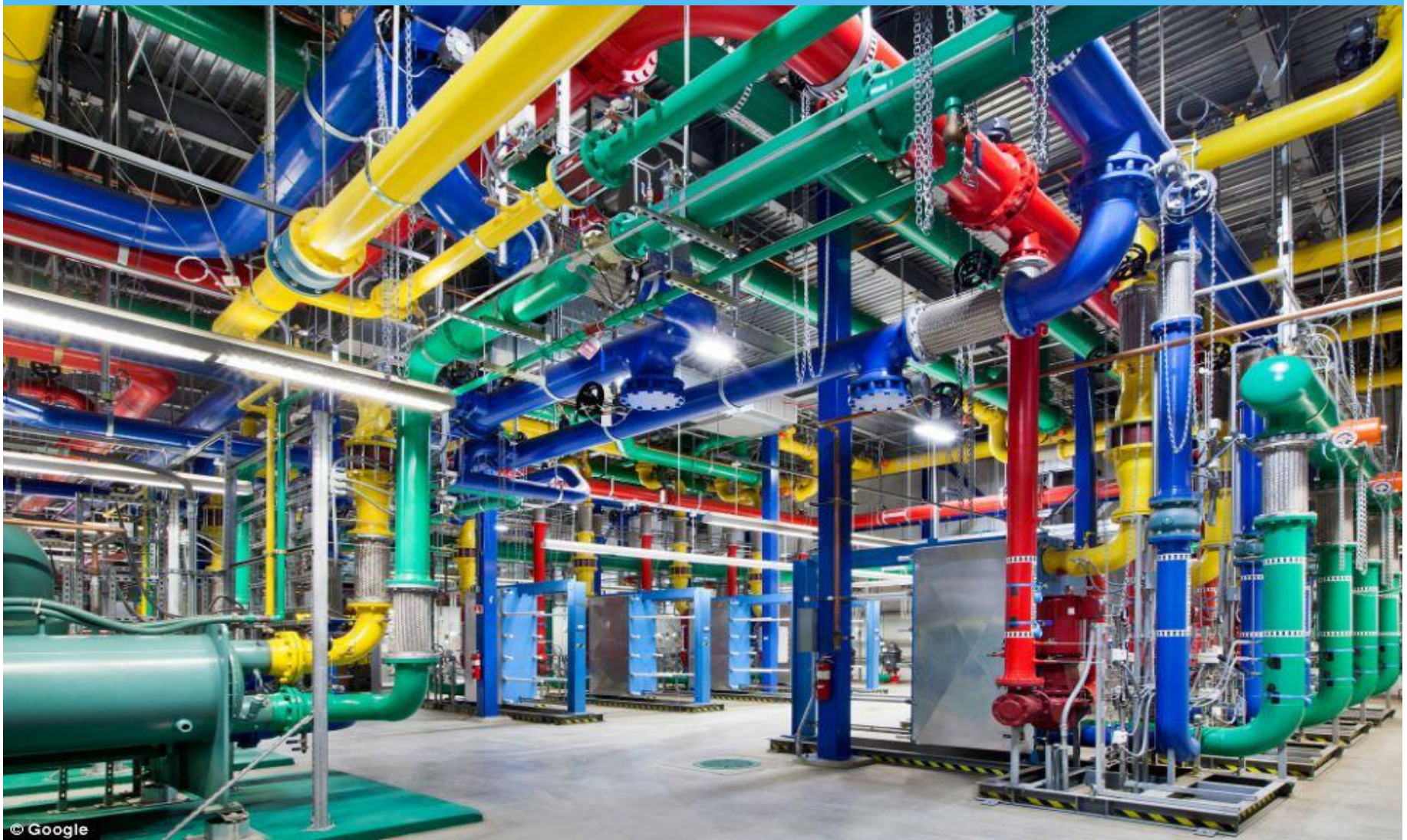
0.0 %

Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

Construction inspection: 0.5 to 1.5 hours (depending on sensor calibration and minimum VFD speed verification)

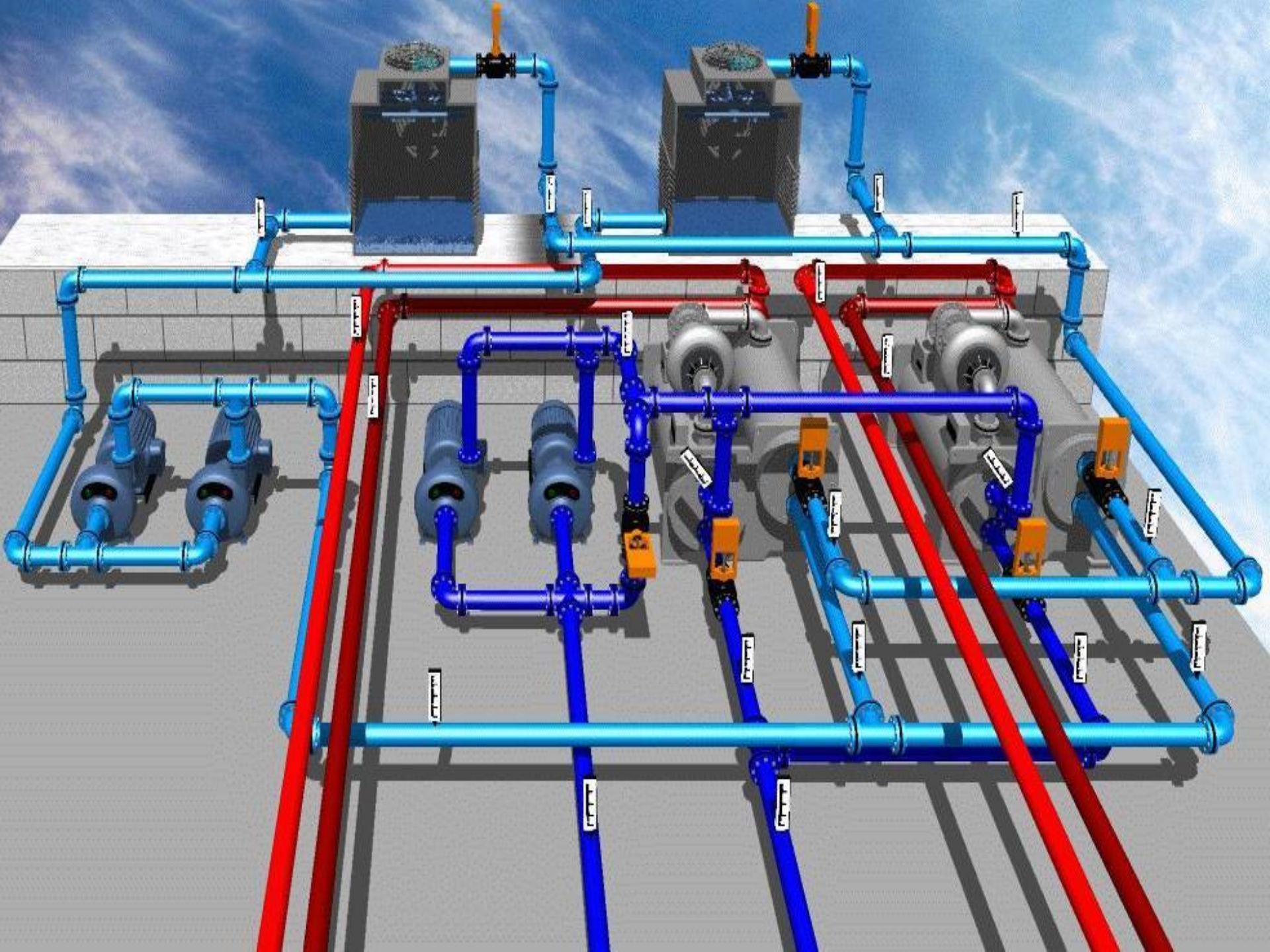
Functional testing: 1 to 2 hours (depending on how total fan power at design airflow is determined and system control stability)

NRCA-MCH-8A
Valve Leakage Acceptance



Purpose of the Test:

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



Functional Testing

Step 1: Deadhead One Pump.

The intent of this test is to establish a baseline pump pressure for use in checking the ability of all valves to close across the system. Use manual isolation or balance valves at the inlet or bypass of all three way valves and close it off. If a balance valve is used be sure to mark its current position so that it can be reset after the test

Verify and Document:

Isolate one circulation pump and make sure that all chillers or boilers are turned off. Close off the isolation valve at the pumps discharge and turn the pump on for not more than 5 minutes. Measure and note the pressure across the pump at this “deadhead” condition.

If the system is piped primary/secondary make sure this is a secondary pump.

At the end of the measurement turn off the pump and open the discharge valve at the pump.

Step 2: Close control valves.

The intent of this test is to ensure that all two-way valves can modulate fully closed and have actuators that can fully close across an operating pump. With the chillers or boiler still off, start the same pump that was used in Step 1 and drive all heat exchanger or coil control valves closed.

Make sure that the pump operates for no more than 5 minutes in this “deadhead” condition.

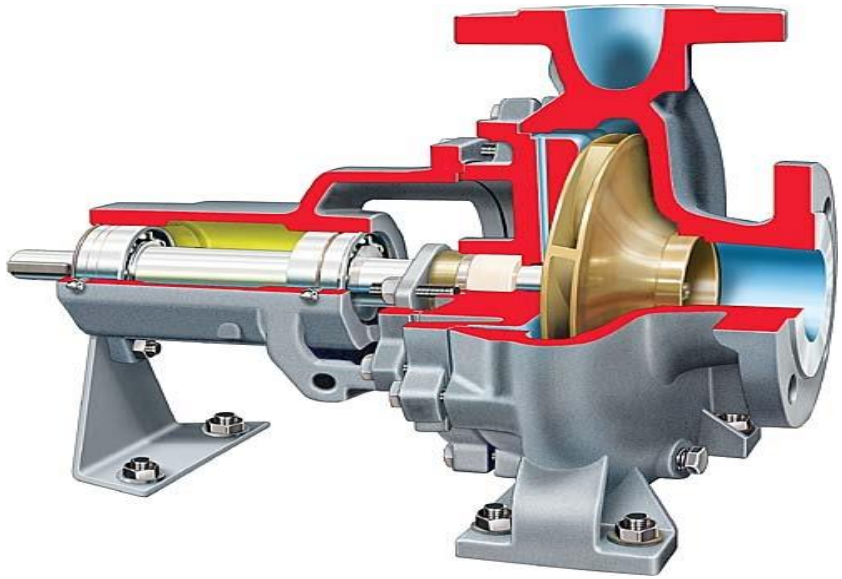
Verify and Document:

Confirm each control valve closes completely under normal operating pressure. The intent is to make sure that the actuator-valve torque requirements are adequate to shut the valve under normal operating system pressure. Verifying complete closure shall be done by measuring the pressure across the operating pump.

If the pressure is more than **5%** less than that previously measured the test fails as one or more valves have not fully closed. Diagnose and fix the problem then retest.

Step 3: Return system back to normal operating condition.

Confirm all schedules, setpoints, isolation and balance valves, operating conditions, and control parameters are placed back at their initial conditions.



Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

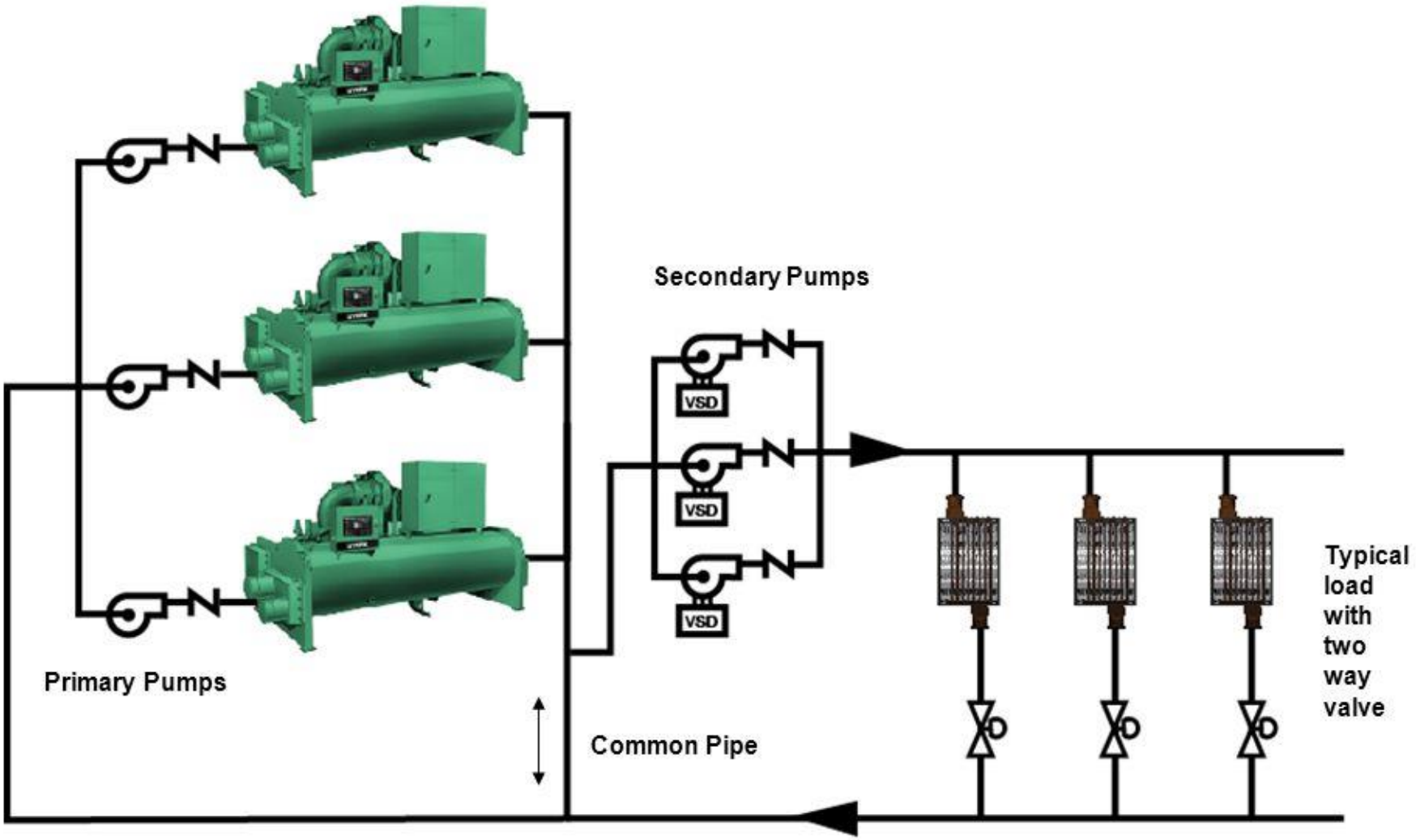
Construction inspection: 0.5 to 2 hours (depending on availability of construction documentation and complexity of the system.)

Functional testing: 30 minutes to 3 hours (depending on the complexity of the system and the number of valves)

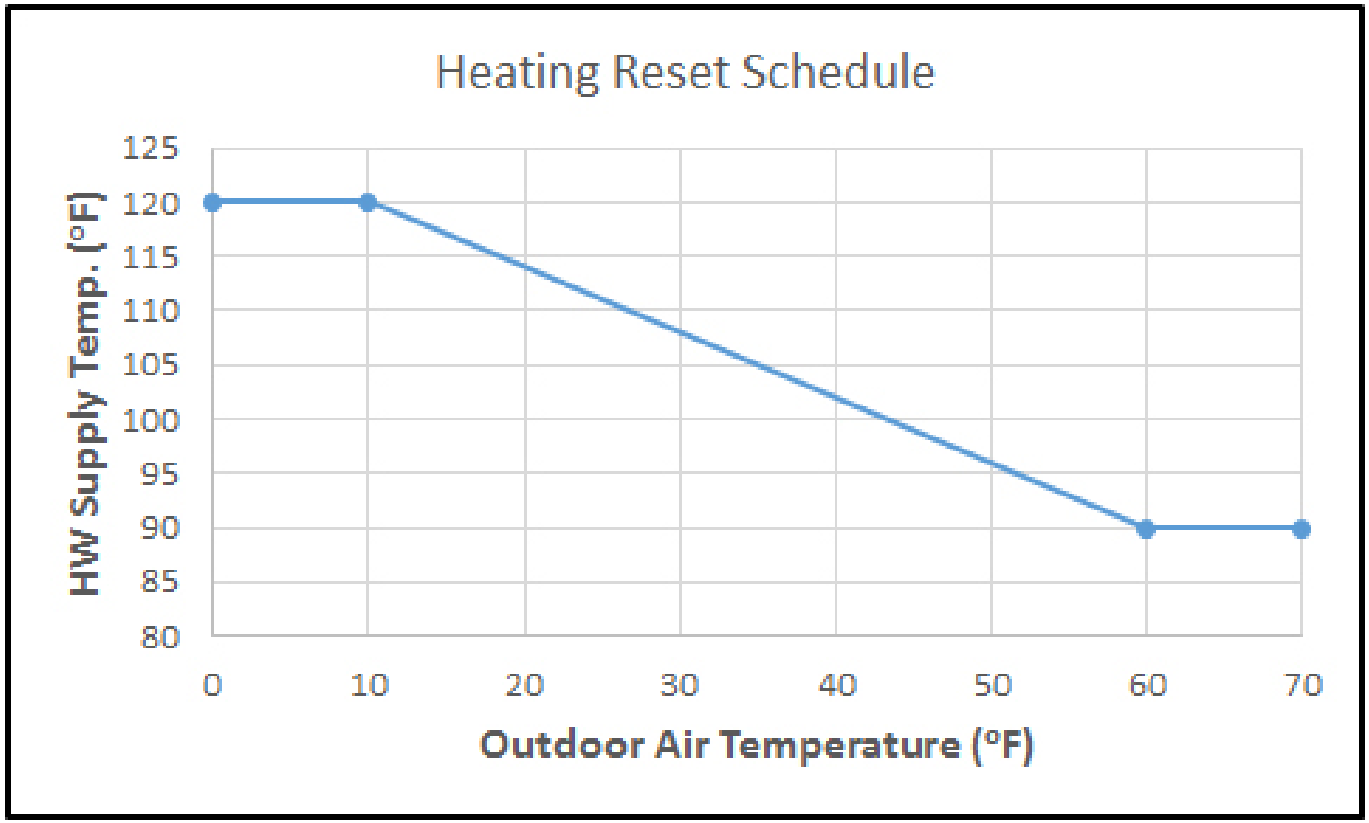
The Primary side of the heating or cooling circuit contains the boilers or chillers as well as the primary pumps. In this circuit the boilers or chillers heat or cool the water which is circulated around by the primary pumps in a continuous loop between the chiller or boiler and the low loss header.

The secondary side of the system contains any of the plant items which transfer thermal energy into the rooms or equipment within the building. For example Fan Coil Units (FCU's) Air handling units (AHU's), Chilled beams or under floor heating as well as radiators etc.

Primary/Secondary System



NRCA-MCH-9A
Supply Water Temperature Reset Controls Acceptance



Purpose of the Test

The intent of the test is to ensure that both the chilled water and heating hot water supply temperatures are automatically reset based on either building loads or outdoor air temperature, as indicated in the control sequences.

Typically the chilled water supply temperature can be raised as the cooling load decreases, and heating hot water supply temperature can be lowered as the heating load decreases.

❖ Outdoor air temperature

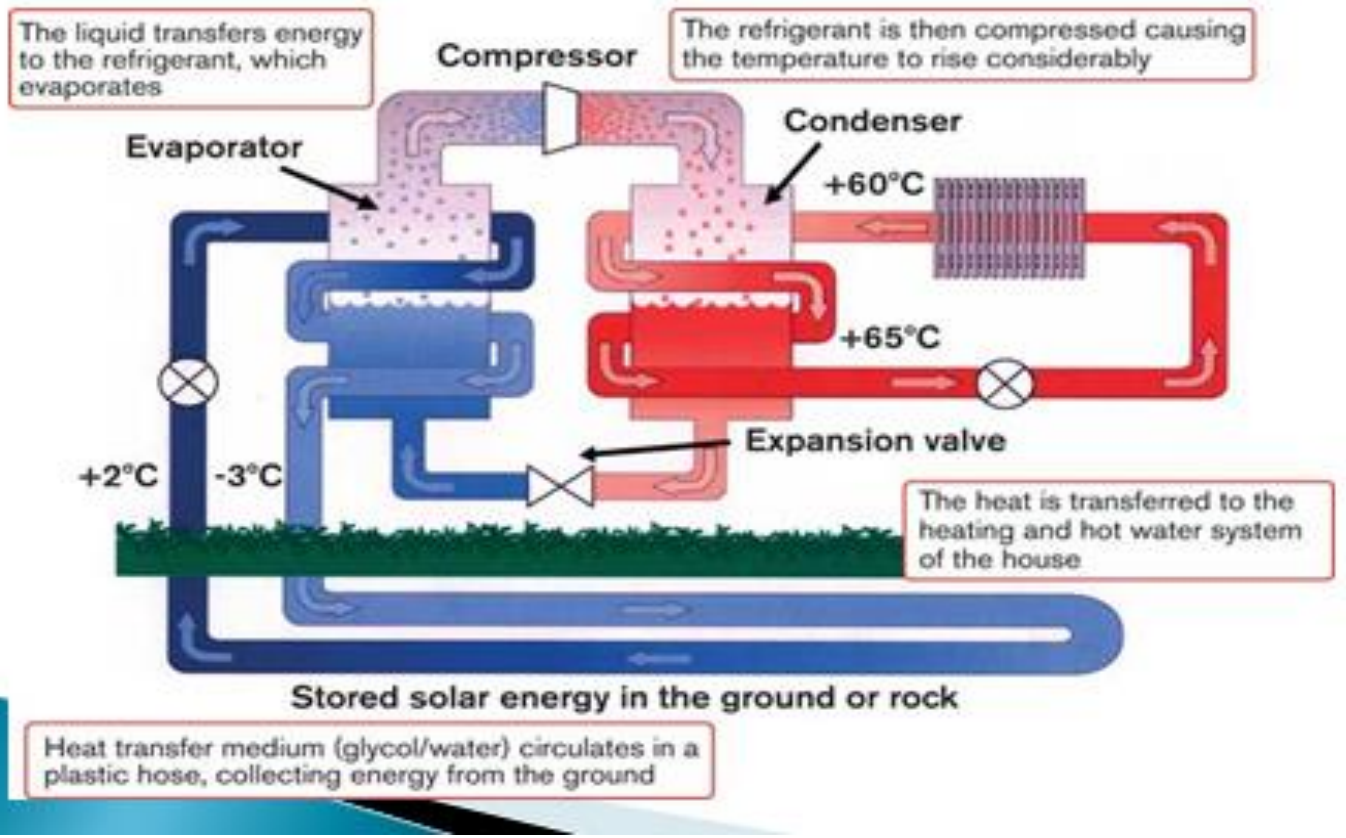
Another very common control strategy is to reset supply water temperature based on outdoor air temperature.

For example, hot water temperature may be reset linearly between 90°F and 140°F when the outdoor air temperature is above 50°F and below 35°F, respectively.

❖ Humidity control

And for special applications like hospitals, museums, semiconductor fabrication and laboratories, the cooling coil control may be based on maintaining a constant relative humidity within the space for not only comfort but also indoor air quality and moisture control (i.e. mold issues).

Supply Water Temperature Reset

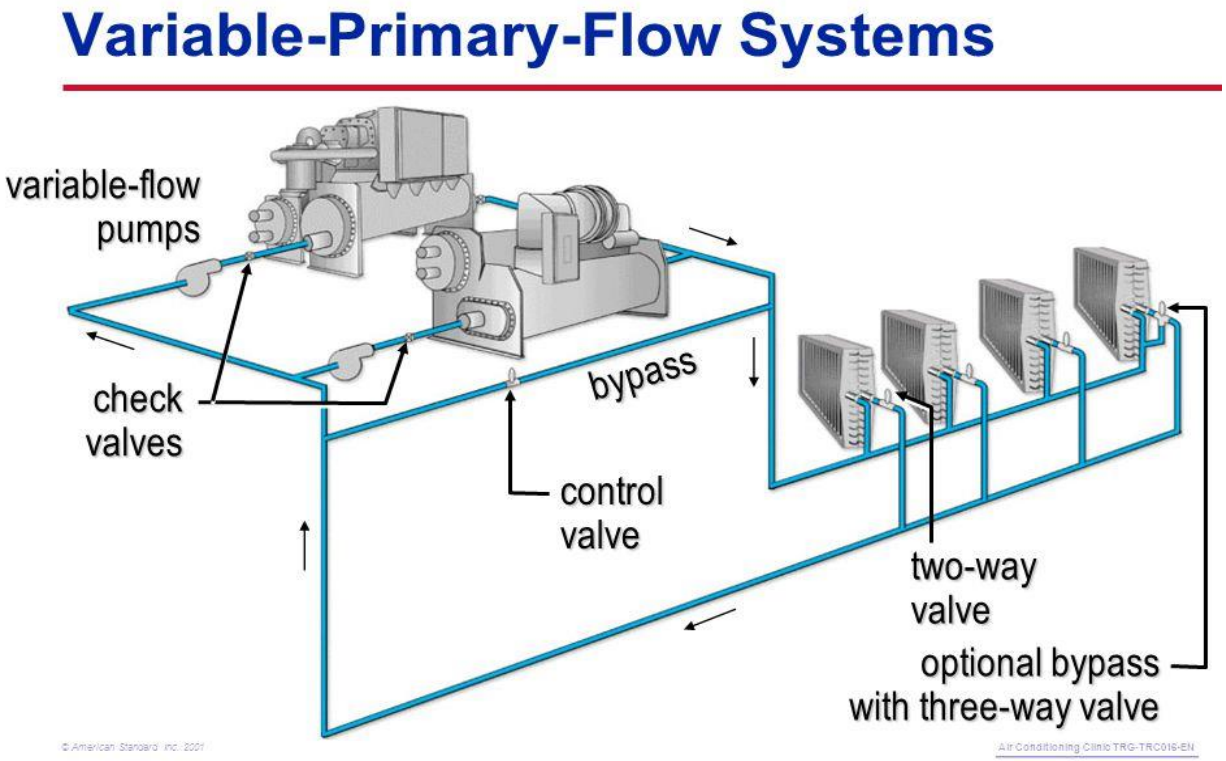


Estimated Time to Complete – (time given is an estimate given by the CEC and must not be taken as time required to perform this test).

- **Construction inspection:** 0.5 to 1 hours (depending on availability of construction documentation (i.e. plumbing drawings, material cut sheets, specifications, etc.) as well as sensor calibration.)

- **Functional testing:** 1 to 2 hours (depending on familiarity with BAS, method employed to vary operating parameters, and time interval between control command and system response)

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



Purpose of the Test

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

The differential pressure sensor (if applicable) is either factory or field calibrated by a Controls contractor or other qualified technician. Field calibration requires measuring system pressure, or differential pressure, as close to the existing sensor as possible using a calibrated hand-held measuring device and comparing the field measured value to the value measured by the building automation system (BAS).

All pressure sensors must be within **10%** of the calibrated reference sensor. Supporting documentation must be attached to the Acceptance Form NRCA-MCH-10A.


MEASURE
BYPASS
37.23
UNITS GAUGE
UNITS ΔP
ZERO GAUGE
TIME CONSTANT
CONTRAST
CONTRAST
HM675

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.

Modulating control valves can be accomplished by simply commanding each valve to a specific position or by adjusting temperature setpoints to be within the existing temperature range.


CHILLED WATER RETURN

Step 2. Open control valves to increase water flow to a minimum of 90 percent design flow.

Open control valves to reach between 90 and 100 percent of design flow. Opening the control valves can be achieved in a variety of ways, such as: resetting control setpoints so that valves respond accordingly, or commanding the valves directly using the DDC control system (i.e., building automation system).


36.84
0 - 50 psi

Verify and Document

- ✓ Pump speed increases to 100%.
- ✓ System pressure increases and is within 5 percent of current operating setpoint,

Record the system pressure as measured at the control sensor.
Record the system pressure setpoint.

- ✓ System pressure setpoint is greater than the setpoint recorded in Step 1.
- ✓ System operation stabilizes within 5 minutes after test procedures are initiated.

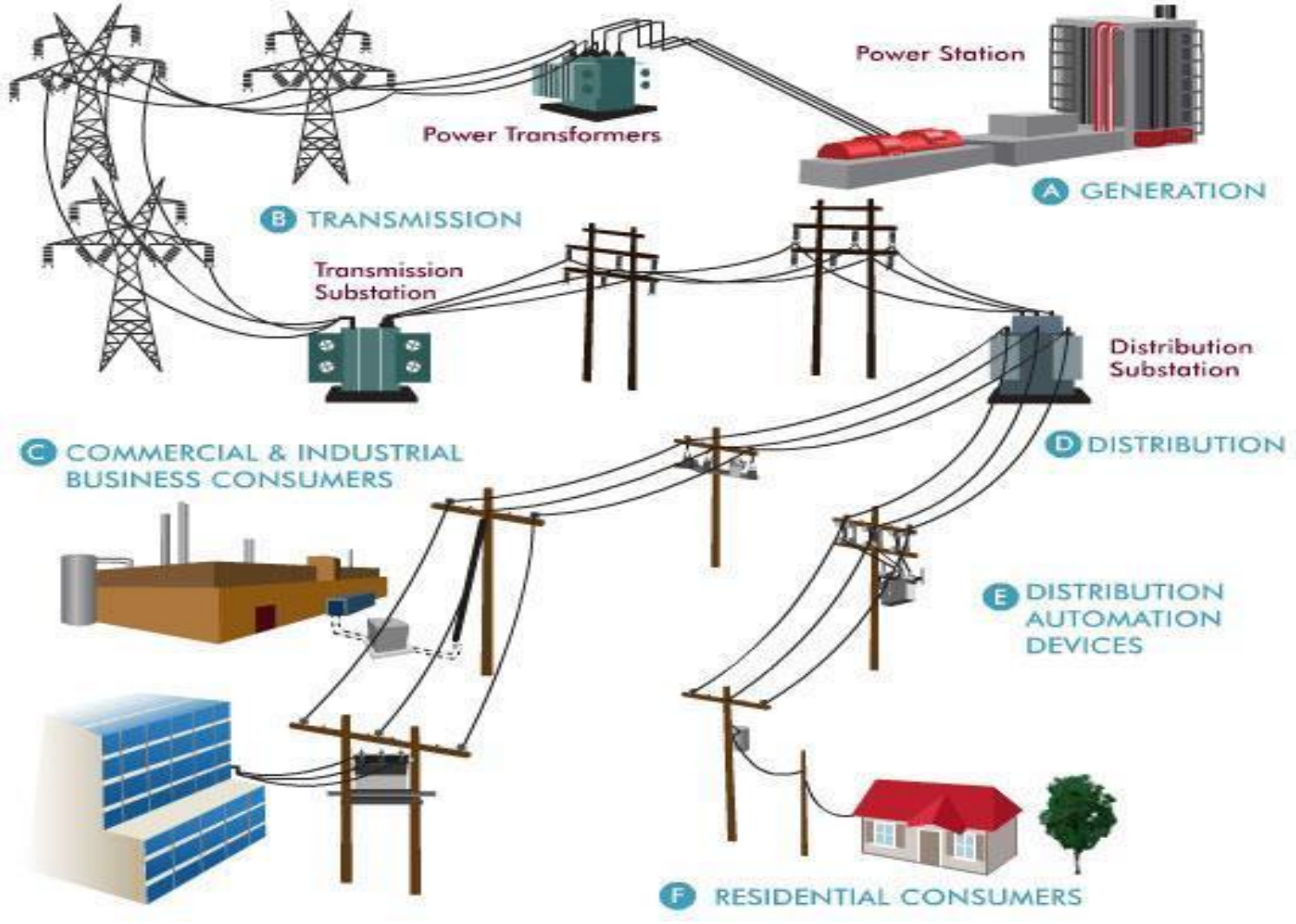
Step 3. Restore system to initial operating conditions.

Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

- **Construction inspection:** 0.5 to 1 hour (depending on availability of construction documentation – i.e. plumbing drawings, material cut sheets, specifications, etc. – as well as sensor calibration)

- **Functional testing:** 2 to 4 hours (depending on familiarity with BAS, method employed to vary operating parameters, verification method for system flow and VFD power)

NRCA-MCH-11A
Automatic Demand Shed Control

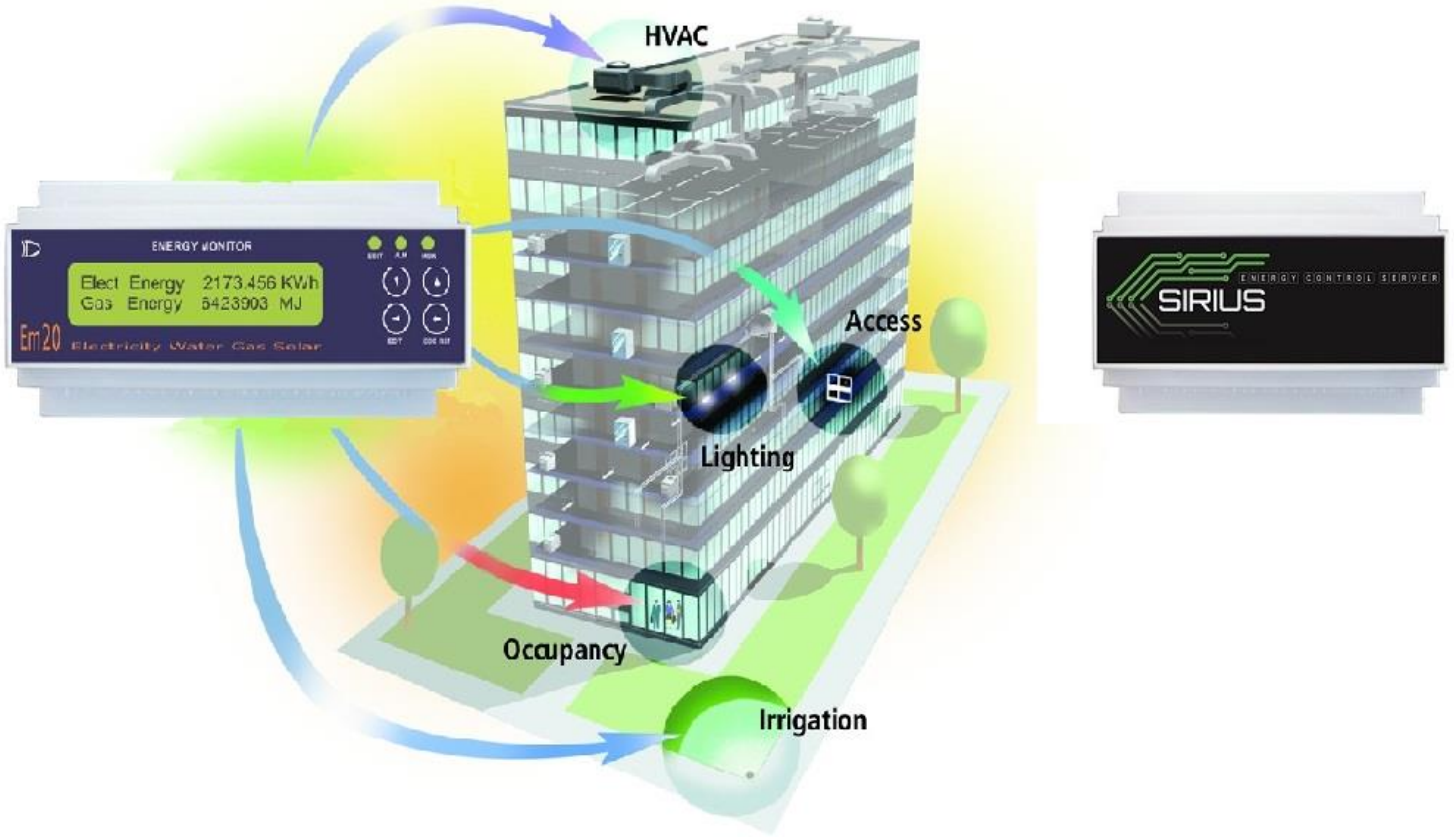


Purpose of the Test:

Is to ensure that all control systems with DDC to the zone level are required to enable centralized demand shed at non-critical control zones from a single software or hardware point in the system §120.2(h).

Field studies have shown that in typical commercial buildings resetting the zone temperatures up by 2°F to 4°F during on-peak times can reduce the peak electrical cooling demand by as much as 30 percent.

Energy Monitoring & Control Systems with (ADR) Automatic Demand Response, Load Shedding and built-in Webserver



Functional Testing

Step 1 Engage the global demand shed system.

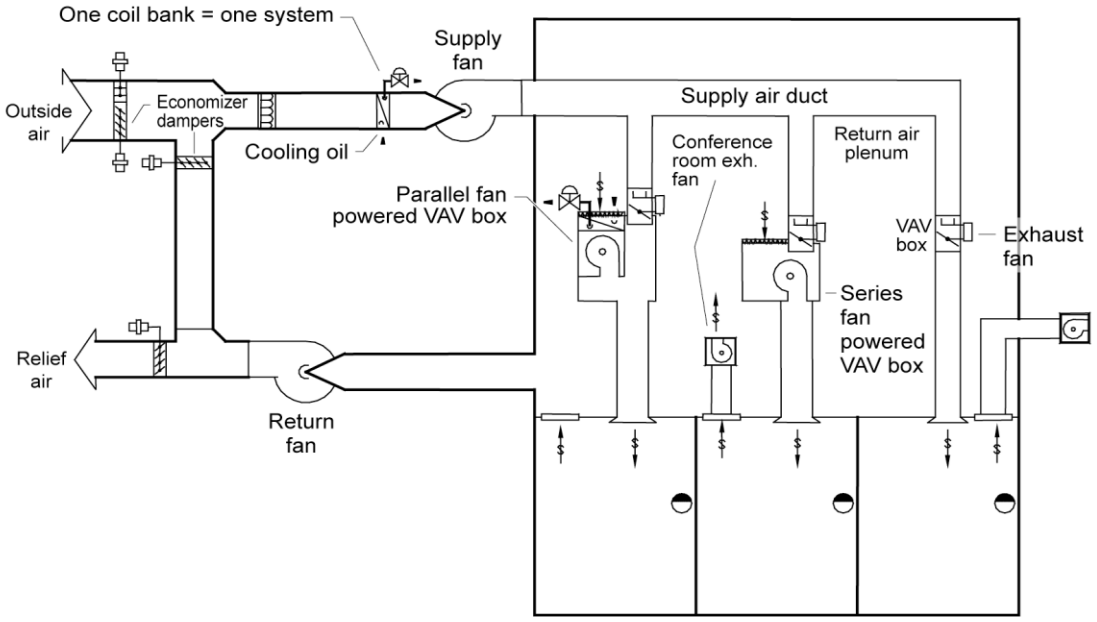
- This can be done by either jumping the digital contact or simply overriding its condition in the EMCS front end. Wait 5-10 minutes to allow the changes take effect.

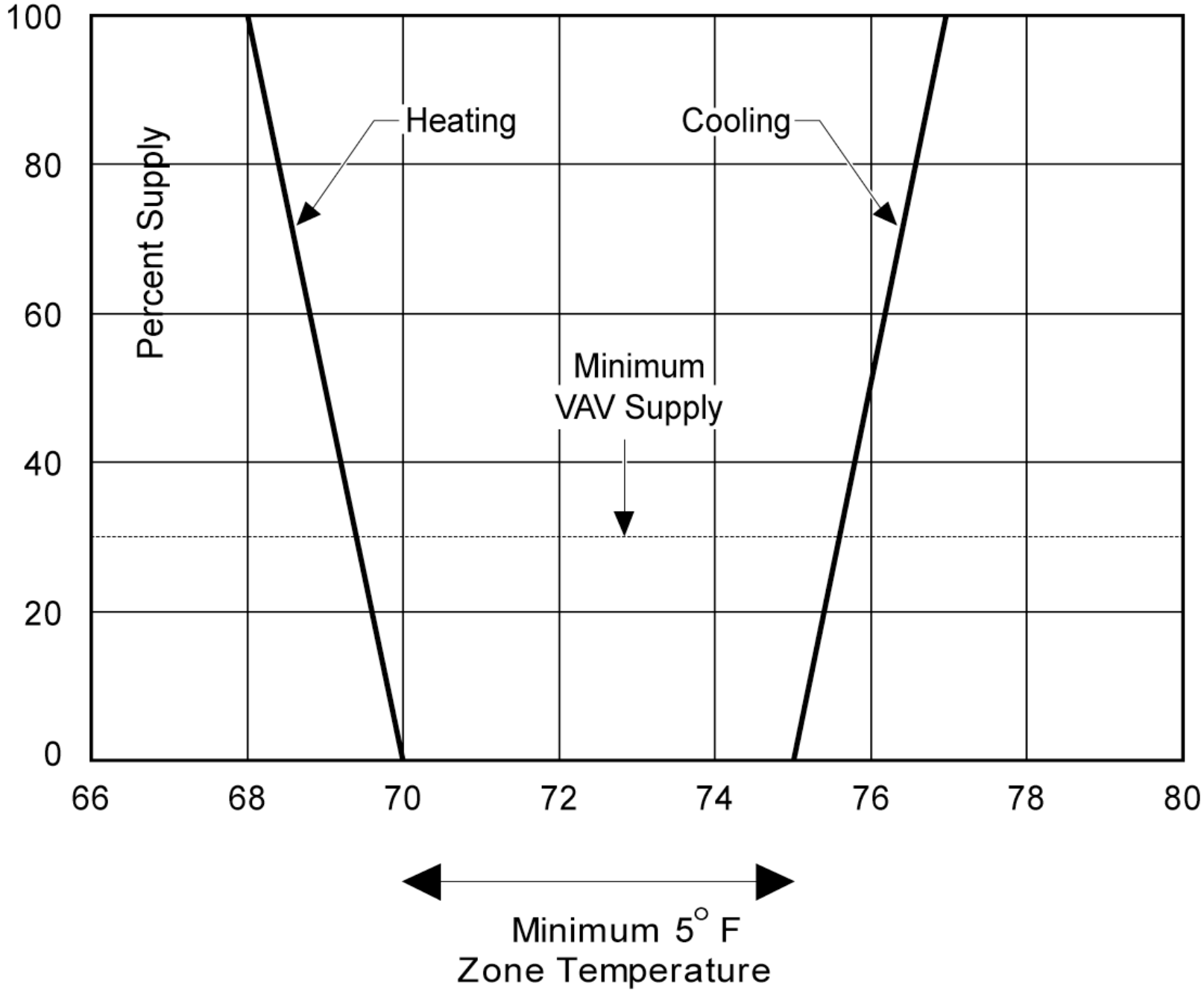
Verify and Document

- Check that the cooling setpoints in the non-critical spaces increase by the proper amount.
- Check that the cooling setpoints in the critical spaces do not change.

Step 2 Disengage the global demand shed system.

- This can be done by either removing the jumper from the digital contact or simply releasing the override of the point in the EMCS front end. Wait 5-10 minutes to allow the changes take effect.




100
80
60
40
20
0
Percent Supply
Heating
Cooling
Minimum
VAV Supply
66
68
70
72
74
76
78
80
Minimum 5° F
Zone Temperature

4.5.1.1 Zone Thermostatic Controls

§120.2(a), (b) and (c)

Thermostatic controls must be provided for each space-conditioning zone or dwelling unit to control the supply of heating and cooling energy within that zone. The controls must have the following characteristics:

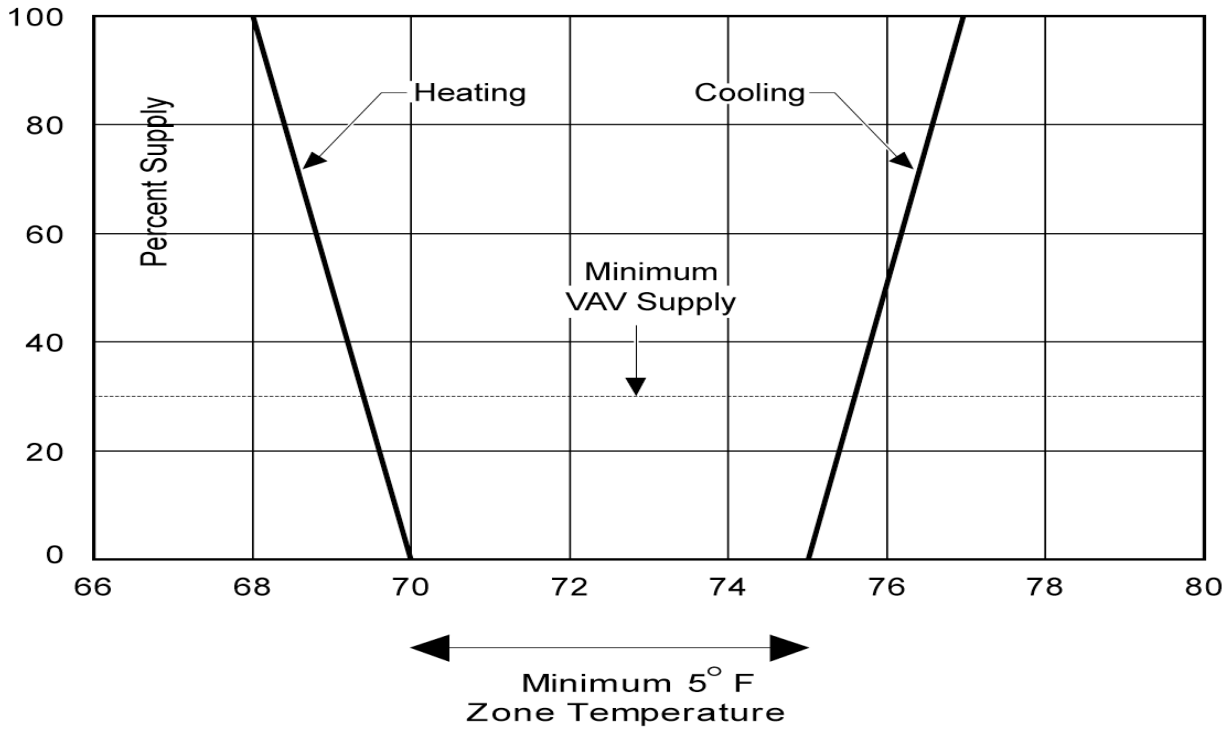
When used to control heating, the thermostatic control must be adjustable down to 55°F or lower.

When used to control cooling, the thermostatic control must be adjustable up to 85°F or higher.

When used to control both heating and cooling, the thermostatic control must be adjustable from 55°F to 85°F and also provide a temperature range or dead band of at least 5°F. When the space temperature is within the dead band, heating and cooling energy must be shut off or reduced to a minimum. A dead band is not required if the thermostat requires a manual changeover between the heating and cooling modes Exception to §120.2(b)3.

For all single zone, air conditioners and heat pumps all thermostats shall have setback capabilities with a minimum of four separate setpoints per 24 hour period. Also the thermostat must comply with the Occupant Controlled Smart Thermostat requirements of Reference Joint Appendix JA5, which is capable of responding to demand response signals in the event of grid congestion and shortages during high electrical demand periods.

Systems equipped with DDC to the zone level, rather than zone thermostats, must be equipped with automatic demand shed controls as per Section 4.5.1.7.



HVAC systems with DDC to the zone level must be programmed to allow centralize demand shed for non-critical zones as follows:

1. The controls shall have the capability to remotely setup the operating cooling temperature set points by four degrees or more in all non-critical zones on signal from a centralized contact or software point within an Energy Management Control System (EMCS).

2. The controls shall also be capable of remotely setdown the operating heating temperature set points by four degrees or more in all non-critical zones on signal from a centralized contact or software point within an EMCS.

3. The controls shall have capabilities to remotely reset the temperatures in all non-critical zones to original operating levels on signal from a centralized contact or software point within an EMCS.

4. The controls shall be programmed to provide an adjustable rate of change for the temperature setup and reset.

5. The controls shall have the following features:

a) The ability to be disabled by authorized facility operators; and

b) The ability to be manually control by authorized facility operators to allow adjustment of heating and cooling set points globally from a single point in the EMCS; and

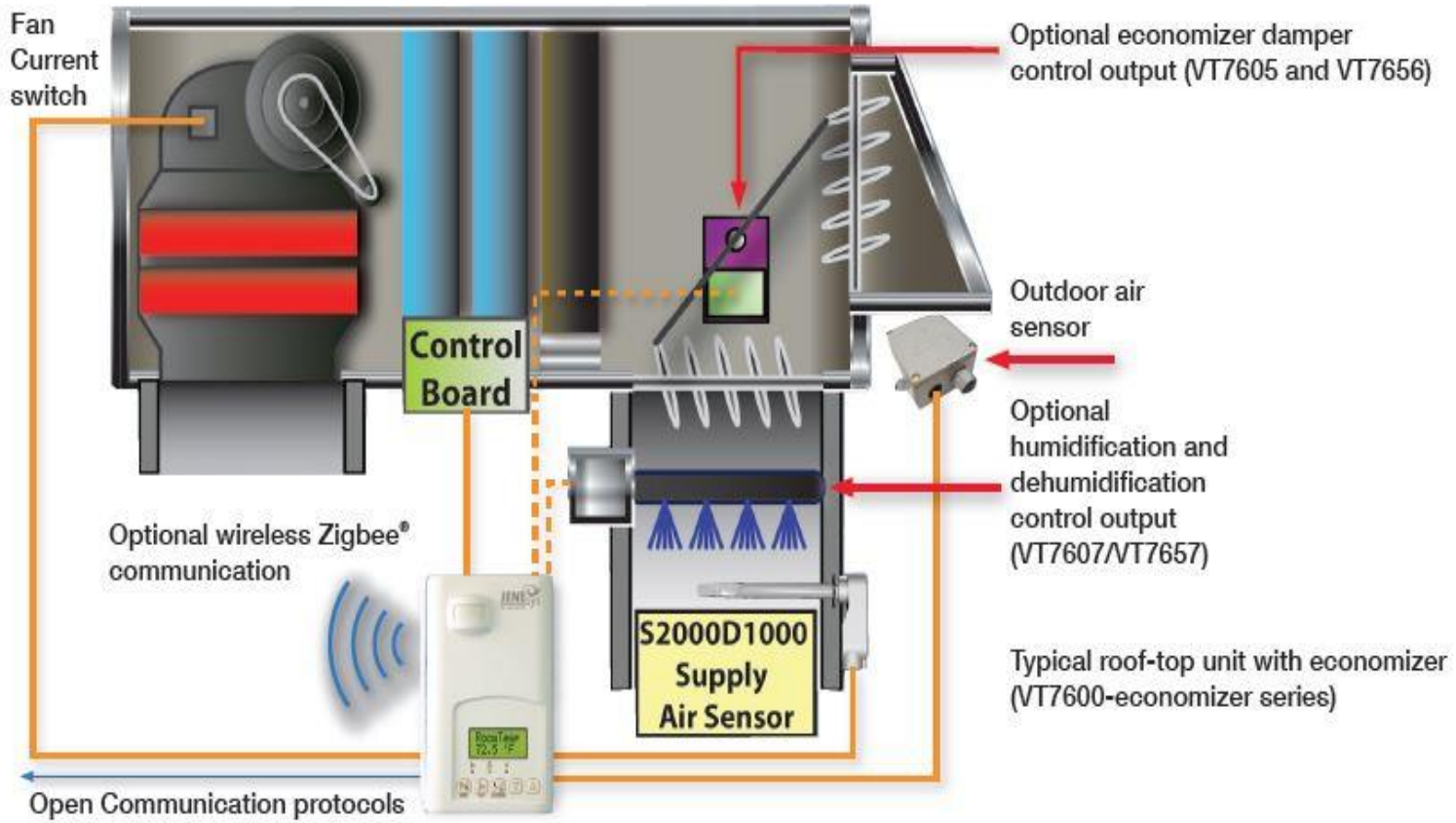
c) Upon receipt of a demand response signal the space-conditioning systems shall conduct a centralized demand shed, as specified in 120.2(h)1 and 120.2(h)2, for non-critical zones during the demand response period.

Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

- **Construction inspection:** 0.5 hour to review the EMCS programming

- **Functional testing:** 0.5 to 1 hour (depending on familiarity with BAS)

NRCA-MCH-12A
Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion (DX) Units Acceptance



Purpose of the Test

The purpose of this test is to verify and notify proper fault detection and reporting for automated fault detection and diagnostics systems for packaged DX units.

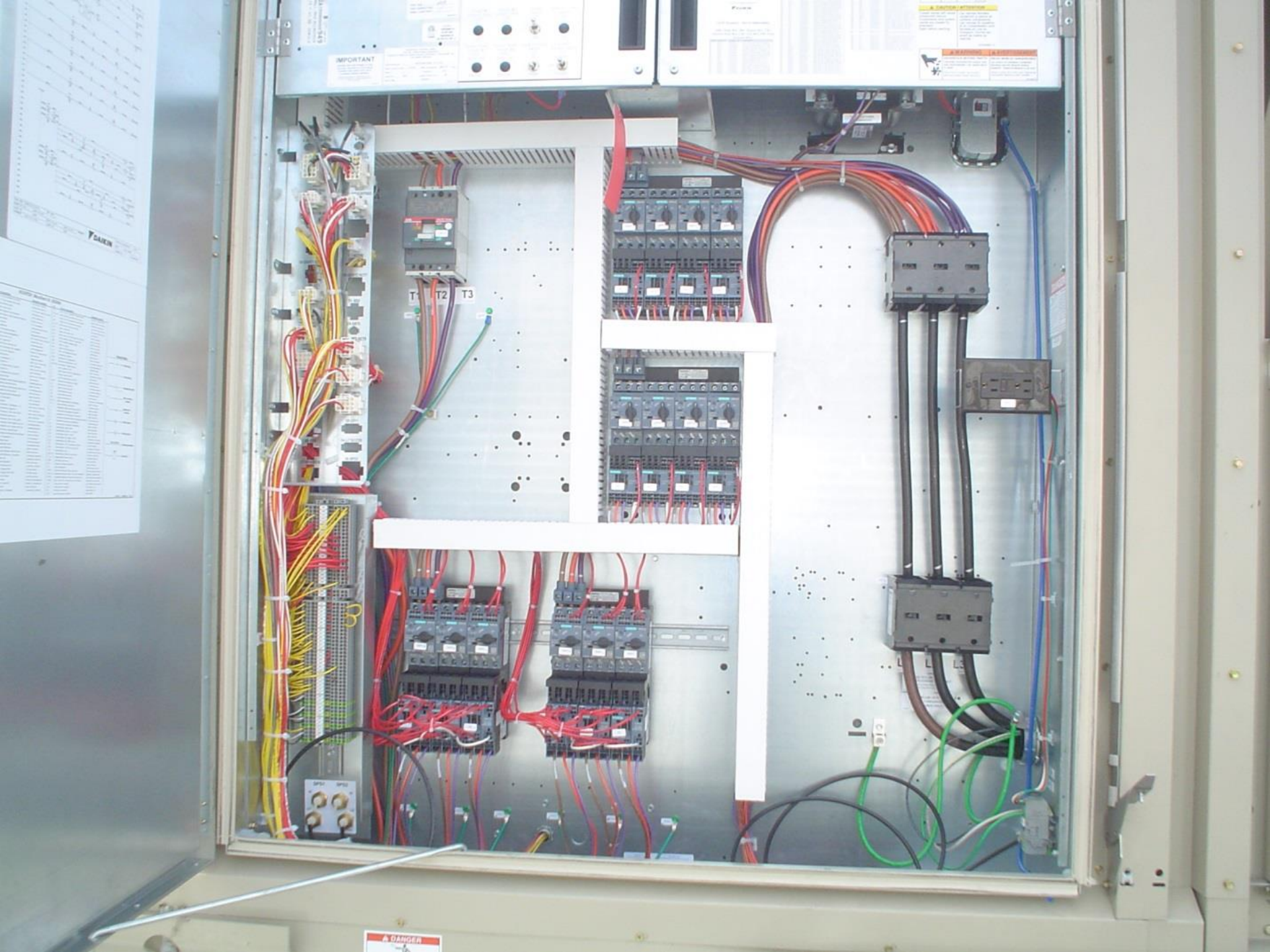
Automated FDD systems ensure proper equipment operation by identifying and diagnosing common equipment problems such as temperature sensor faults, low airflow or faulty economizer operation.

Construction Inspection

Prior to functional testing, verify and document the following:

- Verify that the installed FDD has been certified to the Energy Commission and is listed on the Energy Commission's website

(http://www.energy.ca.gov/title24/equipment_cert/).


IMPORTANT
T1
T2
T3
DANGER

Acceptance Criteria

- The FDD system is able to detect a disconnected outside air temperature sensor and report the fault.
- The FDD system is able to detect excess outside air and report the fault.
- The FDD system is able to detect a stuck outdoor air economizer damper and report the fault.

Functional Testing

For each HVAC unit to be tested do the following:

1. Test 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.

2. Test for Excess Outside Air

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

- If the Mech-2A Outdoor Air passes, verify FDD system indicates normal operation.

3. Test 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 the Mech-5A Air Economizer Controls fails, verify FDD system reports a fault.

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

Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

- **Construction inspection**: 0.5 hour
- **Functional testing**: 1 to 2 hours

NRCA-MCH-13A
Automatic Fault Detection Diagnostics (FDD) for Air Handling Units and Zone Terminal Units Acceptance

Purpose of the Test

Fault detection and diagnostics can also be used to detect common faults with air handling units and zone terminal units (VAV boxes) such as loss of air flow.

LIEBERT DSC DIRECT EXPANSION AIR HANDLER

Acceptance Criteria

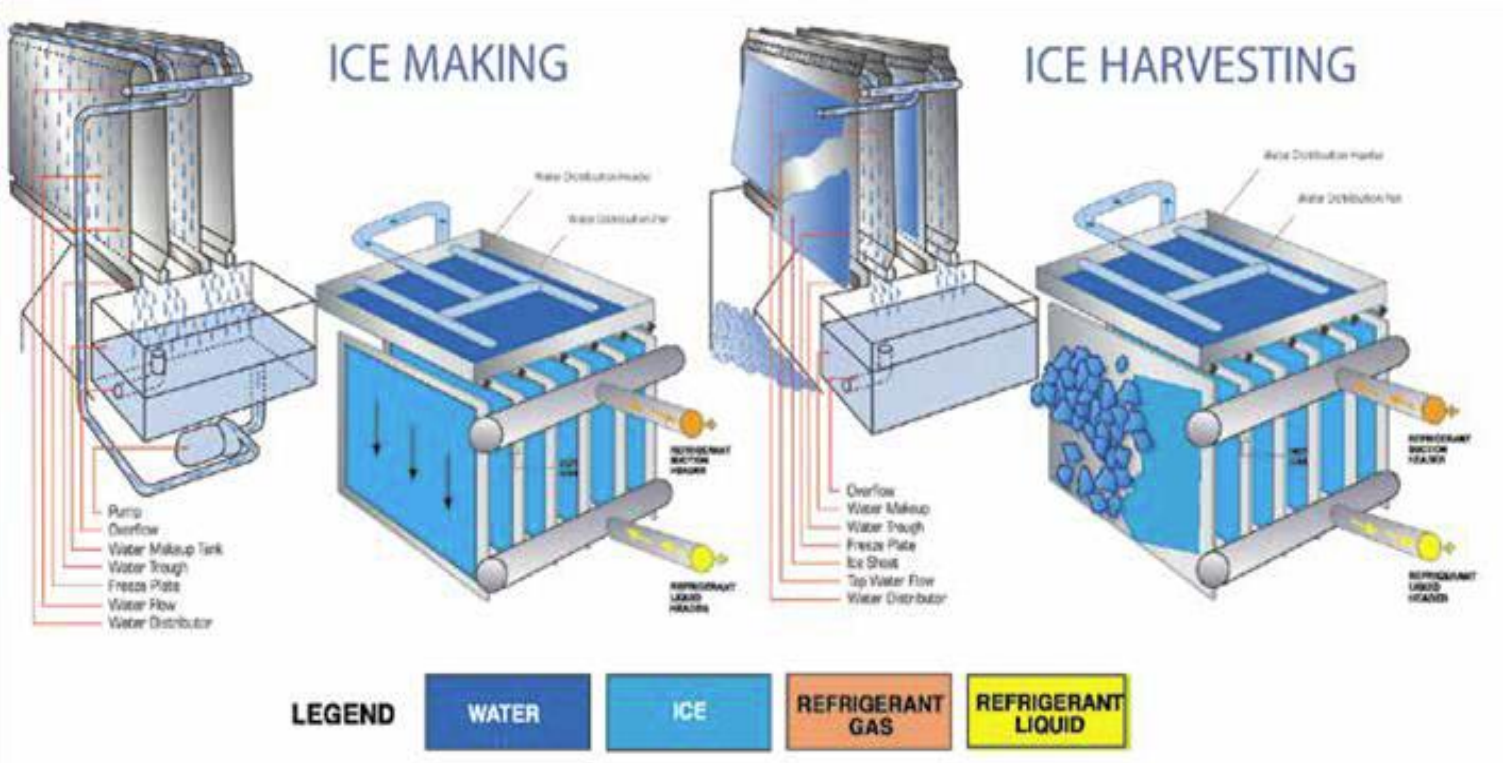
- ✓ The system is able to detect the most common faults with air handling units, such as a sensor failure, a failed damper or actuator or an improper operating mode.

- ✓ The system is able to detect and report these most common faults with zone terminal units, such as a failed damper or actuator or a control tuning issue.

Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

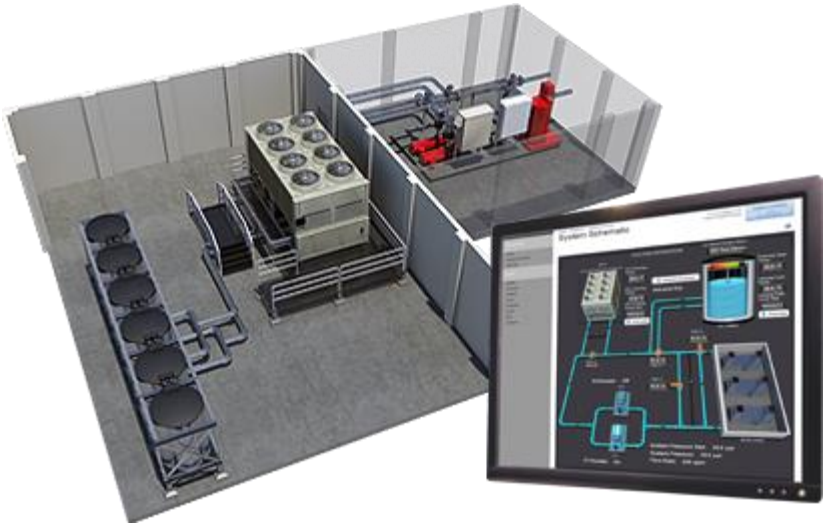
- Acceptance tests will take 1-2 hours for each air handler. It may be helpful to have two persons performing this test. Time for acceptance testing for terminal units depends on the number of boxes to be tested.

NRCA-MCH-14A
Distributed Energy Storage DX AC Acceptance



Purpose of the Test

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



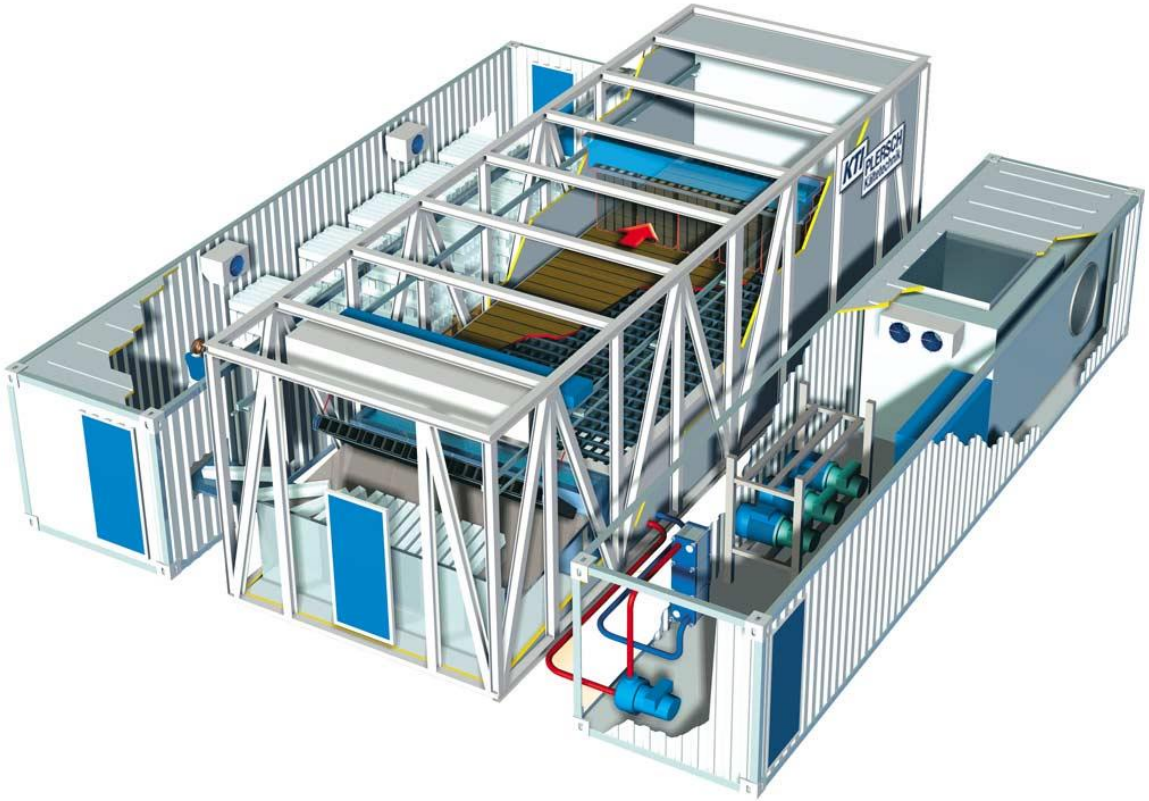
Acceptance Criteria

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

Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

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

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



Purpose of the Test

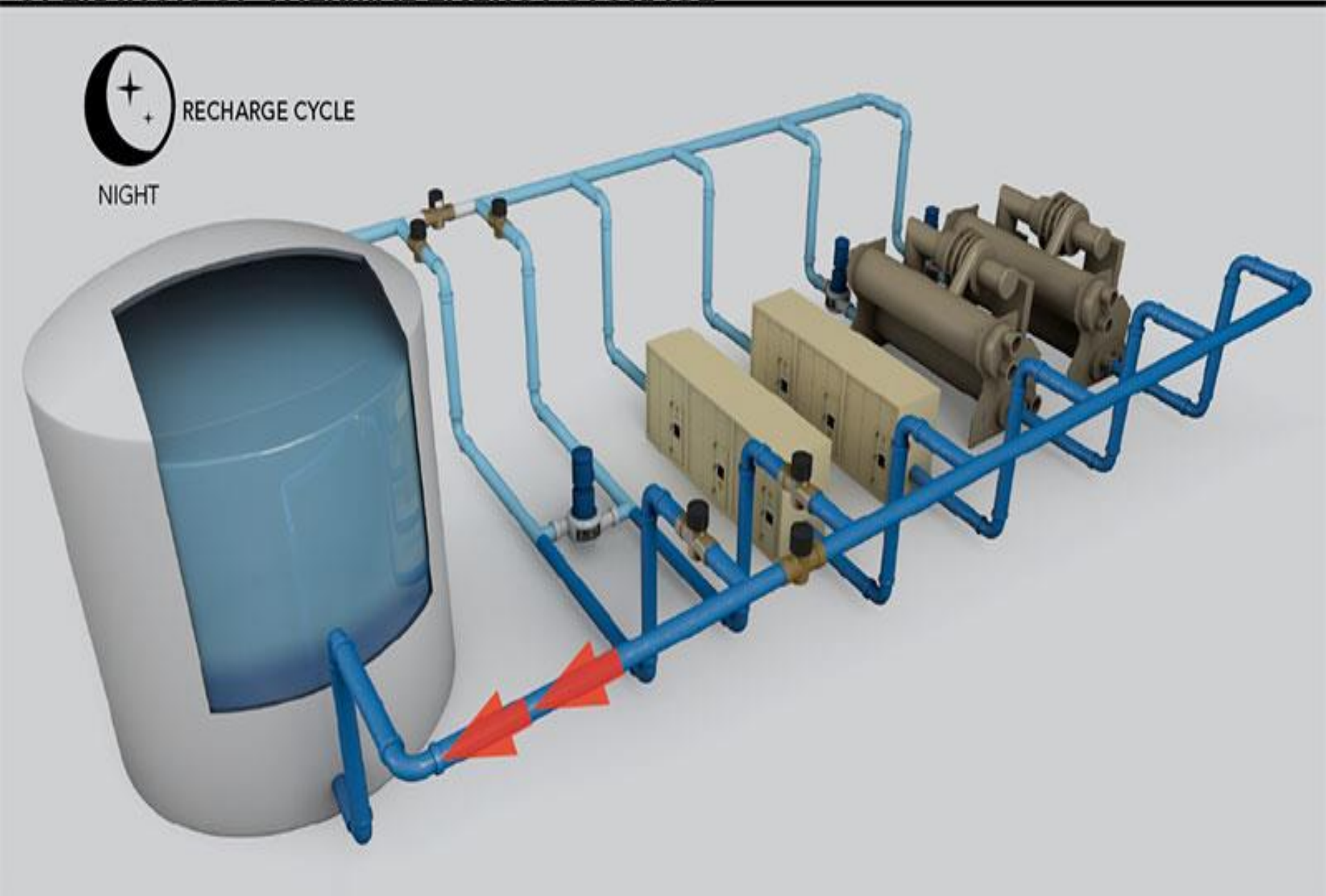
This test confirms proper operation of thermal energy storage (TES) systems.

TES systems reduce energy consumption during peak demand periods by shifting energy consumption to nighttime.

Operation of the thermal energy storage compressor during the night produces cooling energy which is stored in the form of cooled fluid or ice in tanks.

During peak cooling hours the thermal storage is used for cooling to prevent the need for chiller operation.

OPERATION OF THERMAL ENERGY STORAGE



Acceptance Criteria

- The TES system and the chilled water plant is controlled and monitored by an EMS.
- Verify that the TES system stores energy in storage/charge mode.
- Verify that the storage charging is stopped when an end of charge signal is generated.
- Verify that the TES system starts discharging with the compressor(s) off in discharge mode.

- Verify that the TES does not discharge and the cooling load is met by the compressor(s) only in mechanical cooling only mode.

- Verify that the TES discharges with the chiller sharing the load during discharge and mechanical cooling mode.

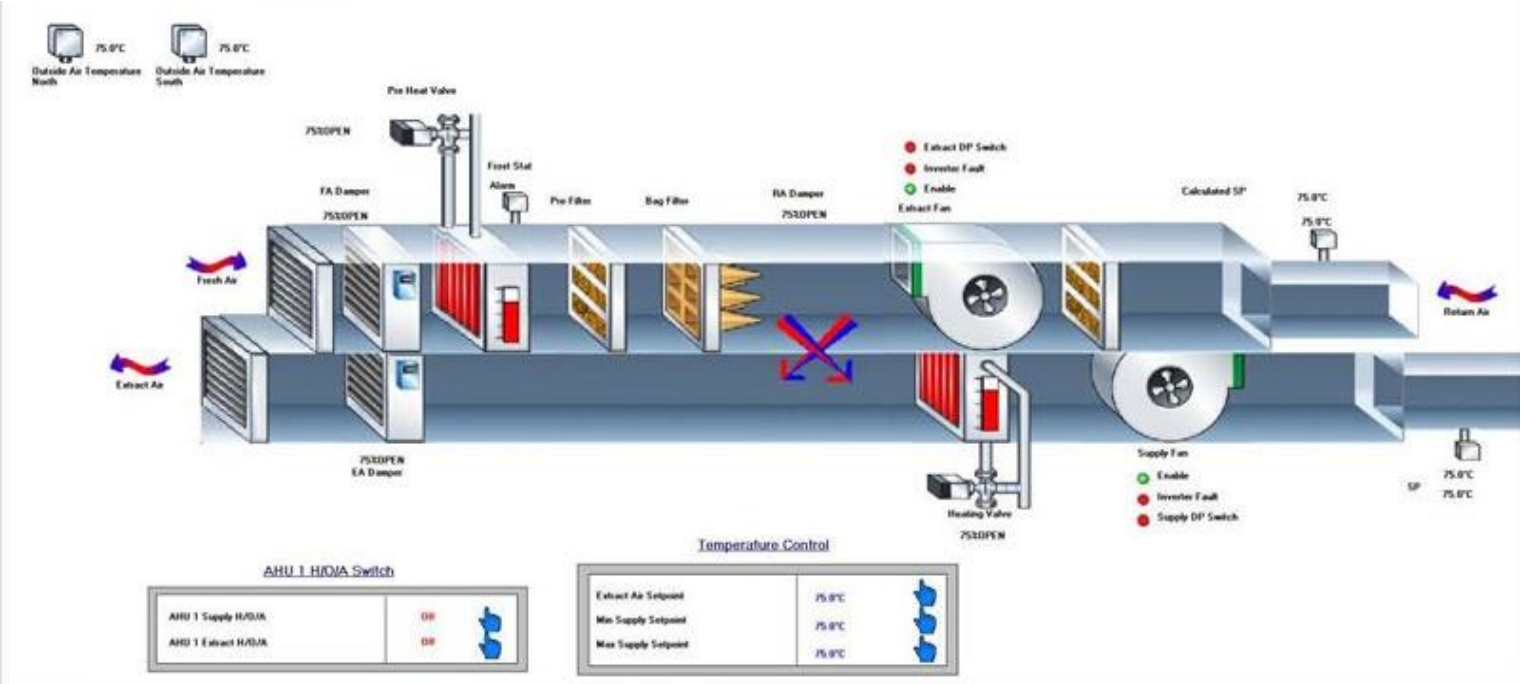
- Verify storage does not discharge and all compressors are off during the off/storage-secure mode.

- When applicable, verify that tanks can be charged while serving in active cooling mode during charge-plus cooling mode.

Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

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

Mech-16A
Supply Air Temperature Reset Controls Acceptance



Purpose of the Test

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

Acceptance Criteria

- Construction Inspection Criteria:

The temperature sensor(s) must be factory calibrated, field calibrated by the Start Up Technician or field checked by test technician with a calibrated standard. Calibration certificate or other supporting documentation must be provided.

Functional Testing: For each system, the test criteria include:

- Supply air temperature controls modulate as intended.

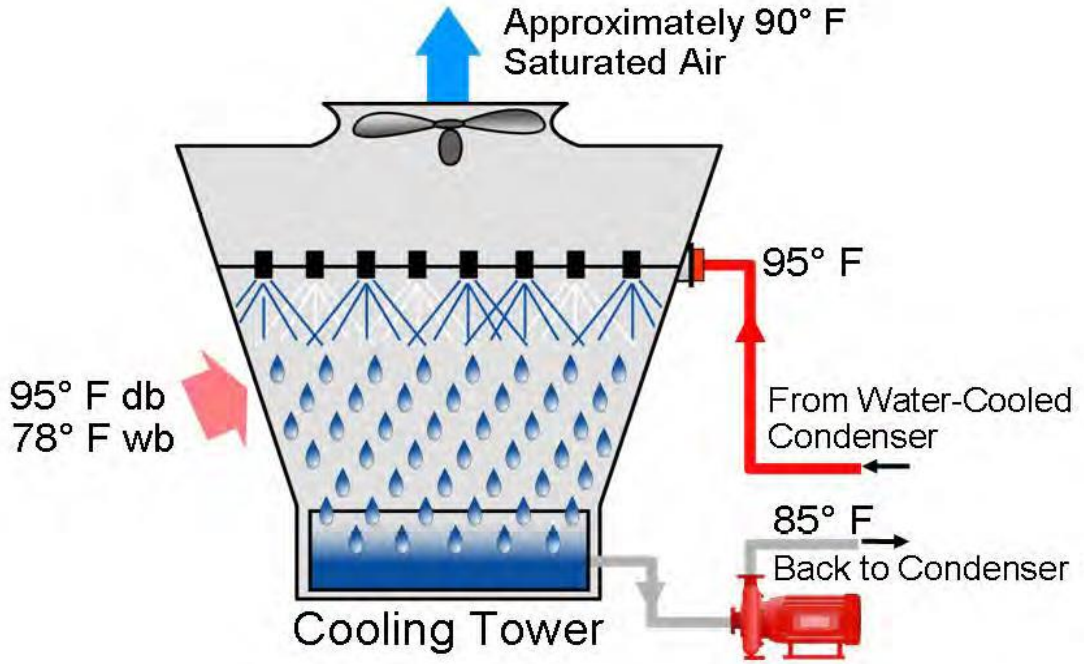
- Actual supply air temperature decreases to meet the new set point within ± 2°F.

- Supply air temperature stabilizes within 15 minutes. Supply air temperature and temperature setpoint must be documented in the acceptance form.

Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

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

NRCA-MCH-17A
Condenser Water Supply Temperature Reset Controls Acceptance



Purpose of the Test

The intent of the test is to verify that the condenser water supply (entering condenser water) temperature is automatically reset as indicated in the control sequences, based on building loads, outdoor air wet bulb temperature, or another appropriate control variable.

All cooling tower system components (e.g. fans, spray pumps) should operate per the control sequences to maintain the proper condenser water temperature and pressure set points as designed.


SPX
Marley

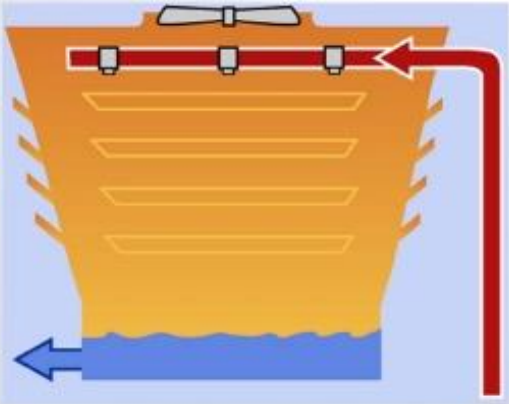
This requirement for condenser water reset acceptance only applies to those chilled water systems with a cooling tower that implement some kind of condenser water temperature reset control.

"**There is no code requirement** that chilled water plants employ this type of control. However, if condenser water temperature reset is implemented, then it must be tested per the Energy Standards.

The purpose of this test is not to evaluate whether a particular control sequence is the most appropriate for the facility, but whether the system follows the intended control sequence".

simple case: constant water flow

Operating Dependencies



- Wet bulb
- Condenser water temperature
- Load
- Tower design

- Load
- Condenser water temperature
- Chiller design

Functional Test: System must meet the following criteria during the test:

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

Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

- **Construction inspection**: 1 to 3 hours (depending on availability of construction documentation – i.e. plumbing drawings, material cut sheets, specifications, etc. – as well as sensor calibration records.)

- **Functional testing**: 2 to 5 hours (depending on familiarity with BAS, method employed to vary operating parameters, ambient conditions, building loads, and time interval between control command and system response)

NRCA-MCH-18A
Energy Management Control System Acceptance

Purpose of the Test

The purpose of this acceptance test is to help ensure the central control system, when installed, is properly installed and configured and capable of meeting the applicable requirements of the “Energy Standards”.

The EMCS is a complex, highly customized control system with many opportunities for installation and programming problems. Obviously it is important to identify, diagnose, and resolve these problems. This acceptance test can help assist with this effort.

Verification Checks

Conduct the following verification checks to validate the functionality of the EMCS:

- Verify the control graphics represent the system configuration
- Verify control points are properly mapped to the graphics screen
- Raise and lower a sampling of space temperature setpoints in the software and verify the system responds appropriately
- Verify the time-of-day start-up and shut-down function initiates a proper system response
- Verify trending capabilities by establishing trend logs for a sampling of control points
- Verify alarm conditions are monitored
- Verify the EMCS panel is installed on an emergency power circuit or has adequate battery back-up

Estimated Time to Complete –
(time given is an estimate given by the CEC and must not be taken as time required to perform this test).

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

How do you become a Certified Mechanical Acceptance Test Technician?

UA locals approved by the California State Pipe Trades Council will offer training and certification to UA members in good standing. To be approved a local must have certified UA instructors and mechanical equipment available for hands-on training.

The Title 24 Certification Course will include the following:

- Minimum 40 hours of classroom instruction and hands-on equipment labs.
- Theoretical training on the content of the current Building Energy Efficiency Standards.
- Hands-on instruction for appropriate understanding of the physical testing of the mechanical equipment.
- One instructor to fifteen trainees for lab/hands-on instruction.
- Written and practical hands-on testing to demonstrate competence of each participant.
- Continued education will be mandatory and apply only to future updates to the Building Energy Efficiency Standards.

What are the requirements to become a Certified Mechanical Acceptance Test Technician through the CSPTC?

- You must be a Journeyman who has gone through the five year apprenticeship.
- You must pass the Start, Test and Balance Course.
- You must pass the HVACR Star Mastery Exam.
- You must pass the Green Professional (GPRO) Course.
- You Must Pass the Energy Audit Course.

To perform Mechanical Acceptance Testing you must be employed by a signatory Certified Acceptance Test Employer in good standing with the local.

The Acceptance Test Technician must be certified for the each Form, conducted all tests required by the Form, and sign the Form. No part of these three functions may be delegated.

Additionally, an Acceptance Test Technician must be employed by a Certified Employer (ATE) in order to perform tests, and complete and sign Forms.

Certification Revocation Procedures.

The ATTCPs shall describe in their applications to the Energy Commission procedures for revoking their certification of ATTs and ATEs based upon poor quality or ineffective work, failure to perform acceptance tests, falsification of documents, failure to comply with the documentation requirements of these regulations or other specified actions that justify decertification.

How do you become a Certified Acceptance Test Employer?

- You must take and pass the minimum four hour Acceptance Test Employer (ATE) training course.

- The ATE course exam is twenty-five questions.

Restrictive employment practices: the ATTCP may restrict the ATE from employing an ATT that is certified by a different ATTCP.

Additionally, the ATTCP may restrict the ATE from holding certificates from multiple ATTCPs.

Quality Assurance Control

The regulations require that the ATTCP review a random sample of no less than 1 percent of each technician's completed compliance documents, and perform randomly selected on-site audits of no less than 1 percent of each ATT's completed acceptance tests. The consequences of failed audits should be fully described by the ATTCP. ATTCPS might consider whether to require a higher percentage of document and on-site audits the first few years of operation in order to ensure that any initial issues with training or compliance are identified and addressed.

ATTCPs have the authority to decertify ATTs and ATEs based upon poor quality or ineffective work, failure to perform acceptance tests, falsification of documents, failure to comply with the documentation requirements of these regulations or other specified actions that justify decertification.

The CSPTC will include quality assurance, independent oversight and accountability measures, such as, independent oversight of the certification processes and procedures, visits to building sites where certified ATTs are completing acceptance tests, certification process evaluations, enforcement agency surveys to determine acceptance testing effectiveness, and expert review of the training curricula developed for the Standards.

Digital Data Registry

Once a data registry service provider has been established, requirements for documentation procedure called registration will take effect. Registration documentation is required for the construction and alteration of any nonresidential buildings.

Compliance documents submitted to an approved nonresidential data registry shall be certified and signed by the applicable responsible person (§10-103).

On the last page of the Form the Technician, the Document Author, and the Responsible Party are required to complete the acknowledgements and sign the Form.

The Registry allows this to be done digitally. Signatures may be manual on printed copies or digital “on file” signatures added to the PDF.

When registration is required, parties responsible for completing and submitting compliance documents (Certificate(s) of Compliance, Certificate(s) of Installation, and Certificate(s) of Acceptance) must submit the compliance document(s) electronically to an approved nonresidential data registry for registration and retention.

The Authority Having Jurisdiction (AHJ) or code enforcement official will have access to hard or digital copies from the Responsible Party, and directly within the Registry database. The AHJ will have real-time access to any Project information filed with the Registry. Additionally, the AHJ can verify credentials, Form fingerprint, and mechanical acceptance test validity instantly.

The submittal of the completed Acceptance Forms are required prior to the issuance of the Certificate of Occupancy.

Thank You

The California State Pipe Trades Council

Ensuring a strong economy while protecting the health and safety of all Californians!