



DRAFT HVAC Functional Testing Checklist¹

ENERGY STAR Multifamily New Construction Version 1.0 / 1.1

Note: This is a draft of a work in progress for the purposes of stakeholder feedback. There may be errors with formatting, numbering, etc.

HVAC Functional Testing Responsibilities:

- The entity performing Functional Testing (“FT Agent”) must either be a Certified Commissioning Professional (CCP), a Certified Building Commissioning Professional (CBCP), a Building Commissioning Professional (BCxP, formerly the Commissioning Process Management Professional (CPMP)), a NEBB Certified Technician (BSC CxCT) or Certified Professional (BSC CP or CxPP), a representative of the Original Equipment Manufacturer (OEM), or a contractor credentialed by an HVAC Quality Installation Training and Oversight organization (H-QUITO) to complete this checklist.²
- Functional Testing checklists must be completed and signed by an “FT Agent”. An “FT Agent” is permitted to complete just the specific sections of this checklist that pertain to their area of expertise. However, all applicable sections must be completed by an “FT Agent”. Multiple “FT Agents” may be needed for one project.
- Functional Testing checklists must include all HVAC systems in the building/project that serve the dwelling units or common spaces, but may exclude systems solely serving commercial/retail spaces. Multiple checklists will be needed to document all HVAC systems in the building/project. No items on the Functional Testing Checklist are permitted to be verified using a sampling protocol.
- The completed checklists, along with the corresponding HVAC Design Report, shall be retained by the “FT Agent” for quality assurance purposes. Furthermore, if the “FT Agent” is not a credentialed contractor, they shall provide the completed and signed checklists to the builder/developer and the Rater responsible for certifying the units/building, prior to the project’s certification. Credentialed contractors shall provide the checklist upon request.

1. Functional Testing Overview

- 1.1 Company performing Functional Testing _____ Contractor/LP name _____ Date _____
- 1.2 If applicable, H-QUITO that your company is credentialed with: ACCA Advanced Energy
- 1.3 Builder/developer client name: _____
- 1.4 Project address: _____ City: _____ State: _____ Zip code: _____
- 1.5 HVAC Design Report corresponding to this project has been collected from designer or builder.
- 1.6 Checklist applies to the following equipment: _____

2. Refrigerant Charge - Run system for 15 minutes before testing. If outdoor ambient temperature at the condenser is $\leq 55^{\circ}\text{F}$ or, if known, below the manufacturer-recommended minimum operating temperature for the cooling cycle, then the system shall include a TXV, the outdoor temperature shall be recorded in Item 2.1, and the contractor shall check “N/A” in this Section.³ This section must be completed for split air conditioners, unitary air conditioners, air-source heat pumps, and water-source (i.e., geothermal or water-loop) heat pumps up to 65 kBtuh with forced-air distribution systems (i.e., ducts > 0 ft), whether serving dwelling units or other common spaces in the building. All other permutations of refrigerant-based systems such as ducted or non-ducted mini-split / multi-split systems are exempt from this section.

	“FT Agent” Verified	N/A
2.1 Outdoor ambient temperature at condenser: _____ °F DB	-	-
2.2 Return-side air temperature inside duct near evaporator, during cooling mode: _____ °F WB	-	<input type="checkbox"/>
2.3 Liquid line pressure: _____ psig	-	<input type="checkbox"/>
2.4 Liquid line temperature: _____ °F DB	-	<input type="checkbox"/>
2.5 Suction line pressure: _____ psig	-	<input type="checkbox"/>
2.6 Suction line temperature: _____ °F DB	-	<input type="checkbox"/>
For System with Thermal Expansion Valve (TXV):		
2.7 Condenser saturation temperature: _____ °F DB (Using Item 2.3)	-	<input type="checkbox"/>
2.8 Subcooling value: _____ °F DB (Item 2.7 - Item 2.4)	-	<input type="checkbox"/>
2.9 OEM subcooling goal: _____ °F DB	-	<input type="checkbox"/>
2.10 Subcooling deviation: _____ °F DB (Item 2.8 – Item 2.9)	-	<input type="checkbox"/>
For System with Fixed Orifice:		
2.11 Evaporator saturation temperature: _____ °F DB (Using Item 2.5)	-	<input type="checkbox"/>
2.12 Superheat value: _____ °F DB (Item 2.6 – Item 2.11)	-	<input type="checkbox"/>
2.13 OEM superheat goal: _____ °F DB (Using superheat tables and Items 2.1 & 2.2)	-	<input type="checkbox"/>
2.14 Superheat deviation: _____ °F DB (Item 2.12 – Item 2.13)	-	<input type="checkbox"/>
2.15 Item 2.10 is $\pm 3^{\circ}\text{F}$ or Item 2.14 is $\pm 5^{\circ}\text{F}$	<input type="checkbox"/>	<input type="checkbox"/>
2.16 An OEM test procedure (e.g., as defined for a ground-source heat pump) has been used in place of the sub-cooling or super-heat process and documentation has been attached that defines this procedure	<input type="checkbox"/>	<input type="checkbox"/>



DRAFT HVAC Functional Testing Checklist¹

ENERGY STAR Multifamily New Construction Version 1.0 / 1.1

3. Indoor HVAC Fan Airflow - This section must be completed for split air conditioners, unitary air conditioners, air-source heat pumps (including multi-splits), and water-source (i.e., geothermal or water-loop) heat pumps up to 65 kBtuh with forced-air distribution systems (i.e., ducts) and to furnaces up to 225 kBtuh with forced-air distribution systems (i.e., ducts > 0 ft), whether serving dwelling units or other common spaces in the building. Mini-splits, ducted or non-ducted, are exempt, however multi-split systems such as central VRF systems, where indoor HVAC fans with forced-air distribution are connected to a shared outdoor unit that exceeds 65 kBtuh, are not exempt.				
3.1 The mode with the higher design HVAC fan airflow used, per Item 5.2 of HVAC Design Report: <input type="checkbox"/> Heating <input type="checkbox"/> Cooling	<input type="checkbox"/>	-		
3.2 Static pressure test holes have been created, and test hole locations are well-marked and accessible.	<input type="checkbox"/>	-		
Test hole location for return external static pressure: <input type="checkbox"/> Plenum <input type="checkbox"/> Cabinet <input type="checkbox"/> Transition <input type="checkbox"/> Other: _____	-	-		
Test hole location for supply external static pressure: <input type="checkbox"/> Plenum <input type="checkbox"/> Cabinet <input type="checkbox"/> Transition <input type="checkbox"/> Other: _____	-	-		
3.3 Measured return external static pressure (Enter value only, without negative sign): _____ IWC	-	-		
3.4 Measured supply external static pressure (Enter value only, without positive sign): _____ IWC	-	-		
3.5 Measured total external static pressure = Value-only from Item 3.3 + Value-only from Item 3.4 = _____	-	-		
3.6 Measured (Item 3.5) - Design (Item 5.2 on HVAC Design Report) total external static pressure = _____ IWC	-	-		
3.7 Measured HVAC fan airflow, using Item 3.5 and fan speed setting: _____ CFM	-	-		
3.8 Measured HVAC fan airflow (Item 3.7) is \pm 15% of design HVAC fan airflow (Item 5.2 on HVAC Design Report)	<input type="checkbox"/>	-		
4. Air Balancing of Supply Registers & Return Grilles (Recommended, but not Required)⁴				
4.1 Balancing report attached with room-by-room design airflows from Item 5.2 on HVAC Design Report, and contractor-measured airflow using ANSI / ACCA 5 QI-2015 protocol	<input type="checkbox"/>	<input type="checkbox"/>		
4.2 Room-by-room airflows verified by contractor to be within the greater of \pm 20% or 25 CFM of design airflow	<input type="checkbox"/>	<input type="checkbox"/>		
5. Functional Testing: Indoor/Terminal Units - This section must be completed for all heating and cooling equipment located within dwelling units or common spaces, including systems identified in Sections 2 and 3, except where specifically noted. Indoor/terminal units include, but are not limited to, mini-splits, PTAC's, PTHP's, WLHP's, fan coils, and hydronic distribution systems.		Rater Verified	"FT Agent" Verified	N/A
5.1 Installation Checks				
5.1.1 Zone thermostat (or remote zone temperature sensor) in dwelling units installed in design location, within the zone being served, and not on an exterior wall	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.1.2 Where specified by design, external condensate pump installed and condensate drain pan drains to a conspicuous point of disposal in case of blockage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.2 Functional Testing				
5.2.1 Zone temperature displayed on thermostat or sensor is within 5°F of measured zone temperature	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.2.2 System turns on when there is a call for heat and heating is provided. System turns off when the heating setpoint has been met. For forced air systems: Measured discharge air temperature ____ °F	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.2.3 System turns on when there is a call for cooling and cooling is provided. System turns off when the cooling setpoint has been met. For forced air systems: Measured discharge air temperature ____ °F	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.2.4 Measure and record the inlet and outlet condenser, chilled, or hot-water temperatures at the terminal unit. Cooling mode: Inlet ____ °F Outlet ____ °F Heating mode: Inlet ____ °F Outlet ____ °F	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.2.5 Where OA dampers are installed, the damper closes when there is no call for ventilation or when fan is off	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.2.6 If more than one system provides heating or cooling to the same space, controls prevent simultaneous heating and cooling	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6. VRF Outdoor Unit - This section must be completed for all VRF outdoor units serving dwelling units or common spaces.		"FT Agent" Verified	N/A	
6.1 Installation Checks				
6.1.1 Pressure testing on refrigerant piping has been completed for this system (indicate exact test in/test out pressure (psig)/time (hours)): _____/_____/_____	<input type="checkbox"/>	<input type="checkbox"/>		
6.1.2 Vacuum testing has been completed (indicate exact test in/test out pressure (microns)/time (hours)): _____/_____/_____	<input type="checkbox"/>	<input type="checkbox"/>		
6.1.3 Refrigerant line lengths have been field measured	<input type="checkbox"/>	<input type="checkbox"/>		
6.1.4 Indicate required additional charge amount (lbs): _____	<input type="checkbox"/>	<input type="checkbox"/>		
6.2 Functional Testing				
6.2.1 In cooling mode ⁵ , the outdoor unit fan is ON and heat is being rejected. Measure and verify that outdoor unit fan discharge air temperature is warmer than the ambient air temperature	<input type="checkbox"/>	<input type="checkbox"/>		
6.2.2 In heating mode ⁵ , the outdoor unit fan is ON and heat is being absorbed. Measure and verify that outdoor unit fan discharge air temperature is colder than the ambient air temperature	<input type="checkbox"/>	<input type="checkbox"/>		
6.2.3 Using the central maintenance tool or controller, none of the outdoor units or connected indoor units are showing an alarm	<input type="checkbox"/>	<input type="checkbox"/>		



DRAFT HVAC Functional Testing Checklist¹

ENERGY STAR Multifamily New Construction Version 1.0 / 1.1

6.2.4 Using the central maintenance tool, the manufacturer's representative confirmed refrigerant charge test per manufacturer's guidelines	<input type="checkbox"/>	<input type="checkbox"/>
7. Central Boilers - This section must be completed for all central boilers serving dwelling units or common spaces.	"FT Agent" Verified	N/A
7.1 Installation Checks		
7.1.1 Boiler piping and all components are free from leaks	<input type="checkbox"/>	<input type="checkbox"/>
7.1.2 Boiler relief valves and discharge piping do not show signs of weeping or leakage	<input type="checkbox"/>	<input type="checkbox"/>
7.1.3 No signs of blockage, leakage, or deterioration in the fresh air intake or flue gas vent piping	<input type="checkbox"/>	<input type="checkbox"/>
7.1.4 Temperature, pressure gauges, air eliminator, expansion tank, check valves and all other piping components installed as specified by HVAC Designer	<input type="checkbox"/>	<input type="checkbox"/>
7.1.5 Boiler supply/header temperature sensor and, where applicable, outdoor air temperature sensor, are located as specified by HVAC Designer	<input type="checkbox"/>	<input type="checkbox"/>
7.1.6 Indicate boiler header/supply setpoint type: <input type="checkbox"/> Fixed <input type="checkbox"/> Seasonal <input type="checkbox"/> Outdoor temperature reset <input type="checkbox"/> Indoor temperature reset <input type="checkbox"/> Other: _____	<input type="checkbox"/>	<input type="checkbox"/>
7.1.7 Where outdoor air temperature reset schedule is applicable, indicate reset schedule (e.g., 180°F Supply @ 10°F outdoor, 120°F supply @ 55°F outdoor) _____ @ _____, _____ @ _____	<input type="checkbox"/>	<input type="checkbox"/>
7.1.8 Where Warm Weather Shut Down (WWSD) is applicable, list temperature (NA if boilers and system pumps also serve DHW)	_____°F	<input type="checkbox"/>
7.2 Functional Testing: Boilers		
7.2.1 Measure the combustion gas efficiency at high fire and low fire for one of the boilers. Note which one and record information. _____% <input type="checkbox"/> high fire <input type="checkbox"/> low fire	<input type="checkbox"/>	<input type="checkbox"/>
7.2.2 Boiler combustion air intake dampers open/close with boiler operation	<input type="checkbox"/>	<input type="checkbox"/>
7.2.3 If each boiler has its own dedicated boiler circulator pump, it operates only when the respective boiler is firing. (Circulator pump may run for a short period of time before or after the boiler fires, as recommended by the equipment manufacturer.)	<input type="checkbox"/>	<input type="checkbox"/>
7.2.4 When there is a call for heating, the boiler(s) are enabled according to their design sequence of operation	<input type="checkbox"/>	<input type="checkbox"/>
7.2.5 If multiple boilers are supposed to fire at the same time according to the Engineer of Record's Sequence, all boilers operate with a large enough heating demand	<input type="checkbox"/>	<input type="checkbox"/>
7.2.6 Boiler(s) modulate/step down to the minimum firing rate before shutting off	<input type="checkbox"/>	<input type="checkbox"/>
7.2.7 Boiler(s) do not short cycle (i.e., the minimum on time is 5 minutes and the minimum off time is 5 minutes, or as recommended by the boiler manufacturer to prevent short cycling)	<input type="checkbox"/>	<input type="checkbox"/>
7.2.8 Condensing Boiler: Boiler return temperature is appropriate for condensing. Measured temp: _____°F	<input type="checkbox"/>	<input type="checkbox"/>
7.2.9 Boiler supply/header temperature sensor is reading within 3°F of measured boiler supply/header temperature	<input type="checkbox"/>	<input type="checkbox"/>
7.3: Functional Testing: Heating System Pumps		
7.3.1 Where heating system pumps (i.e., the pumps which are responsible for moving the water through the terminal units) are equipped with a VFD which is responding to a pressure sensor within the system or a sensorless pumping system, indicate which one. VFD+Sensor <input type="checkbox"/> Sensorless <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.3.2 If a variable speed pumping system is installed, the VFD increases and decreases pump speed in response to changes in the system	<input type="checkbox"/>	<input type="checkbox"/>
7.3.3 If a variable speed pumping system is installed, system prevents "dead-heading". (May be tested under real or simulated low flow conditions.) Select the method of water flow bypass: <input type="checkbox"/> Minimum Flow Bypass Valve <input type="checkbox"/> 3 way valves on specific terminal units <input type="checkbox"/> Other	<input type="checkbox"/>	<input type="checkbox"/>
7.3.4 Pumps are off when outside air temperature is above WWSD (N/A if pumps serve DHW as well as heating)	<input type="checkbox"/>	<input type="checkbox"/>
8. Cooling Towers -This section must be completed for all cooling towers serving dwelling units or common spaces.	"FT Agent" Verified	N/A
8.1 Installation Checks		
8.1.1 Cooling Tower piping and all components are free from leaks	<input type="checkbox"/>	<input type="checkbox"/>
8.1.2 Temperature gauges, check valves, tower bypass valve and all other piping components installed as specified by HVAC Designer	<input type="checkbox"/>	<input type="checkbox"/>
8.1.3 Condenser Water Supply setpoint type: <input type="checkbox"/> Fixed <input type="checkbox"/> Outdoor temperature reset <input type="checkbox"/> Seasonal/based on free cooling	-	<input type="checkbox"/>
8.1.4 All control sensors (condenser water supply temperature, outdoor air humidity, etc.) are located as specified by HVAC Designer	<input type="checkbox"/>	<input type="checkbox"/>
8.2: Functional Testing: Tower Fans		



DRAFT HVAC Functional Testing Checklist¹

ENERGY STAR Multifamily New Construction Version 1.0 / 1.1

8.2.1 Tower fan(s) do not short cycle (i.e., the minimum on time is 5 minutes and the minimum off time is 5 minutes, or as recommended by the manufacturer to prevent short cycling)	<input type="checkbox"/>	<input type="checkbox"/>
8.2.2 Cooling Tower fan(s) do not run unless associated cooling tower pump(s) are running	<input type="checkbox"/>	<input type="checkbox"/>
8.2.3 If installed, basin heater is not enabled when the basin water temperature is at or above the setpoint	<input type="checkbox"/>	<input type="checkbox"/>
8.2.4 Condenser Water Supply Sensor is reading within 3°F of measured temperature	<input type="checkbox"/>	<input type="checkbox"/>
8.3: Functional Testing: Cooling Tower Pumps		
8.3.1 Cooling tower pumps are disabled when there is no call for heat rejection (N/A if tower pumps are set to run year round).	<input type="checkbox"/>	<input type="checkbox"/>
9. Chillers - This section must be completed for all chillers serving dwelling units or common spaces.		"FT Agent" Verified
9.1 Installation Checks		N/A
9.1.1 Chiller piping and all components are free from leaks	<input type="checkbox"/>	<input type="checkbox"/>
9.1.2 If multiple chillers, water flow is balanced across chillers using (indicate which one): <input type="checkbox"/> Balancing valves <input type="checkbox"/> Reverse return piping <input type="checkbox"/> Individual boiler pumps <input type="checkbox"/> Other: _____	<input type="checkbox"/>	<input type="checkbox"/>
9.1.3 Temperature, pressure gauges, air eliminator, expansion tank, check valves and all other piping components installed as specified by HVAC Designer	<input type="checkbox"/>	<input type="checkbox"/>
9.1.4 Chilled Water Supply temperature sensor (and outdoor air temperature sensor where applicable) are located as specified by HVAC Designer	<input type="checkbox"/>	<input type="checkbox"/>
9.2 Functional Testing: Chillers		
9.2.1 When there is a call for cooling, chillers are operating and maintaining chilled water setpoint	<input type="checkbox"/>	<input type="checkbox"/>
9.2.2 If multiple chillers are supposed to operate at the same time according to the Engineer of Record's Sequence, all chillers operate with a large enough cooling demand	<input type="checkbox"/>	<input type="checkbox"/>
9.2.3 Chiller(s) do not short cycle (i.e. the minimum on time is 5 minutes and the minimum off time is 5 minutes, or as recommended by the chiller manufacturer to prevent short cycling)	<input type="checkbox"/>	<input type="checkbox"/>
9.2.4 Chilled Water Supply Sensor is reading within 3°F of measured chiller temperature	<input type="checkbox"/>	<input type="checkbox"/>
9.3: Functional Testing: Chilled Water System Pumps		
9.3.1 Where Chilled Water System pumps (i.e., the pumps which are responsible for moving the chilled water through the terminal units) are equipped with a VFD, which is responding to a pressure sensor within the system or a sensorless VFD system, indicate which one. VFD+Sensor <input type="checkbox"/> Sensorless <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9.3.2 If a variable speed pumping system is installed, confirm that the VFD increases and decreases pump speed in response to changes in the system	<input type="checkbox"/>	<input type="checkbox"/>
9.3.3 If a variable speed pumping system is installed, system prevents "dead-heading". (May be tested under real or simulated low flow conditions.) Select the method of water flow bypass: <input type="checkbox"/> Minimum Flow Bypass Valve <input type="checkbox"/> 3 way valves on specific terminal units <input type="checkbox"/> Other	<input type="checkbox"/>	<input type="checkbox"/>
9.3.4 Pumps are off when cooling is not required (N/A if chilled water is required year round)	<input type="checkbox"/>	<input type="checkbox"/>
"FT Agent" Name: _____ Date: _____		
"FT Agent" Signature: _____ Company Name: _____		
Rater Name (if applicable): _____ Date: _____		
Rater Signature: _____ Company Name: _____		

Footnotes

- This Checklist is designed to align with the requirements of ANSI / ACCA's 5 QI-2015 protocol, thereby improving the performance of HVAC equipment in new multifamily buildings when compared to new multifamily buildings built to minimum code. However, these features alone cannot prevent all ventilation, indoor air quality, and HVAC problems (e.g., those caused by a lack of maintenance or occupant behavior). Therefore, this Checklist is not a guarantee of proper ventilation, indoor air quality, or HVAC performance.
Sections 2, 3, and 4 of this Checklist generally apply to split air conditioners, unitary air conditioners, air-source heat pumps, and water-source (i.e., geothermal) heat pumps up to 65 kBtuh with forced-air distribution systems (i.e., ducts) and to furnaces up to 225 kBtuh with forced-air distribution systems (i.e., ducts). See specific sections for exemptions.



DRAFT HVAC Functional Testing Checklist¹

ENERGY STAR Multifamily New Construction Version 1.0 / 1.1

Where the term 'dwelling unit' is used in this Checklist, the requirement is also required of 'sleeping' units. The term 'sleeping unit' refers to a room or space in which people sleep, which can also include permanent provisions for living, eating, and either sanitation or kitchen facilities but not both.

The term 'common space' refers to any spaces on the property that serve a function in support of the residential part of the building that is not part of a dwelling or sleeping unit. This includes spaces used by residents, such as corridors, stairs, lobbies, laundry rooms, exercise rooms, residential recreation rooms, or parking garages used exclusively by residents, building staff, and their guests. This also includes offices used by building management, administration or maintenance and all special use areas located on the property to serve and support the residents such as day-care facilities, gyms, dining halls, etc.

2. An explanation of the credentialing process and links to H-QUITOs, which maintain lists of credentialed contractors, can be found at energystar.gov/newhomeshvac. "FT Agents" may not be the installing contractor unless they are a credentialed contractor. All "FT Agents" that are not credentialed contractors must sign up online in EPA's online database as an FT Agent and watch the online FT Agent video [Note: will be created for new program and will be similar to the current process for builders]
3. Either factory-installed or field-installed TXV's may be used. For field-installed TXV's, ensure that sensing bulbs are insulated and tightly clamped to the vapor line with good linear thermal contact at the recommended orientation, usually 4 or 8 o'clock.
4. Air balancing of supply registers and return grilles is highly recommended to improve the performance of the HVAC system and comfort of the occupants, but is not required at this time for certification. When air balancing is completed, balancing dampers or proper duct sizing shall be used instead of looped or coiled ductwork to limit flow to diffusers. When balancing dampers are used, they shall be located at the trunk to limit noise unless the trunk will not be accessible when the balancing process is conducted. In such cases, Opposable Blade Dampers (OBD) or dampers located in the duct boot are permitted to be used.
5. When testing outdoor unit heating or cooling mode of operation, at least 25% of associated indoor/terminal units connected to the outdoor unit(s) shall be controlled to the same heating or cooling mode being tested. The "FT Agent" shall increase the number of indoor/terminal units as needed in order to verify the discharge temperature is warmer/colder than ambient.