



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 Licensed Professional², a Certified Commissioning Professional (CCP), a Certified Building Commissioning Professional (CBCP), a Building Commissioning Professional (BCxP, formerly the Commissioning Process Management Professional (CPMP)), a representative of the Original Equipment Manufacturer (OEM), or a contractor credentialed by an HVAC oversight organization to complete this checklist.
- Functional Testing checklists must be completed and signed and must include all HVAC systems in the building/project. 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 checklists may be submitted for one project.
- 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. Credentialed contractors shall provide the checklist upon request.
- Visit www.energystar.gov/newhomeshvac for information about the credentialed contractor requirement and this checklist.

1. Functional Testing Overview

- 1.1 Company performing Functional Testing _____ Contractor/LP name _____ Date _____
- 1.2 If applicable, Organization 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.

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 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"/>

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 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"/>	<input type="checkbox"/>	-
3.2 Static pressure test holes have been created, and test hole locations are well-marked and accessible.	<input type="checkbox"/>	-



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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 5.4 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 5.5 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, except where specifically noted.	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 pitches to the drain	<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 2°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. Measured discharge air temperature _____ °F. System turns off when the heating setpoint has been met.	<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. Measured discharge air temperature _____ °F System turns off when the heating setpoint has been met.	<input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
5.2.4 For WLHP's, measure and record the inlet and outlet temperatures on the condenser water at the terminal unit. 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"/>
6.2 Functional Testing		
6.2.1 In cooling mode, condenser fan is ON and heat is being rejected by condenser	<input type="checkbox"/>	<input type="checkbox"/>
6.2.2 In heating mode, condenser fan is ON and heat is being absorbed by condenser	<input type="checkbox"/>	<input type="checkbox"/>
6.2.3 Using the central maintenance tool or controller, none of the condenser modules or connected indoor units are showing an alarm	<input type="checkbox"/>	<input type="checkbox"/>
6.2.4 Using 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"/>



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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 temperature reset schedule is applicable, indicate reset schedule (e.g. 180F Supply @ 10F outdoor, 120F supply @55F 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 - If outdoor ambient temperature is $\geq 85^{\circ}\text{F}$, how to comply with items 7.2.5, 7.2.7 and 7.2.8 is under review.			
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 may run for 60 seconds before or 90 seconds after the boiler fires.)	<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)	<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 Header/supply Sensor is reading within 3°F of measured boiler 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 - If cooling tower is used seasonally and has been drained, how to comply with this Section is under review.			
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)	<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	N/A
9.1 Installation Checks			
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"/>	



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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 - If outdoor ambient temperature is $\leq 55^{\circ}\text{F}$, how to comply with items 9.2.1, 9.2.2, and 9.2.3 is under review.		
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)	<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

1. 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 by occupants). 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.

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, parking garages or lots 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. A Licensed Professional is a Registered Architect or Professional Engineer in good standing and with a current license.
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.