ENERGY STAR Multifamily New Construction
National HVAC Functional Testing Checklist [1], Version 1 / 1.1 /1.2 (Rev.043)

HVAC Functional Testing Agent Responsibilities:

- The entity verifying Functional Testing, the Functional Testing Agent ("FT Agent"), must be a contractor credentialed by an HVAC Quality Installation Training and Oversight organization (H-QUITO), or must hold an approved credential, as listed at www.energystar.gov/ftas, or must be a representative of the Original Equipment Manufacturer (OEM) to complete this checklist. A contractor credentialed by an H-QUITO is only permitted to complete Sections 1-5 of this checklist. [2]
- Functional Testing checklists must be completed and signed by an FT Agent. [1] 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, which may result in multiple checklists signed by multiple FT Agents. FT Agents shall only sign checklists that contain items that they have verified or have been verified under their oversight. An FT Agent may mark an item as 'verified' by conducting the test or inspection, or witness the test or inspection being conducted by the installing contractor or other HVAC professional. Where a checkbox for "FT Agent Verified" is not provided, FT Agents should fill in all applicable data fields.
- Functional Testing checklists must include all HVAC systems in the building that serve the dwelling units, common spaces, and where applicable, parking garages, but may exclude systems solely serving commercial / retail spaces. Multiple checklists will be needed to document all HVAC systems in the building. Except where items are verified by the installing contractor, items on the Functional Testing Checklist are permitted to be verified using MFNC HVAC Functional Testing Checklist Sampling Protocols.
- The completed checklists, along with the corresponding National 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 [3] responsible for certifying the units / building, prior to the building's certification. Credentialed contractors shall provide the checklist upon request.

1. Functional Testing Overview

1.1 Company performing Functional Testing: _____ FT Agent name: _____ Date: _____

1.2 Functional Testing Agent Credential: _____
If a credentialed contractor, fill out applicable H-QUITO and ID Number: ☐ ACCA ☐ Advanced Energy ID Number: _____

1.3 Builder / developer client name: _____

1.4 Building address: _____ City: _____ State: _____ Zip code: _____

1.5 National HVAC Design Report corresponding to this building has been collected from designer or builder. ☐

1.6 Checklist applies to the following equipment (include unit # as applicable): _____

1.7 Where sampling is used by the FT Agent, the installing contractor(s) have provided signed letter(s) attesting that they have completed testing on all systems in the building for the following Sections: ☐ Section 2 ☐ Section 3 ☐ Section 5 ☐ Section 6 ☐ N/A

2. Refrigerant Charge - Run system for 15 minutes before testing. If outdoor ambient temperature at the condenser is ≤ 55°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. [4] This section must be completed for refrigerant-based systems with field-installed refrigerant piping or components (i.e., split air conditioners, air-source heat pumps, and water-source heat pumps), up to 65 kBtu/h, whether serving dwelling units or common spaces in the building. Ducted or non-ducted single-packaged systems (i.e., PTAC), mini-splits, or multi-splits are exempt from this section. When using the alternative OEM test procedure in Item 2.16, check "NA" for Items 2.1-2.15. [5]			**FT Agent Verified[1]**	**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	-	☐
2.3 Liquid line pressure:	_____	psig	-	☐
2.4 Liquid line temperature:	_____	°F DB	-	☐
2.5 Suction line pressure:	_____	psig	-	☐
2.6 Suction line temperature:	_____	°F DB	-	☐
For System with Thermal Expansion Valve (TXV):				
2.7 Condenser saturation temperature:	_____	°F DB (Using Item 2.3)	-	☐
2.8 Subcooling value:	_____	°F DB (Item 2.7 – Item 2.4)	-	☐
2.9 OEM subcooling goal:	_____	°F DB	-	☐
2.10 Subcooling deviation:	_____	°F DB (Item 2.8 – Item 2.9)	-	☐
For System with Fixed Orifice:				
2.11 Evaporator saturation temperature:	_____	°F DB (Using Item 2.5)	-	☐
2.12 Superheat value:	_____	°F DB (Item 2.6 – Item 2.11)	-	☐
2.13 OEM superheat goal:	_____	°F DB (Using superheat tables and Items 2.1 & 2.2)	-	☐
2.14 Superheat deviation:	_____	°F DB (Item 2.12 – Item 2.13)	-	☐
2.15 Item 2.10 is ± 3°F or Item 2.14 is ± 5°F.			☐	☐

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.	☐	☐

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), 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 shared VRF systems, where indoor HVAC fans with forced-air distribution are connected to a shared outdoor unit that exceeds 65 kBtuh, are not exempt. [5]	**FT Agent Verified[1]**	**N/A** ☐
3.1 The mode with the higher design HVAC fan airflow used, per Item 5.2 of National HVAC Design Report: ☐ Heating ☐ Cooling	☐	-
3.2 Static pressure test holes have been created, and test hole locations are well-marked and accessible.	☐	-
Test hole location for **return** external static pressure: ☐ Plenum ☐ Cabinet ☐ Transition ☐ Other: _____	-	-
Test hole location for **supply** external static pressure: ☐ Plenum ☐ Cabinet ☐ Transition ☐ 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 = _____ IWC	-	-
3.6 **Measured** (Item 3.5) - **Design** (Item 5.2 on National 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 ± 15% of design HVAC fan airflow (Item 5.2 on National HVAC Design Report).	☐	-

4. Air Balancing of Supply Registers & Return Grilles (Recommended, but not Required) [6]	**Rater Verified**	**FT Agent Verified[1]**	**N/A**
4.1 Balancing report attached with room-by-room design airflows from Item 5.2 on National HVAC Design Report, and contractor-measured airflow using ANSI / ACCA 5 QI-2015 protocol.	☐	☐	☐
4.2 Room-by-room airflows verified to be within the greater of ± 20% or 25 CFM of design airflow.	☐	☐	☐
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, multi-splits, PTAC's, PTHP's, WLHP's, fan coils, and hydronic distribution systems. [5]	**Rater Verified**	**FT Agent Verified[1]**	**N/A**
5.1 Installation Checks			
5.1.1 Zone thermostat (or remote zone temperature sensor) in dwelling units, within the zone being served.	☐	☐	☐
5.2 Functional Testing			
5.2.1 Measured zone temperature is within 5°F of zone temperature displayed on thermostat or sensor.	☐	☐	☐
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. [7]	☐	☐	☐
If N/A, select the reason: ☐ due to high ambient temperature OR ☐ equipment lock-out	-	-	-
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. [7]	☐	☐	☐
If N/A, select the reason: ☐ due to low ambient temperature OR ☐ equipment lock-out	-	-	-
5.2.4 Where OA inlets are connected to the dwelling unit HVAC system, a motorized damper is installed that closes when there is no call for ventilation or when fan is off.	☐	☐	☐

6. Shared VRF Outdoor Units - This section must be completed for commercial-grade VRF outdoor units serving multiple dwelling units or common spaces.	**FT Agent Verified[1]**	**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)): _____/_____/_____	-	☐
6.1.2 Vacuum testing has been completed. (indicate exact test in / test out pressure (psig) / time (hours)): _____/_____/_____	-	☐
6.1.3 Refrigerant line lengths and height differences have been recorded from as-built shop drawings or field measured, and documentation of the measurement is available, if requested.	☐	☐
6.1.4 Indicate required additional charge amount (lbs): _____	-	☐

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6.2 Functional Testing		
6.2.1 In cooling mode, the outdoor unit fan is ON and heat is being rejected. [7, 8] Measure and verify that outdoor unit fan discharge air temperature is warmer than the ambient air temperature. N/A due to ambient temperature ___ °F or equipment lock-out ☐	☐	☐
6.2.2 In heating mode, the outdoor unit fan is ON and heat is being absorbed. [7, 8] Measure and verify that outdoor unit fan discharge air temperature is colder than the ambient air temperature. N/A due to ambient temperature ___ °F or equipment lock-out ☐	☐	☐
6.2.3 Using the central maintenance tool or controller, none of the outdoor units or connected indoor units are showing an alarm.	☐	☐
6.2.4 Using the central maintenance tool, the manufacturer's representative confirmed refrigerant charge test per manufacturer's guidelines.	☐	☐
7. Boilers - This section must be completed for all commercial-grade space heating boilers serving multiple dwelling units.	**FT Agent Verified[1]**	**N/A**
7.1 Installation Checks		
7.1.1 Piping pressure testing is completed, and all accessible boiler piping, fittings, and accessories are free from leaks.	☐	☐
7.1.2 Boiler relief valves and discharge piping do not show signs of weeping or leakage.	☐	☐
7.1.3 No signs of blockage, leakage, or deterioration in the fresh air intake or flue gas vent piping.	☐	☐
7.1.4 Temperature, pressure gauges, air eliminator, expansion tank, check valves and all other piping components installed as specified by HVAC Designer.	☐	☐
7.1.5 Boiler supply / header temperature sensor and, where applicable, outdoor air temperature sensor, are located as specified by HVAC Designer.	☐	☐
7.1.6 Indicate boiler header / supply setpoint type: ☐ Fixed ☐ Seasonal ☐ Outdoor temperature reset ☐ Indoor temperature reset ☐ Other: _____	-	☐
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.) _____ @ _____ , _____ @ _____	-	☐
7.1.8 Where Warm Weather Shut Down (WWSD) is applicable, list temperature. (NA if boilers and system pumps also serve DHW.)	_____°F	☐
7.2 Functional Testing: Boilers [7] - N/A due to ambient temperature ___ °F or equipment lock-out ☐		☐
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. [7] _____% ☐ high fire _____% ☐ low fire	-	☐
7.2.2 Where not direct-vented, boiler combustion air intake dampers open / close with boiler operation. [7]	☐	☐
7.2.3 If each boiler has its own dedicated boiler circulator pump, it operates only when the respective boiler is firing. [7] (Circulator pump may run for a short period of time before or after the boiler fires, as recommended by the equipment manufacturer.)	☐	☐
7.2.4 When there is a call for heating, the boiler(s) are enabled according to their design sequence of operation. [7]	☐	☐
7.2.5 When multiple boilers are supposed to operate at the same time, they operate according to the Engineer of Record's sequence of operation and the on / off sequencing is observed. [7]	☐	☐
7.2.6 Cycle the boilers on and off 1 time. Boiler(s) modulate / step down to the minimum firing rate before shutting off. [7]	☐	☐
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). [7]	☐	☐
7.2.8 Condensing Boiler Return Temperature: ~~Return temperature enables condensing.~~ [7] Design / OEM temp: _____°F Measured temp: _____°F Where measured return temperature does not enable condensing, building owner has been notified. [7]	☐	☐
7.2.9 Boiler supply / header temperature sensor is reading within 3°F of measured boiler supply / header temperature. [7]	☐	☐
7.2.10 Boiler minimum flow rate and change in flow rate are maintained within the manufacturer's stated limits throughout the sequence of operation. [7, 9]	☐	☐
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 ☐ Sensorless	-	☐
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.	☐	☐
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: ☐Minimum Flow Bypass Valve ☐ 3 way valves on specific terminal units ☐Other: _____	☐	☐
7.3.4 Pumps are off when outside air temperature is above WWSD. (N/A if pumps serve DHW as well as heating.)	☐	☐

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8. Cooling Towers - This section must be completed for all cooling towers serving dwelling units or common spaces.	**FT Agent Verified[1]**	**N/A**
8.1 Installation Checks		
8.1.1 Cooling Tower piping and all components are free from leaks.	☐	☐
8.1.2 Temperature gauges, check valves, tower bypass valve and all other piping components installed as specified by HVAC Designer.	☐	☐
8.1.3 Condenser Water Supply setpoint type: ☐ Fixed ☐Outdoor temperature reset ☐Seasonal / based on free cooling	-	☐
8.1.4 All control sensors (condenser water supply temperature, outdoor air humidity, etc.) are located as specified by HVAC Designer.	☐	☐
8.2 Functional Testing: Tower Fans [7] - N/A due to ambient temperature ___ °F or equipment lock-out ☐		☐
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). [7]	☐	☐
8.2.2 Cooling Tower fan(s) do not run unless associated cooling tower pump(s) are running. [7]	☐	☐
8.2.3 If installed, basin heater is not enabled when the basin water temperature is above the setpoint. [7]	☐	☐
8.2.4 Condenser Water Supply Sensor is reading within 3°F of measured temperature. [7]	☐	☐
8.3 Functional Testing: Cooling Tower Pumps		
8.3.1 Cycle the cooling tower pumps on and off 1 time. Cooling tower pumps only operate when controls call for operation. (N/A if tower pumps are set to run year round.) [7]	☐	☐
9. Chillers - This section must be completed for all chillers serving dwelling units or common spaces.	**FT Agent Verified[1]**	**N/A**
9.1 Installation Checks		
9.1.1 Chiller piping and all components are free from leaks.	☐	☐
9.1.2 If multiple chillers, water flow is balanced across chillers using (indicate which one): ☐ Balancing valves ☐ Reverse return piping ☐ Individual chiller pumps ☐ Other: _____	-	☐
9.1.3 Temperature, pressure gauges, air eliminator, expansion tank, check valves and all other piping components installed as specified by HVAC Designer.	☐	☐
9.1.4 Chilled Water Supply temperature sensor (and outdoor air temperature sensor where applicable) are located as specified by HVAC Designer.	☐	☐
9.2 Functional Testing: Chillers [7] - N/A due to ambient temperature ___ °F or equipment lock-out ☐		☐
9.2.1 When there is a call for cooling, chillers are operating and maintaining chilled water setpoint. [7]	☐	☐
9.2.2 When multiple chillers are supposed to operate at the same time, they operate according to the Engineer of Record's sequence of operations and the on / off sequencing is observed. [7]	☐	☐
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). [7]	☐	☐
9.2.4 Chilled Water Supply Sensor is reading within 3°F of measured chiller temperature. [7]	☐	☐
9.2.5 Chiller minimum flow rate and change in flow rate are maintained within the manufacturer's stated limits throughout the sequence of operation. [7, 9]	☐	☐
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 ☐ Sensorless	-	☐
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.	☐	☐
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: ☐ Minimum Flow Bypass Valve ☐ 3 way valves on specific terminal units ☐Other:	☐	☐
9.3.4 Pumps are off when cooling is not required. (N/A if chilled water is required year round.)	☐	☐

FT Agent Name: _____ Date: _____

FT Agent Signature: _____ Company Name: _____

Rater Name (if applicable): _____ Date: _____

Rater Signature: _____ Company Name: _____

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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 or occupant behavior). Therefore, this Checklist is not a guarantee of proper ventilation, indoor air quality, or HVAC performance.

   The items in this checklist may be marked as "FT Agent Verified" by an individual employed at the Company listed in Item 1.1, if performed under the oversight of the Functional Testing Agent signing this Checklist.

   The checklist may be completed and signed by a Rater, rather than a Functional Testing Agent, if only Sections 1, 4 and 5 are applicable. A Rater completing Section 5 or Item 4.2 for a system that is also being verified by a Functional Testing Agent, may sign the same checklist as the FT Agent. For units following Track A, a Functional Testing Agent is not needed to complete Sections 2 and 3 for unitary HVAC systems serving dwelling units that will be verified and graded by the Rater. Track A – Dwelling Unit HVAC Grading shall not be used until an implementation schedule has been defined for ANSI / RESNET / ACCA 310 by the Home Certification Organization (HCO) or Multifamily Review Organization (MRO) that the building is being certified under. Track A – Dwelling Unit HVAC Grading shall then use ANSI / RESNET / ACCA 310 including all Addenda and Normative Appendices, with new versions and Addenda implemented according to the schedule defined by the HCO or MRO that the building is being certified under.

   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 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). See specific sections for exemptions. If exempted, a Rater may complete those sections as N/A.

   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 in the building being certified 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, and dining halls, as well as offices or other spaces used by building management, administration or maintenance in support of the residents.

2. An explanation of the credentialing process and links to H-QUITOs, which maintain lists of credentialed contractors, can be found at www.energystar.gov/findhvac. FT Agents may not be the installing contractor, nor employed by the same company as 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 orientation. See www.energystar.gov/ftas.

3. The term 'Rater' refers to the person(s) completing the third-party verification required for certification. The person(s) shall: a) be a Certified Rater, Approved Inspector, as defined by ANSI / RESNET / IECC 301, or an equivalent designation as determined by an HCO or MRO; and, b) have attended and successfully completed an EPA-recognized training class. See www.energystar.gov/mftraining.

4. 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.

5. The term "mini-split" refers to air conditioners and heat pumps that have variable refrigerant flow and distributed refrigerant technology with a single outdoor section serving a single indoor section. The indoor section is typically, but not exclusively, mounted on room walls and/or ceilings and designed to heat or cool air within the conditioned space either directly or through limited duct runs. The term "multi-split" refers to air conditioners and heat pumps that have variable refrigerant flow and distributed refrigerant technology with the capability of serving multiple indoor sections with a single outdoor section. The indoor sections are typically, but not exclusively, mounted on room walls and/or ceilings and designed to heat or cool air within the conditioned space either directly or through a ducted system. A single outdoor section can serve one or more dwelling units. The length of the duct system is not a determinant for meeting either of these definitions. Systems where total supply duct length of the entire system, including the sum of all supply trunks and branches, is 10 ft or less, may complete Item 4.2 in lieu of Section 3.

6. 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.

7. For seasonally dependent testing: Where temperature lock-outs or equipment safety lock-outs prevent systems from operating in the specified mode during functional testing, "N/A" may be checked. The builder or developer must then provide signed documentation acknowledging that components of the Functional Testing were not completed due to temperature lock-outs or equipment safety lock-outs.

8. When manually 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.

9. This test can be marked "Verified" if the boiler or chiller does not shut off on low water or high temperature during sequence testing. Direct water flow measurements can be taken throughout testing but are not required.