ENERGY STAR Multifamily New Construction
HVAC Functional Testing Checklist Sampling Protocols

This document describes the protocols that must be followed when sampling is used to verify items contained within the ENERGY STAR Multifamily New Construction HVAC Functional Testing Checklist.

Sampling of Functional Testing Checklist items by the Functional Testing Agent is permitted only if the following requirements are met for a given project:

1. The Functional Testing Agent is *not* the installation contractor.
2. The installation contractor or qualified professional completes all required tests on all systems.

Where eligible to use sampling, Functional Testing (FT) Agents may apply sampling on all qualifying HVAC systems, or on a subset of their HVAC systems and/or on a subset of the required functional tests.

When an FT Agent is sampling Functional Testing Checklist items, the following rules apply:

1. Sampling may be used to complete Sections 2, 3, 4, and 5, but not Sections 6, 7, or 8.
    a. Exception: 100% of systems that serve common spaces must meet Functional Testing Sections 5.2.
2. In this document, the 'similar systems' refers to all systems of the same system type, meaning they are the same fuel type, manufacturer, class and series. They may be different nominal sizes.
3. Similar systems may be grouped together regardless of whether they are serving common spaces or dwelling units, however at least one system must be tested in a common space and in a dwelling unit.
4. Each sampled item shall qualify for sampling independently of the other sampled items.
5. When pursuing sampling, a representative sampling of similar systems must be tested. At a minimum there must be one test of each similar system, per floor, per building.
6. Sampling may be applied to multiple multifamily buildings, but only if they are within the same project, and installed by the same installation contractor company.
7. The Rater is responsible to ensure the minimum number of systems have been verified by the Functional Testing Agent. The Rater is responsible for collecting all sampling documentation, including any reports of failures.
8. Where sampling is used for Item 5.1.1 and 5.1.2, data for all the outdoor units must still be reported using the HVAC Functional Testing Checklist (PDF or Excel version).

In addition to the above rules, the Functional Testing (FT Agent) must follow the requirements in one of the two options, based on whether they choose to verify Functional Testing Checklist items directly, by re-testing and re-inspecting items that have already been tested or inspected OR they choose to witness the tests or inspections as they are being conducted.

Sampling Option 1: Re-testing

Before beginning the sampling process, the FT Agent must test five (5) similar systems.

Next, in order to start sampling, the FT Agent must test at least five (5) similar systems in a row without failure.

- *This brings the minimum number of systems tested before sampling is started to ten (10).*

After a minimum of 5 systems have passed in a row, the FT Agent may test a minimum of 20% of the remaining similar systems.

Any system that fails the test or inspection shall be corrected and re-inspected and/or re-tested on that system until it passes.

The failed item(s) shall then be tested on five (5) similar systems in a row without a failure, before the FT Agent may again start sampling on a minimum of 20% of the remaining similar systems.

Sampling Option 2: Witnessing

Before beginning the sampling process, the FT Agent must witness the testing of five (5) systems. See below for alternative process when sampling Items 5.1.1 or 5.1.2.

Next, in order to start sampling, the FT Agent must witness at least five (5) similar systems in a row without failure. A failure occurs if the system does not meet the requirements or the test is done improperly and therefore the system is not assessed correctly.

- *This brings the minimum number of systems witnessed before sampling is started to ten (10).*
- *These initial tests may not be witnessed remotely.*

After a minimum of 5 systems have passed in a row, the FT Agent witnesses the installation contractor or qualified professional performing all required tests and inspections on a minimum of 30% of the remaining similar systems.

- *These tests may not be witnessed remotely, but the EPA is evaluating this option.*

Any system that fails shall be corrected and re-inspected and/or re-tested on that system until it meets the requirements.

The failed item(s) shall then be tested and witnessed on five (5) similar systems in a row without failure before the FT Agent may again start sampling and witness a minimum of 30% of the remaining similar systems.

For all systems witnessed, the FT Agent, rather than the installation contractor, is responsible for selecting the systems to be witnessed.

Alternative for Section 5, Item 5.1.1: Where the first outdoor unit is pressure tested and the FTA is on-site to witness the initial pressure reading and the final pressure reading (24 hours later), rather than following the sampling steps above, all remaining outdoor units can instead be verified by the FTA by reviewing photos of pressure gauges where the FTA can verify the date and time the photos were taken. Where this verification approach is used, test in pressure, test out pressure, and test length (hours) for each of the outdoor units shall be reported in Section 5 of the HVAC Functional Testing Checklist and each shall demonstrate that the test out pressure is no less than 95% of the test in pressure after a minimum of 24 hours.

Alternative for Section 5, Item 5.1.2: Where the first outdoor unit is vacuum tested and the FTA is on-site to witness the initial micron gauge reading and the final micron gauge reading (24 hours later), rather than following the sampling steps above, all remaining outdoor units can instead be verified by the FTA by reviewing documentation and photos of micron gauges where the FTA can verify the date and time the photos were taken. Where this verification approach is used, all the outdoor units that are not being witnessed must go through a triple evacuation procedure. Documentation and photos of the micron gauges at each step of the evacuation must be provided to the FTA (i.e., 2,000 microns, 1,000 microns, and 500 microns) and retained by the FTA for a minimum of three years for quality assurance purposes. The applicable data for each of the outdoor units shall be reported in Section 5 of the HVAC Functional Testing Checklist and shall demonstrate that the 500 microns has not been exceeded after a minimum of 24 hours.

Examples

Example 1

In a 12 story 100-unit building with 2 leasing offices and a large lobby, each dwelling unit and leasing office has its own furnace (which vary in size between 18,000 btu/h and 54,000 btu/h) and there are two furnaces in the lobby. All furnaces are from the same manufacturer and are of the same series/line. There would be 104 furnaces that qualify as ‘similar systems’. Sampling of these 104 similar systems must include re-testing or witnessing of at least one system in the leasing offices or lobby, and at least one system on each floor (12).

If the FT Agent is re-testing rather than witnessing, after completing functional testing on 5 furnaces that have already been tested by the installation contractor, the FT Agent then begins testing additional systems with the goal of having 5 consecutive systems pass. While already tested by the installation contractor, when re-tested by the FT Agent, system #7 has measured indoor fan airflow that is less than 15% of the design airflow, which is considered an incidence of failure. After correcting the issue, and verifying the corrected airflow was within the design parameters, functional testing by the FT Agent continued.

When re-tested by the FT Agent, systems 8-12 passed all functional tests, allowing the FT Agent to start sampling the remaining 92 furnaces at a minimum rate of 20% (92 x 20% = 18.4) which rounds up to 19 remaining systems. Assuming there were no additional incidences of failure, the FT Agent ensures they test at least one furnace per floor, as well as one of the furnaces in the office/lobby, and only selects systems that have already been tested by the installation contractor.

Example 2

Four garden style apartment buildings are constructed simultaneously. The same design and construction team is used, and all construction details are similar. The same installation contractor is also used, making the project eligible for sampling. Two buildings are three stories, containing 60 units each. Two buildings are two stories, containing 45 units. All buildings use heat pumps from the same manufacturer and series/line for heating/cooling the dwelling units. There are 210 heat pumps installed in these four buildings.

If the FT Agent is witnessing rather than re-testing, the FT Agent witnesses in-person, the installation contractor performing all items in the HVAC Functional Testing Checklist on five initial systems. In this example, there are no restrictions on whether the initial systems are from different buildings or floors. On two of these systems the refrigerant charge's subcooling deviation is greater than 3 degrees from the subcooling goal, which is considered a failure. The refrigerant charges on these systems are corrected and re-tested by the installation contractor. Despite witnessing the installation contractor tests of fifteen additional heat pumps, the refrigerant charge subcooling never had 5 consecutive passes without an incidence of failure. The FT Agent discusses the item with the project team and the Rater. They elect to remove the refrigerant charge testing from sampling. All heat pumps will have their refrigerant charge test witnessed by the FT Agent.

Since no other items on the HVAC Functional Testing Checklist had a failure, the FT Agent may continue sampling on all other items in the checklist. The total number of witnessed systems for these items is calculated as 30% of the total number of heat pumps (210), less the required initial set of 10. Therefore, the total required to be witnessed is 60 ((210-10) x 30% = 60). The 60 may include the 10 systems they have already witnessed as there were no failures for the items that are being sampled. The FT Agent ensures that when selecting systems for witnessing, at least one heat pump, per floor, per building is tested.

As noted in the HVAC Functional Testing Checklist, under FT Agent responsibilities, upon concluding sampling of items on the HVAC Functional Testing Checklist, the FT Agent shall provide the completed and signed checklists to the builder / developer and the Rater for the systems they re-tested or witnessed. In addition, they must submit sampling documentation to the Rater that demonstrates systems selected meet the requirements in these protocols, including any reports of failures. This documentation must note at a minimum: the number of total applicable systems to be tested, the number of systems re-tested by the FT Agent or the number of tests witnessed by the FT Agent, and the number of failures. This data will be included in the Excel version of the HVAC Functional Testing Checklist. The installing contractor(s) must also provide signed letter(s) attesting that testing has been completed on all systems in the building for specific Sections of the checklist.

As noted above, the Rater is then responsible to ensure the minimum number of systems have been verified by the Functional Testing Agent, prior to the units / building earning ENERGY STAR certification.

The EPA will continue to work with stakeholders to develop clarifications or adjustments to these protocols. Please submit all sampling related questions or comments to energystarhomes@energystar.gov.