Building Science Education Solution Center – Commissioning  
PNNL-SA-200645

Proficiency Level 2: Understand

# Learning Objective 2.1:

* Understand key tests and procedures involved in commissioning a residential HVAC system to verify quality installation.

**Lecture Notes 2.1:**

Effective commissioning plays a critical role in ensuring the intended performance and efficiency of residential HVAC systems. It involves a series of key tests and procedures aimed at evaluating existing systems and verifying the quality of installation. Knowing about these tests is important for professionals, contractors, and all the stakeholders involved in the commissioning of residential HVAC systems to ensure efficient and reliable operation, as well as the comfort and safety of occupants.

Commissioning a residential HVAC system requires thorough testing and verification to ensure optimal performance and efficiency. Key tests and procedures involved in this process are outlined in Table 1.

Table 1. Key Tests and Procedures for Commissioning Residential HVAC System.

|  |  |
| --- | --- |
| **Test/Procedure** | **Description** |
| Nitrogen Pressure Test | Pressurizes refrigerant lines with dry nitrogen gas. This test checks for leaks and ensures proper sealing, as even small leaks can impact system performance and efficiency, leading to refrigerant loss and potential system failure. It is performed by purging the system with nitrogen, gradually pressurizing between 250-600 PSIG, holding for 30-60 minutes, and checking for pressure drops to identify and correct leaks. |
| Vacuum Decay Test | Evacuates refrigerant lines using a vacuum pump. This process removes moisture and air, verifying the system is dry and tight, eliminating non-condensable gases and serves as an additional check for leaks. It is performed by evacuating the system below 500 microns, valving off pump and hose, and monitoring for at least 10 minutes to ensure no significant vacuum decay. |
| Refrigerant Charge Verification | Verifies the proper refrigerant charge. This ensures accurate operation and warranty compliance, as improper charge affects efficiency and performance. It is performed using superheat, subcooling, or weigh-in methods depending on system type and manufacturer recommendations. |
| Total External Static Pressure (TESP) | Measure TESP in the ductwork. This evaluates ductwork performance, identifies restrictions, and ensures operation within equipment specifications. High TESP can reduce airflow and efficiency. It is performed by measuring static pressure at specified locations in the system, calculating TESP, and comparing with manufacturer specifications. |
| Airflow Measurement | Measures airflow across coils and supply registers. This ensures the system delivers the designed volume of air for proper heating/cooling. It is performed using methods like TESP and fan curves, flow grid, flow hood, or pressure matching, and comparing measured airflow to manufacturer specifications. |
| Duct Leakage Test | Quantifies leaks in the ductwork. This verifies compliance with building codes and energy efficiency standards, as excessive leakage decreases performance and increases energy bills. It is performed using specialized equipment to measure leakage rates and compare with acceptable standards. |
| System Performance Verification | Measures in-field heating/cooling capacity and efficiency. This ensures the system operates as designed and meets performance expectations. It is performed using tools to measure temperature, humidity, airflow, and power consumption, then calculating capacity and efficiency metrics like EER or COP. |
| Controls Verification | Tests system control components. This ensures proper operation and response to user settings, and verifies the accuracy and functionality of the thermostat, safety controls, and airflow components. It is performed by checking thermostat communication, temperature sensing, and operation of safety controls and airflow components. |

Understanding these key tests and procedures is crucial for ensuring the quality installation and performance of residential HVAC systems. By conducting comprehensive commissioning activities, building professionals can verify that the HVAC system operates as intended, meets performance standards, and provides optimal comfort and energy efficiency.

Relevant Resources:

* HVAC Commissioning <https://www.energy.gov/eere/buildings/hvac-commissioning#:~:text=Commissioning%20is%20the%20process%20of,original%20design%20and%20engineering%20documentation>.
* Guidelines for Residential Commissioning <https://www.osti.gov/servlets/purl/810476>
* ACAA Standard 9: HVAC Quality Installation Verification Protocols <https://www.acca.org/communities/community-home/librarydocuments/viewdocument?DocumentKey=90a03963-fb59-43bc-a80d-1acac52febdc>
* ANSI/RESNET/ACCA 310-2020 Standard for Grading the Installation of HVAC Systems <https://www.resnet.us/wp-content/uploads/ANSIRESNETACCA_310-2020_v7.1.pdf>
* ANSI/ACCA 5 QI - 2015: HVAC Quality Installation Specification <https://www.acca.org/communities/community-home/librarydocuments/viewdocument?DocumentKey=b1d2a39d-fda8-4af9-b8de-0ae579bfe24a>
* Residential System Commissioning <https://www.youtube.com/watch?v=H_-YAIB_4Dw>
* What is True Residential HVAC Design & Commissioning; What Standards Apply? <https://www.youtube.com/watch?v=z543N8fxBjw>
* Residential HVAC Installation Practices: A Review of Research Findings <https://www.energy.gov/eere/buildings/articles/residential-hvac-installation-practices-review-research-findings>
* Best Practices Guide for Residential HVAC Retrofits <https://www.osti.gov/servlets/purl/824856>

**Problem Set 2.1:**

1. You're evaluating an older system with complaints of inconsistent temperatures. What three tests would be your priority, and why?

2. A client is unsure why their energy bills remain high after a newer, efficient HVAC was installed. Without major re-commissioning, what test(s) could uncover likely causes?

# Learning Objective 2.2:

* Describe how smart diagnostic tools can be used to streamline the commissioning process.

**Lecture Notes 2.2:**

Commissioning HVAC systems traditionally relies on manual measurements, experience-based observations, and multiple technicians for certain stages. This can be time-consuming, and subject to human error and limitations of tools.

Smart diagnostic tools have revolutionized the commissioning process for HVAC systems by offering advanced capabilities to streamline and enhance efficiency. These tools leverage advanced technologies like smart sensors, data analytics, and automation, offering many benefits, including ease of data collection, standardized workflows for commissioning, and streamlined documentation and reporting functions. By harnessing the power of smart diagnostic tools, HVAC professionals can expedite the commissioning process, improve accuracy, and deliver satisfactory outcomes for building owners and occupants. The specific tool features and application examples are summarized in Table 1 and the associated key benefits are listed in Table 2.

Table 1. Features and Applications for Smart Diagnostic Tools

|  |  |
| --- | --- |
| **Feature** | **Application Example** |
| Airflow | Real-time airflow measurements, consolidated data for calculating airflow across systems. |
| Refrigerant Charge | Automatic superheat/subcooling calculations, flags deviations from target values. |
| Ductwork | Monitor air velocity and pressure differentials to detect leaks or blockages |
| Electrical | Monitor voltage and current draw, aiding in motor and wiring problem detection |
| Overall System View | Integrate pressure, temperature, airflow, and electrical data for a comprehensive assessment of system performance |

Table 2. Key Benefits of Smart Diagnostic Tools.

|  |  |
| --- | --- |
| **Benefit** | **Description** |
| Enhanced Accuracy | Real-time data and automated calculations reduce errors compared to manual measurements. |
| Speed and Efficiency | Data visualizations and automatic calculations accelerate the commissioning process. |
| Troubleshooting | Fault detection algorithms or reference databases guide fast problem diagnosis. |
| Documentation and Reporting | Automatic data logging simplifies report generation and improves communication. |

In summary, smart diagnostic tools represent a valuable asset in the HVAC commissioning process, offering a range of features and benefits that streamline workflow, improve accuracy, and enhance customer satisfaction. By embracing these innovative technologies, HVAC professionals can elevate their commissioning practices, deliver superior results, and drive business success.

Relevant Resources:

* Smart Tools for Efficient HVAC Performance Campaign <https://www.energy.gov/eere/buildings/smart-tools-efficient-hvac-performance-campaign>
* About the Smart Tools for Efficient HVAC Performance Campaign <https://www.energy.gov/eere/buildings/about-smart-tools-efficient-hvac-performance-campaign>
* PNNL Quality Install Tool <https://www.pnnl.gov/projects/quality-install-tool>
* How to use MeasureQuick for Reporting Commissioning and System Diagnostics <https://www.youtube.com/watch?v=6XglTvYVr6c>
* Fieldpiece Training Courses for HVACR System Analysis <https://go.bluevolt.com/fieldpiece/s/categorydetail/30849/hvacr-system-analysis>
* Commissioning a Residential Split Heat Pump <https://hvacrschool.com/commissioning-a-residential-split-heat-pump/>
* HVAC 155 Nitrogen test with MQ and Probes <https://www.youtube.com/watch?v=hV8dUsaSURc>

**Problem Set 2.2:**

1. Describe a traditional method for measuring refrigerant charge vs. how a smart diagnostic tool streamlines the process.