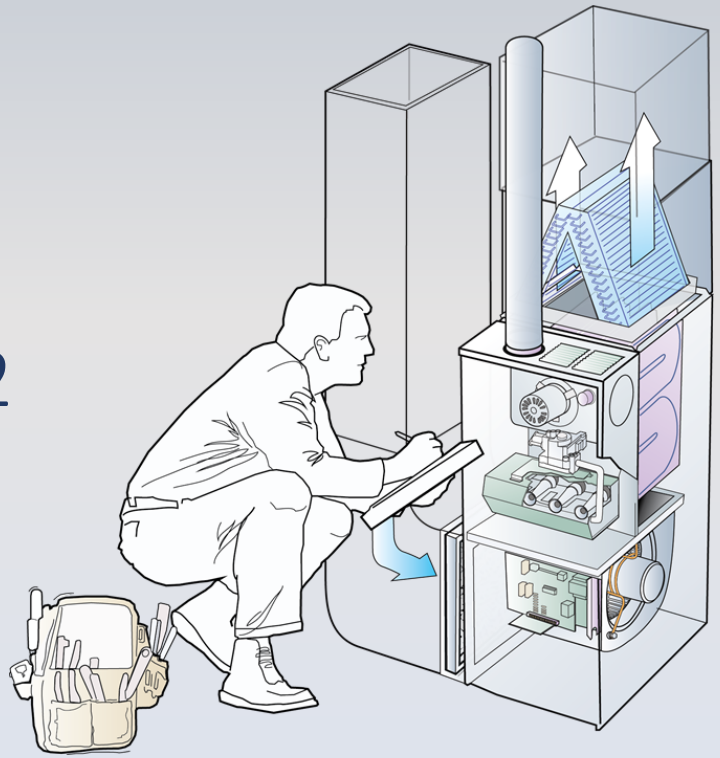
What it takes to get an installed HVAC system to operate at rated capacity



Tuesday January 15 1:00 to 2:30 Room B 312

Rob Falke

National Comfort Institute

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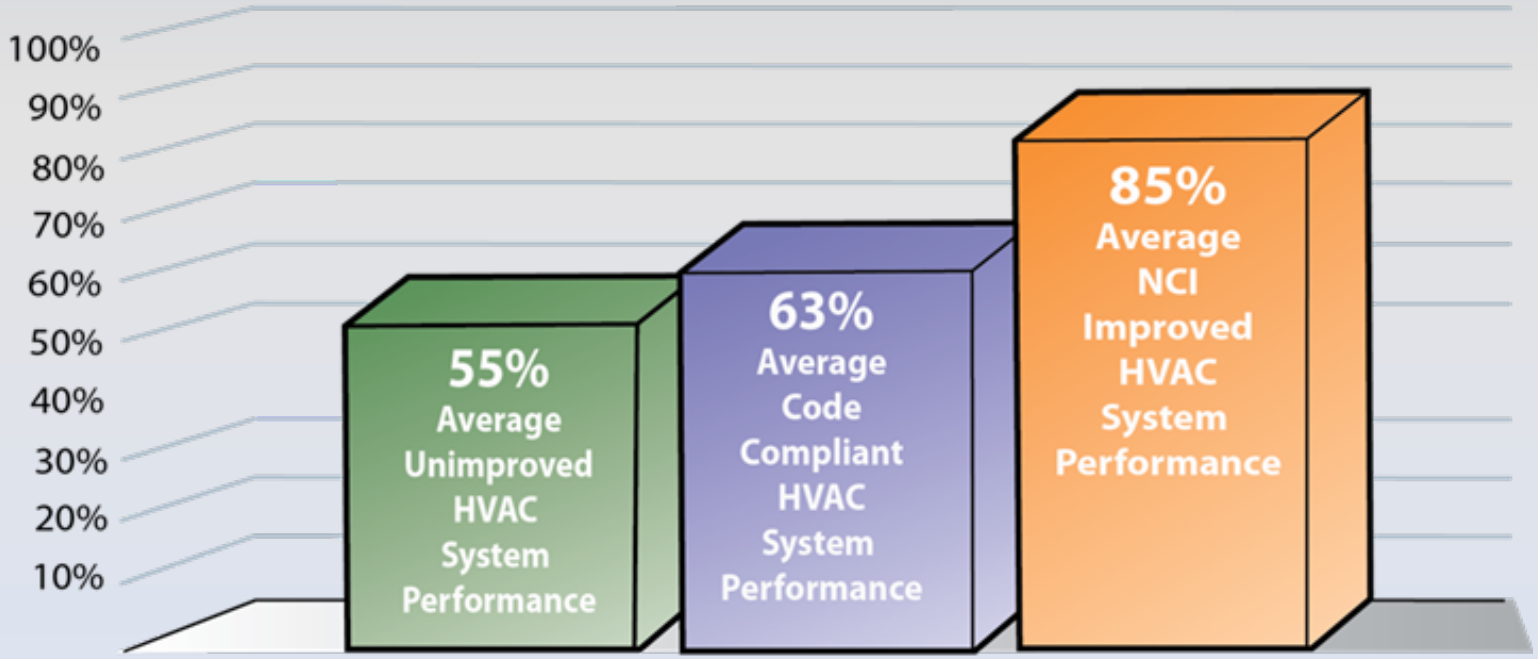
“But all my systems do operate at rated capacity!”

Congratulations, you’re in the top 1% of designers and installing contractors. We would be thrilled to review your installed system documentation.

This illustration represents the typical installed HVAC system performance from data gathered around the USA



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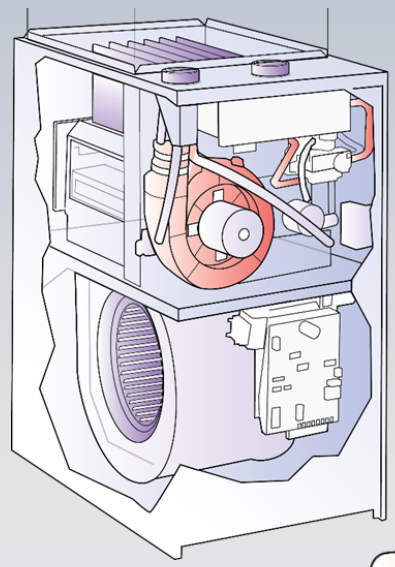
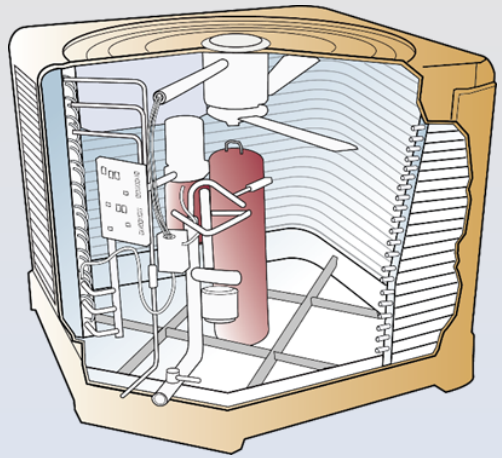
Equipment and an installed system are two different manufactured products

"The industry often refers to equipment as a system"

Equipment is:

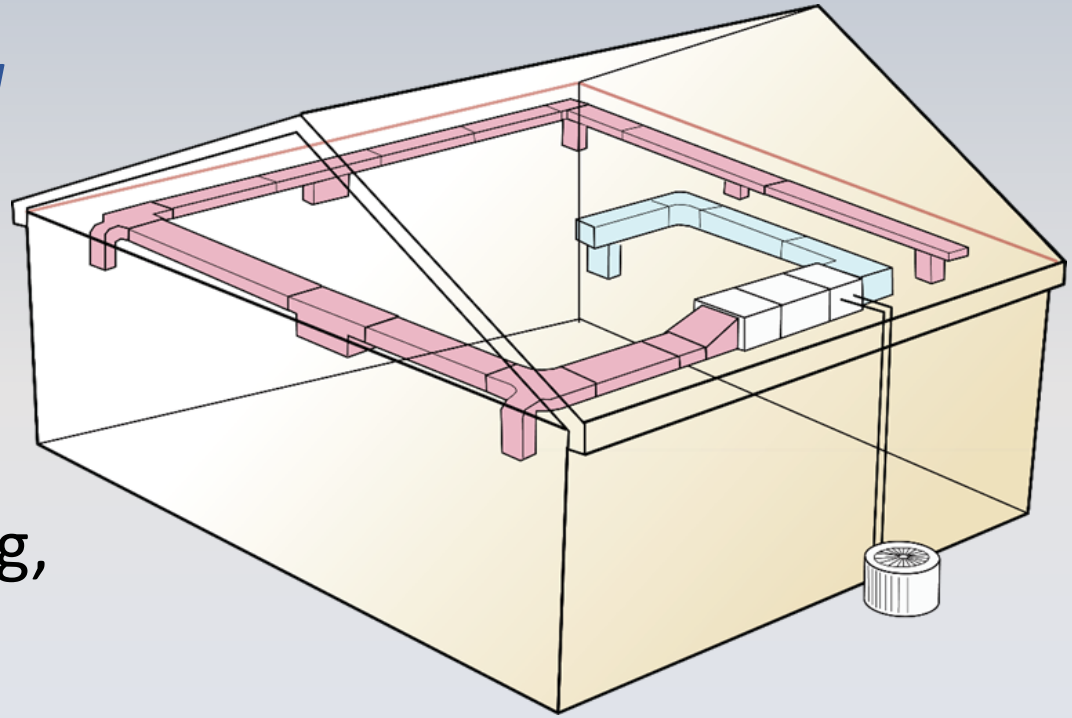
- A manufactured and shipped product
- Built in a factory
- Rated for capacity and efficiency according to time proven industry standards.
- Normally sold to the installing contractor





Equipment and an installed system are two different manufactured products

An HVAC system is a different manufactured product.

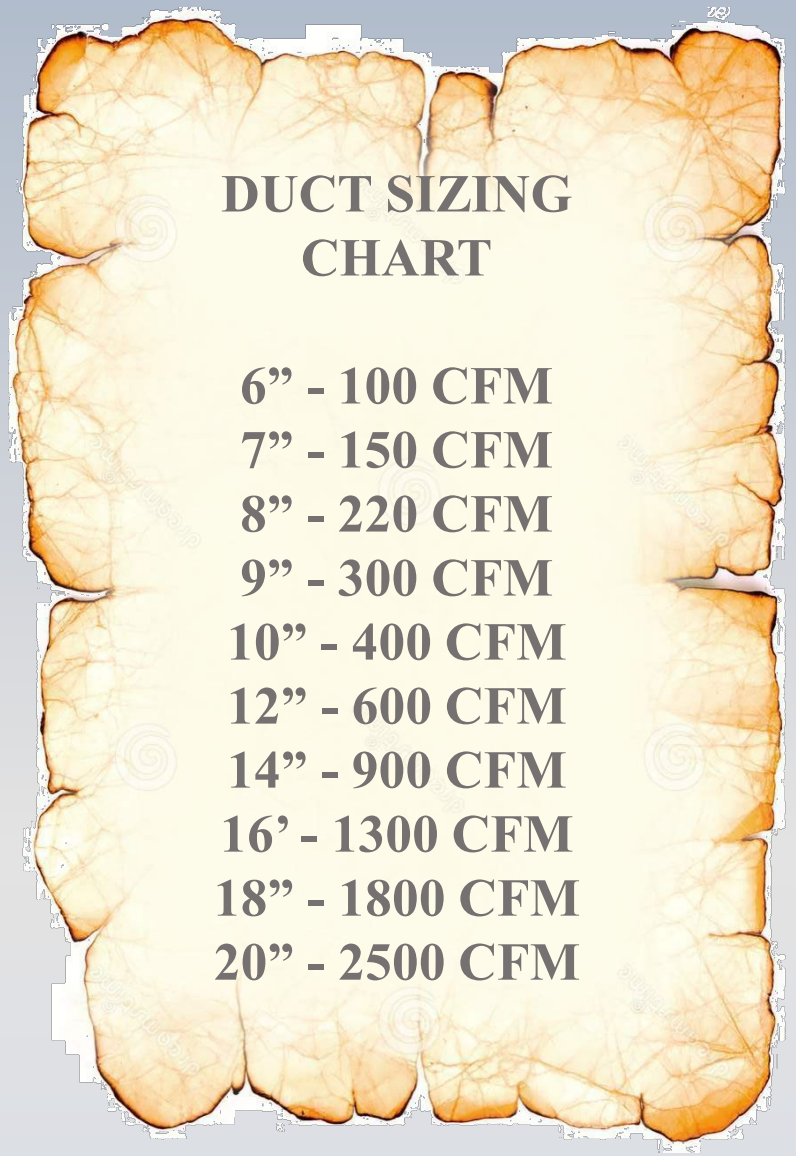


A system is:

- Built by a mechanical contractor
- It consists of ducts, fittings, grilles venting, flues, is attached to the building and the equipment
- Now, it can also be measured and scored.

Many believe installed system performance is found through design

- Dad's Duct Sizing Chart
- Began to purchase instruments and to test installed system values
- Learn our designs did not perform as we assumed they did.
- Began to make changes in design, equipment and installation.



“So, how do I know my installed systems are operating as they should?”

The *Western HVAC Performance Alliance* defines an efficient HVAC system by the ratio of the **installed system delivered Btu/hr** and the **equipment rated Btu/hr.**

Example:

$$\frac{\text{Installed System delivered Btu/hr}}{\text{Equipment rated Btu/hr}} = \frac{48{,}000}{100{,}000}$$

Or, expressed as a percent **48%**

100%

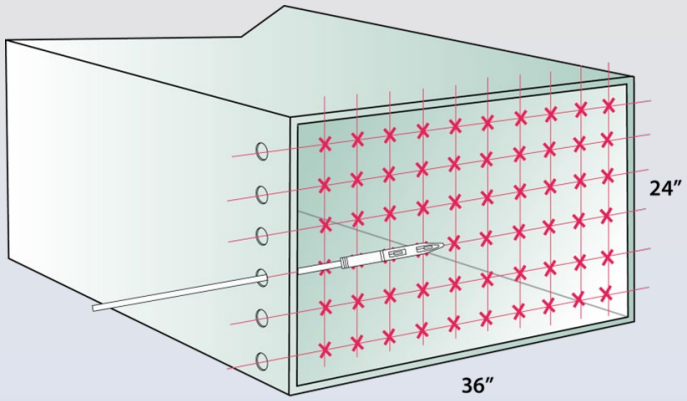
or

48%?

1a. Fan Airflow

Measure

- Traverse airflow near fan
- Plot fan airflow

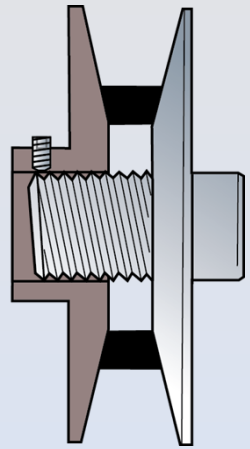


Diagnose

- Compare actual fan airflow to required airflow
- If actual is more or less than 10% of design, make repairs and adjustments

Repair

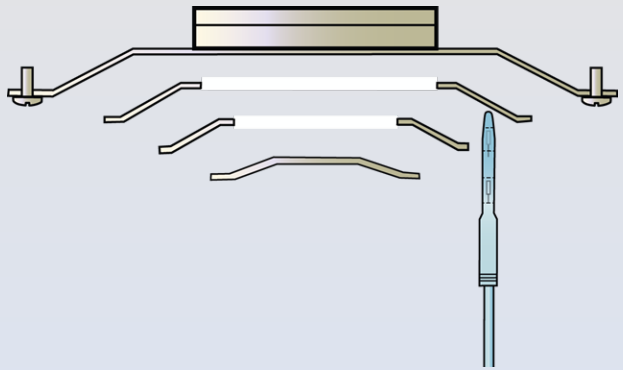
- Adjust fan speed
- Reduce restrictions in system components or in air distribution system



1b. Supply Register and Return Grille Airflow

Measure

- Air balance hood
- Traverse in duct or at grille with correction factors



Diagnose

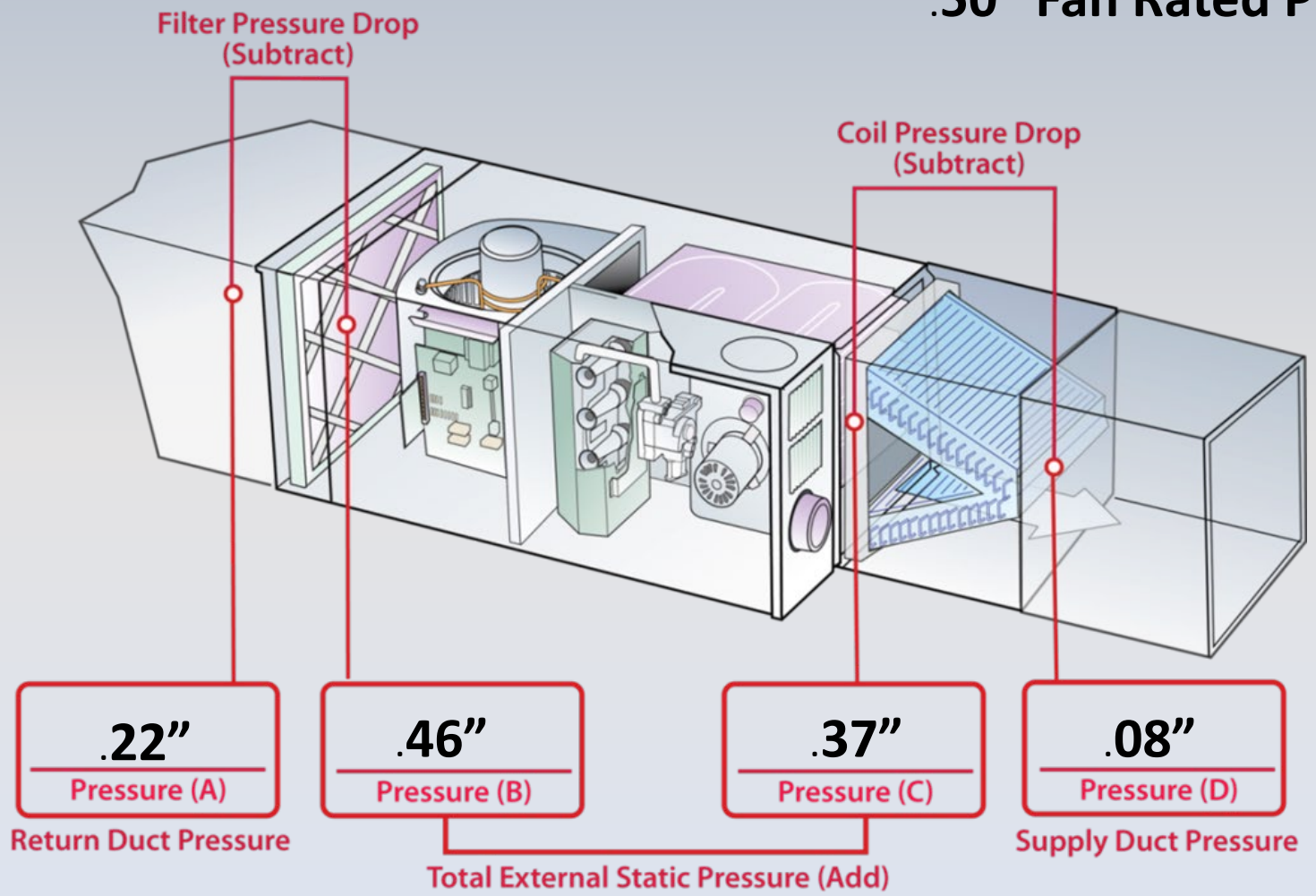
- Add together grille or register airflows and compare total to fan or required system airflows
- Compare required room and zone airflows to actual airflows

Repair

- Adjust balancing dampers
- Repair or replace damaged or undersized ducting
- Replace register or diffuser

1c. Static Pressure Profiles

.50” Fan Rated Pressure



Pressure	Actual	Budget
Total Ext.	.83”	.50”
Filter	.24”	.10”
Coil	.29”	.20”
Return	.22”	.10”
Supply	.08”	.10”

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1d. Static pressure testing

Measure

- Total external static pressure
- Filter pressure drop
- Coil pressure drop
- Supply and return duct pressure drop
- Obstruction pressure drop

Diagnose

- Compare each pressure measurement to specification
- Compare each pressure drop to appropriate static pressure budget

Repair

- Increase duct system capacity
- Remove restrictive filters and fittings
- Clean coils
- Remove obstructions in duct and reconnect duct

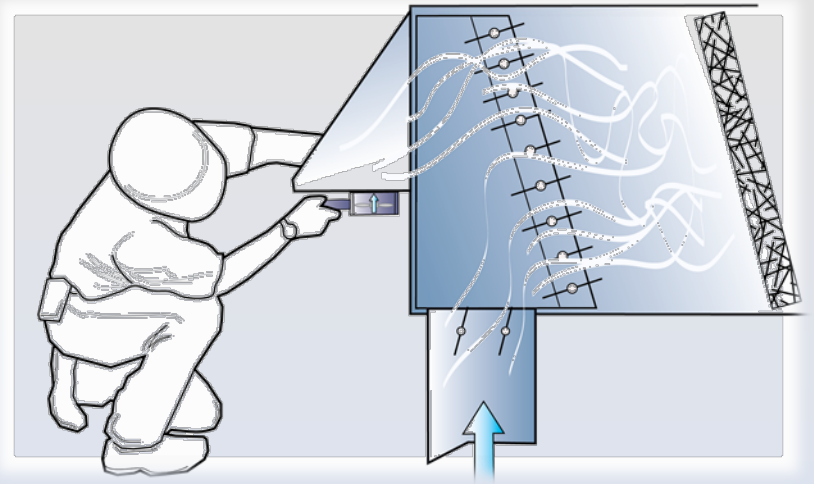
1e. Economizer Airflow

Measure

- Measure economizer airflow at minimum position
- Measure economizer airflow at full open position

Diagnose

- Compare actual economizer airflow to design airflow



Repair

- Adjust economizer louvers and controls to meet design airflow.
- Replace economizer components and controls or replace economizer

1f. Power Measurement

Measure

- Verify fam motor watt draw for variable speed fans
- Measure system watt consumption and delivered system Btu to calculate installed system EER

Diagnose

- Compare measured motor watt draw to watts reported for equipment rating
- If system Btu delivered/EER Watts consumed, continue testing to discover cause of low performance.

Repair

- Reduce wattage by bringing blower motor into spec. May require system renovation
- Pinpoint system defects deteriorating performance and make needed repairs

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2. Temperature Measurements

a. Equipment and ambient air temperatures
b. Supply and return duct temperatures
c. Room temperatures
d. Refrigerant and combustion circuit temperatures

Air temperatures are of little diagnostic worth unless airflow values are measured and considered.

2a. Equipment and ambient air temperatures

Measure

- Measure dry bulb temperatures for heating and wet bulb temperatures for cooling
- Temperatures entering and exiting the equipment
- Ambient outdoor air

Diagnose

- Subtract to find equipment temperature change.
- Considering equipment airflow, and ambient temperature, evaluate temperature change

Repair

- Adjust fan speed
- Repair defective equipment parts or components
- Adjust refrigerant or combustion circuit

2a. Equipment and ambient temperatures

Measure

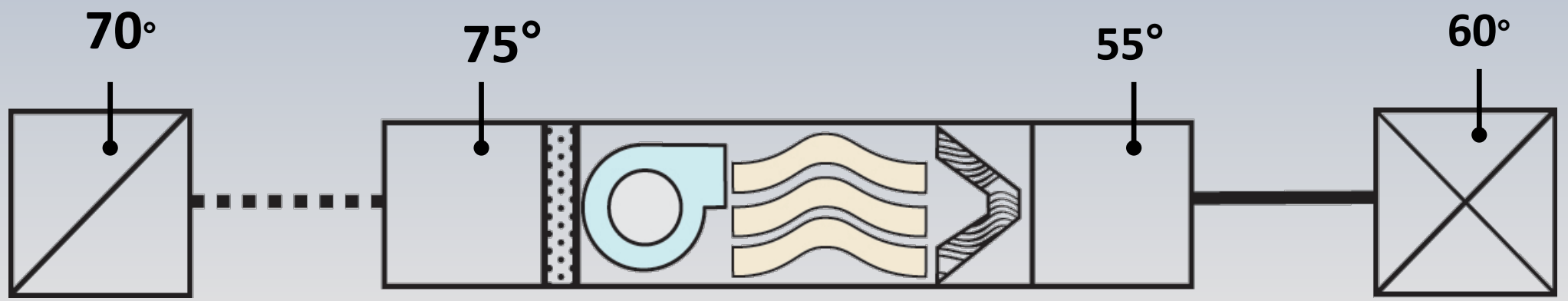
- Equipment entering
- Equipment exiting
- WB Cooling
- DB Heating
- Ambient air temperature

Diagnose

- Calculate equipment temperature change and duct losses
- Compare to required temperature change

Repair

- Adjust airflow
- Test and adjust refrigerant circuit
- Test and adjust combustion circuit



What is the equipment Δt? **20°**

What is the system Δt? **10°**

What is the return duct Δt? **5°**

What is the supply duct Δt? **5°**

2b. Supply and Return Duct Temperatures

Measure

- Measure dry bulb temperatures entering and exiting the supply and return duct system
- Measure air temperatures in duct locations

Diagnose

- Subtract to find duct system temperature loss or gains.
- Total supply and return temperature changes exceeding 10% of equipment Δt may require repair

Repair

- Decrease duct leakage
- Install additional insulation
- Move ducts into conditioned space

2c. Room Temperatures

Measure

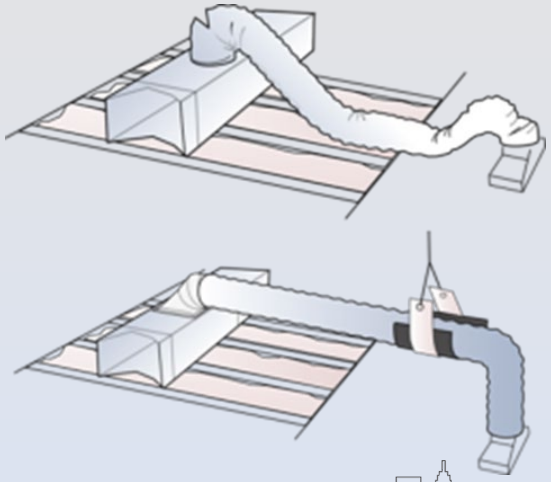
- Each rooms air temperature (inside wall, chest high, away from windows, supply registers or heat sources.)

Diagnose

- Compare room temperature differences to evaluate building temperature balance.

Repair

- Balance the HVAC system.
- Prescribe building envelope repairs



2d. Refrigerant and combustion circuit temperatures

Measure

- Complete airflow, temperature, draft 0_2 and CO measurements and
- Complete airside measurement before connecting refrigerant gauges

Diagnose

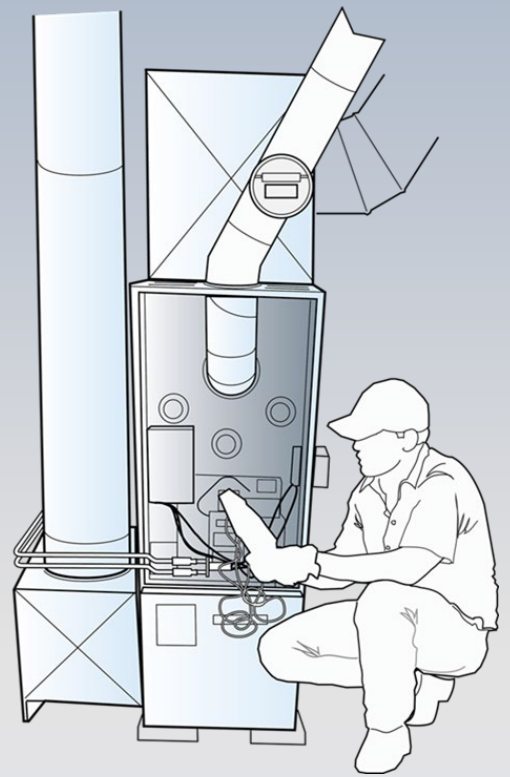
- Compare combustion measurements to combustion testing standards
- Diagnose airside measurements. If needed, connect gauges to continue diagnostics

Repair

- Make required Combustion adjustments (Airflow, venting, CO and Combustion repairs)
- Make required airside and refrigerant repays

3. Btu capacity and delivery

a. System Btu delivery



Sensible Btu = Airflow in cfm x temperature change x 1.08

Total Btu = Airflow in cfm x enthalpy change x 4.5

3a. Installed System Btu delivery

Measure

- Supply register airflow
- Average Supply Register air temperature and average return grill air temperatures

Diagnose

- Apply the system delivered Btu formula
- Compare delivered Btu to rated Btu
- Use additional test data to diagnose defects

Repair

- Make needed repairs as directed by diagnostics
- Typical repairs include system renovation, balancing, adjustment and verification

Conclusion – Improve HVAC system delivered capacity

To measure, diagnose and repair is the **universal process** to improve performance:

- **Used by** surgeons and physicians, consultants, the automotive Industry, accounting firms, manufacturers, engineers and maintenance professionals
- HVAC professionals **follow this process daily** for typical repairs
- **New technology and training** now enables HVAC professionals to measure, diagnose, repair and improve the delivery of HVAC system efficiency.

Thank You!

From National Comfort Institute

For additional information call: 800-633-7058

For the latest training schedule: NCILink.com/ClassSched

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