BUILDING PERFORMANCE INSTITUTE TECHNICAL STANDARDS FOR CERTIFIED HEATING SPECIALISTS

Health and Safety

Personal Safety

All technicians performing diagnostic tests, inspections, or installations, must have access to all necessary personal safety equipment required by OSHA. Required safety equipment includes, but is not limited to:

- ✓ Fitted respirators with canister filters
- ✓ Dust masks
- ✓ Gloves
- ✓ Protective clothing
- ✓ Safety glasses
- ✓ Hard hats, as required

Technicians must be trained in proper use and applications for these devices and must adhere to OSHA regulations when on the job site.

All hand tools, power tools, ladders, and diagnostic equipment must be handled and used in a safe manner and kept in good working condition. Equipment and diagnostic tools must be maintained and calibrated according to manufacturer's specifications.

A copy of the Material Safety Data Sheets (MSDS) for all materials used on the job and installed in the home, must be kept on each crew vehicle and made available to all workers and clients upon request.

Where the presence of asbestos, lead, mold and/or other known or suspected hazardous material is present, all relevant state and federal (EPA) guidelines must be followed to ensure technician and occupant safety. Blower door depressurization tests may not be performed in homes where there is a risk of asbestos becoming airborne and being drawn into the dwelling.

Respirators with filter cartridges must be worn when working in areas where exposure to airborne mold, asbestos, lead, fiberglass, or formaldehyde is a risk.

Carbon monoxide levels in the ambient air around the technician must be monitored throughout all combustion safety tests. Diagnostic evaluations and inspections must be aborted if ambient CO concentrations greater than 35 ppm are recorded. CO producing appliances must be disabled and repaired before proceeding with additional diagnostics or inspections.

Refer to standards on combustion safety (Building Analyst I) for requirements applicable to carbon monoxide exposure.

Electrical power must be shut off before working on mechanical equipment.

Occupant Safety

A deteriorated chimney must be repaired or relined and the cause corrected before reusing. Repairs and/or replacements must be installed in compliance with the following standards: NFPA 31 for oil fired units, NFPA 54 for gas fired units, NFPA 211 for solid fuel units.

Measured carbon monoxide levels of undiluted flue gases in combustion appliances should be below 25 ppm. Appliances with multiple burners may have multiple ports and CO must be measured in each one. Efforts should be made to lower the CO level if it is higher than 25 ppm, but in no case should the level be higher than 100 ppm without servicing the system to reduce its CO production. If CO levels exceed 100 ppm and the appliance spills under natural conditions, the problem must be repaired before proceeding with other measures.

A thorough inspection of the fuel supply for both oil and gas must be conducted to ensure the system is leak free. Leaks that are found must be repaired prior to proceeding with work on the system.

The following are the minimum required health and safety diagnostics and specifications for Heating Specialist level certification. These requirements are in addition to those set forth in the BPI Technical Standards for Certified Building Analyst I. Minimum health and safety requirements apply to all jobs with work related to energy efficiency and/or indoor air quality performed by BPI accredited firms.

Minimum Health and Safety Requirements
(Heating Specialist)

(refer to main text and the Building Analyst I Standards for detailed descriptions and applications of the standards below)

- Combustion appliances which fail any combustion safety test, as described in the Building Analyst I Standards, must be adjusted, repaired, or replaced; and the problem effectively remedied before proceeding with additional installations.
- When atmospherically vented combustion appliances are removed or replaced with sealed combustion units, a blower door test must be done to verify adequate air exchange across the building shell. Mechanical ventilation must be added, as needed to provide adequate air exchange in compliance with ASHRAE 62-89.
- When a high efficiency appliance, such as a furnace, is installed and no longer requires chimney venting, "orphaned" water heaters must be tested and verified for safe operation.
- In homes with natural gas service, the gas line must be inspected thoroughly and all leaks repaired.
- Forced warm air furnaces must be inspected for flame interference and additional heat exchanger integrity tests must be performed as indicated by the flame interference inspection. Cracked heat exchangers must be replaced.
- Steam distribution system pipes must be insulated in all accessible locations.
- All water heaters must have a pressure and temperature relief valve and a safety discharge pipe. Install a relief valve and discharge pipe if none exists.

Heating System Replacement and New Installations

Replacement System Sizing
New installations of heating systems must be designed and sized based on actual heating load calculations for the building. Acceptable sizing calculation methods include ACCA Manual J and Manual S, IBR load calculations, or other comparable calculation procedures. Replacement systems may not be sized larger than the existing system without providing a load calculation verifying the need for a larger system. Gas and electrically fueled heating systems must be sized within 25% of calculated design loads. Oil fueled heating systems must use the smallest available burner size that meets the calculated heating load for the building.

It is recommended that blower door test results are used to determine the building air leakage rates input into load calculations.

Hydronic Systems
New installations of hydronic distribution systems shall be designed based on actual calculated Btu loads for the space being conditioned utilizing Manual J or comparable calculation methodology. Radiator size must be within 20% of calculated loads for the space being conditioned.

Ducted Distribution Systems
New installations of ducted distribution systems shall be designed to provide the appropriate airflow based on actual calculated Btu loads for the space being conditioned using Manual J or comparable calculation methodology. Duct systems shall incorporate provisions for friction losses in the design, and shall provide for balanced supply and return airflows in each zone of the building. After installation, register airflows must be measured and verified to deliver airflows that are within 20% of design airflows. Deviations from design criteria greater than 20% must be corrected.

New installations of ducted distribution systems must be tested for leakage using a duct leakage testing device and duct tightness must meet or exceed the requirements set forth in the EPA standards for Energy Star Ducts. The sum of the supply and return leakage to outside, measured in cfm25, divided by the fan flow shall be no more than 10%.

When quantifying duct leakage, an appropriate type of measurement system shall be used, which includes a metered and calibrated duct pressurization device.

Maximum Allowable Duct Leakage Calculation Example

System Airflow: 1200 cfm

Formula:
Total_Allowable_ Duct_Leakage = System_Airflow x 0.10

Example:
Total_Allowable_Duct_Leakage = 1200 x 0.10 = 120 cfm25

Note: This calculation is based on duct leakage to outside. Leakage to outside must be determined through direct testing using a duct leakage pressurization device in conjunction with the blower door. If a blower door is not available, duct leakage to outside may be estimated by measuring total duct leakage and estimating the percentage of measured leakage that is leaking to outside based the location of the ductwork.

Replacing Naturally Vented Appliances
When atmospherically vented combustion appliances are replaced with sealed combustion units, an exhaust appliance has been removed from the home. To ensure that the building will have adequate air exchange after this retrofit, a blower door test must be completed and mechanical ventilation installed as needed to provide ventilation levels compliant with ASHRAE Standard 62-89. This procedure must be followed even if no alterations to the building shell are anticipated as part of the work scope.

When a high efficiency appliance, such as a furnace, is installed and no longer requires chimney venting, "orphaned" water heaters must be tested for safe operation. Water heaters may not be left venting alone into a previously shared chimney without ensuring the chimney meets appropriate NFPA requirements under the new condition and the water heater has been tested and passed all required combustion safety tests (spillage, draft, CAZ depressurization).

Water Heater Replacements
Domestic hot water heater replacements shall be sized according to the guidelines established by the Gas Appliance Manufacturer's Association (GAMA). The first hour rating for new systems shall match the calculated peak hour demand within 1-2 gallons. When installing new water heating systems or retrofitting existing systems, measures to reduce the peak demand should be recommended as part of the work scope.

General Heating System Inspections

Combustion Gas Analysis
A combustion gas analysis is required on oil-fired and gas-fired furnaces and boilers, any time replacement or repair is not part of the intended work scope.

A complete clean and tune of the heating system shall be recommended whenever:

- The system shows signs of neglect or the customer indicates it has not been serviced within 1 year for oil systems or 2 years for gas systems.
- Safety diagnostics indicate a problem.
- Airflow diagnostics indicate incorrect flow that is not readily correctable.

Default Multipliers for Heating System Efficiencies

If you have manufacturers rated AFUE for the system, use it to calculate the system efficiency

If you do not have the manufacturers rated AFUE, for forced air furnaces, use the furnace Steady State Efficiency as determined by completing a Combustion Efficiency Test. The efficiency of the forced air system equals the efficiency determined by the Steady State Efficiency Test result multiplied by the distribution efficiency.

For the following types of heating systems use the measured Steady State Efficiency multiplied by the default from the table below multiplied by the distribution efficiency to get the system efficiency.

	System Type	**Default Multipliers**
Air	Forced Air	Use test value
	Gravity Feed	0.8
	Freestanding Heater	0.95
	Floor Furnace	0.9
	Wall Furnace	0.85
Water	Forced Circulation (high mass)	0.85
	Forced Circulation (low mass)	0.9
	Gravity Feed	0.85
	Steam	0.75

For use in savings calculations and system sizing, seasonal efficiency must be calculated and applied. To determine the seasonal efficiency, first obtain the rated AFUE for the system. AFUE is assigned efficiency of an appliance. A standard efficiency forced air furnace will have an AFUE of approximately 65%, while a newer non-condensing furnace will have a nominal AFUE of 80%. A condensing furnace will have an AFUE of 90% or greater. (Actual AFUE ratings may be found in the GAMA listing.)

Associate efficiency to the distribution system using the chart below, or use accepted modeling tools that take distribution losses into account. The seasonal efficiency is equal to the AFUE multiplied by the distribution efficiency.

Distribution Efficiency Look-up Table

Distribution Efficiency Table

System Charateristics (there are 3 questions you need to answer about the distirbution system)

1 What percentage of the ducts are located within the conditioned space
2 How well are the connections on the duct system sealed
3 What is the insulation value on the ducts for the portion outside the conditioned space

	1. % within conditioned space			2. Duct leakage Charateristics					3. Duct insulation value		
Distribution Efficiency	90% or more inside envelope	50% or more inside envelope	less than 50% inside envelope	Connections sealed w/mastic	No observable leaks	Some observable leaks	Significant leaks	Catastrophic leaks	Ducts outside envelope R-8 or greater	Ducts outside envelope R-4 - R-7	Ducts outside envelope < R-4
95%	XXX			XXX					XXX		
94%	XXX			XXX						XXX	
93%	XXX			XXX							XXX
94%		XXX				XXX				XXX	
93%		XXX				XXX					XXX
92%		XXX				XXX					
90%		XXX					XXX			XXX	
89%		XXX					XXX				XXX
88%		XXX					XXX				
85%		XXX						XXX		XXX	
84%		XXX						XXX			XXX
83%		XXX						XXX			
80%		XXX							XXX	XXX	
79%		XXX							XXX		XXX
78%		XXX							XXX		
90%			XXX		XXX					XXX	
89%			XXX		XXX						XXX
88%			XXX		XXX						
84%			XXX			XXX				XXX	
83%			XXX			XXX					XXX
82%			XXX			XXX					
80%			XXX				XXX			XXX	
79%			XXX				XXX				XXX
78%			XXX				XXX				
75%			XXX					XXX		XXX	
74%			XXX					XXX			XXX
73%			XXX					XXX			
70%			XXX						XXX	XXX	
69%			XXX						XXX		XXX
68%			XXX						XXX		
80%				XXX	XXX					XXX	
79%				XXX	XXX						XXX
78%				XXX	XXX						
74%				XXX		XXX				XXX	
73%				XXX		XXX					XXX
72%				XXX		XXX					
70%				XXX			XXX			XXX	
69%				XXX			XXX				XXX
68%				XXX			XXX				
65%				XXX				XXX		XXX	
64%				XXX				XXX			XXX
63%				XXX				XXX			
60%				XXX					XXX	XXX	
59%				XXX					XXX		XXX
58%				XXX					XXX		

Example: If you have a system with more than 90% inside the conditioned space (i.e. in a heated basement) and the system is sealed with mastic and the portion of the duct system that is not in the heated space has an R-value of R-4, the distribution efficiency of the system is 94%.

Gas Systems

Gas Supply Safety
The entire gas line must be examined and all leaks repaired. Particular care should be made in the immediate vicinity of the appliances and at the joints, shutoff valves, and pilot lines. Identify leaks using a gas leak detector and accurately locate the source of the leak using a soap bubble solution.

Flexible gas lines must be replaced if they are: kinked, corroded or show signs of visible wear, the line was manufactured before 1973 (date is stamped on the date ring attached to the line), or the line has any soldered connections.

Gas Appliance Safety Inspection
In addition to the testing and inspection procedures set forth in the BPI Technical Standards for Building Analyst I, the following inspections shall be completed.

No significant carbon buildup should be visible anywhere in the unit. This includes the draft hood, heat exchanger, and burners. If carbon is present, it must be totally removed and the source of the combustion problems must be determined and remedied before proceeding.

The burner flames must be directly inspected to ensure that all burners are operating properly. The flames should be consistent with the burner design. All sections of the burner should be ignited properly with no irregularities in the flame, ghosting, or white tips on the flames. If the flames are not firing properly, the burner jets must be cleaned.

Thermostat anticipator settings must be adjusted, as needed, to match the amperage measured in the control circuit or to meet the thermostat manufacturer's specifications.

Oil Systems

Oil Supply Systems
Fuel oil supplied to a combustion appliance must be free of water and other contaminants. In cold climates, steps shall be taken to ensure continuous flow and to avoid freeze ups.

Fuel oil storage system integrity must be checked and appropriate necessary repairs included in the work scope.

When a new oil heating system is installed, the oil filter must be replaced and deposits at the bottom of the tank must be removed. Tank and oil lines must be in compliance with NFPA 31.

Oil Appliance Safety Inspection
In addition to the testing and inspection procedures set forth in the BPI Technical Standards for Building Analyst I, the following inspections shall be completed.

All oil-fired heating systems must be equipped with a barometric draft control, except for systems with high-static pressure burners or mobile home units.

CAD cell or stack control activation must be timed to verify that the burner will shut off if the fuel is not ignited.

Oil Burner Replacements
Where burner and nozzle replacements are installed, the assembly must be sized according to actual building heat load calculations. Oil systems may be downsized by replacing the nozzle using the following criteria:

- With cast iron head burners, the firing rate may not be reduced below the manufacturer's rating. (Check the nameplate for acceptable firing rates.)
- With flame retention head burners, the flue gas exit temperature must not go below 325 degrees F.

Where CAZ depressurization is a problem, a high static pressure retention head may be installed as an alternative to providing make-up air to the system as long as no other combustion appliances exist in the CAZ.

Furnaces and Forced Air Distribution

Heat Exchanger Inspection
Forced warm air furnaces must be inspected for flame interference. Visually inspect the burner as the blower fan comes on. If the flames burn differently when the blower comes on, a complete analysis needs to be done to find the source of the flame interference. Appropriate inspection techniques include visual inspections using a mirror and flashlight or tracer gas tests when the problem is not visually apparent. This problem must be referred to a heating system service contractor for repairs. A cracked heat exchanger cannot effectively be repaired and must be replaced.

Furnace Airflow
Heating system airflow shall be measured before and after work is performed on the system or its ductwork. Forced air furnaces must be tested using a heat rise measurement.

Forced air furnace airflow must be within manufacturer's specifications. Where the rated temperature rise range is not indicated on the furnace nameplate, ensure the measured temperature rise is within 40-70 degrees F. For standard efficiency furnaces where the rated temperature rise range is not indicated on the furnace nameplate, ensure the measured temperature rise is within 70-100 degrees F. For 80% and 90% AFUE units, the heat rise will vary depending on the manufacturer. In most cases, it will fall within 20-60 degrees F.

If the heat rise on a forced air furnace is higher than manufacturer's specifications, repairs must be completed to increase the airflow. Measures may include: cleaning of filters or removing blockages in the ductwork, adding returns, and increasing the fan speed.

If the heat rise is lower than the manufacturer's specifications and the customer has indicated concerns of uncomfortable conditions in the home, (i.e. cool delivery temperatures), check that the fan speed is not set too high. On rare occasions the gas input may be may be too low or the orifice may be too small. If you suspect this, measure the gas input and adjust it to the correct recommended pressure, or chance the orifice to the correct size.

The fan off temperature must be set as close to 90 degree F as possible.

The fan on temperature must be set as close to the fan off temperature as possible (usually 120-130 degrees F), but the fan on delay may be no shorter than 20 seconds after the gas valve is energized.

If the limit switch setting is low enough to cause cycling during a 5-minute test, the switch can be reset, but never above 275 degrees F.

Duct Leakage
When quantifying duct leakage, an appropriate type of measurement system shall be used, which includes a metered and calibrated duct pressurization device. Pre and post-installation duct leakage shall be measured any time that duct sealing is part of the work scope to verify the success of the installation.

Duct leakage areas must be diagnosed using appropriate duct leakage testing equipment and/or pressure pan tests to prioritize leakage areas (treating the largest leaks and the highest pressure areas first) anytime duct sealing is installed.

Use the following checklist as a guide for prioritizing duct sealing installations:

- ✓ Seal the largest leaks first. These include: disconnected ducts, missing end-caps, and other catastrophic holes
- ✓ Seal the areas of highest pressure. These included all the connections near the air-handler cabinet and supply and return plenums, flexible canvas plenum connectors, and filter slot covers.
- ✓ Seal all return leaks which may be contributing to negative pressures in the combustion appliance zone.
- ✓ Seal all accessible connections between duct sections, at branches, and where take-offs connect to main trunk lines.
- ✓ Seal take-off connections to register boots and boot connections to floors, walls, and ceilings.

Sheet metal and flexible ductwork shall be sealed at all duct connections using duct mastic or similar product designed for sealing ducts. Duct tape is not an allowable duct sealing material. Aluminum FSK tape may be used on ductboard systems and at the connections to the air handler cabinet.

Filter slots must be tightly covered and the cover must be easily removed for cleaning and/or replacement. The homeowner should be instructed to replace the filter at every month for oil systems and every three months for heat pumps and gas systems.

Boilers and Hydronic Distribution

Hydronic System Safety and Efficiency Inspection
All systems must have an appropriate pressure relief valve, an operating pressure gauge, and a high temperature aquastat.

All water leaks must be identified and repaired.

All systems must have an operating control that will disable the gas valve when the high water temperature setting has been reached.

Open expansion tanks must be replaced with sealed and pressurized expansion tanks.

An effective air-excluding device must be installed as part of any new hydronic system.

All heating supply pipes in unconditioned areas must be insulated with closed-cell foam or fiberglass pipe insulation.

Thermostatic radiator valves may be used to balance temperatures from room to room, but cannot be installed on series loop systems.

Steam Distribution

Steam System Safety and Efficiency Inspection
Steam boilers must be equipped with high pressure limits and low-water cut-off controls. High pressure limit controls must be set at or below 10 psi.

Low-water cut-off flush valves that leak or are inoperable must be repaired or replaced.

Steam vents must be operable and all radiators must receive steam during every cycle. Unplug vents as necessary.

Check steam traps with a digital thermometer or listening device to detect any steam escaping from the radiators through the condensate return. Replace leaking steam traps or their thermostatic elements. Repair leaks on the steam supply piping and on the condensate return piping.

All exposed steam piping in conditioned and unconditioned areas must be insulated with pipe wrap rated for steam pipes.

Domestic Hot Water Systems

All water heaters must have a pressure and temperature relief valve and a safety discharge pipe. Install a relief valve and discharge pipe if none exists. The pipe must terminate 6 inches above the floor and be made of copper or high temperature plastic.

Water heater insulation wraps shall not cover the top of oil or gas systems, and shall not obstruct the pressure relief valve, thermostats, hi-limit switch, plumbing pipes, or access plates. A minimum 2-inch clearance is required from the access door for gas burners.

Water heater insulation wraps shall not be installed where forbidden by the manufacturer's instructions found on the nameplate.