U.S. Safety Standards

Gas Fired Furnaces, Boilers and Water Heaters

Presented By

Frank A. Stanonik

Gas Appliance Manufacturers Association

U.S. Safety Standards

- Focus on safety standards for Gas-Fired Furnaces, Boilers and Water Heaters
- Developed by ANSI accredited Z21/83 Committee with CSA America support
- Most standards are harmonized U.S. and Canadian standards

Specific Standards

- These specific standards are:
  - Z21.13 Gas-Fired Low Pressure Steam and Hot Water Boilers
  - Z21.47 Gas-Fired Central Furnaces

Specific Standards

- Z21.10.1 Gas Water Heaters, Volume 1, Storage Water Heaters with Input Ratings of 75, 000 Btu Per Hour or Less

- Z21.10.3 Gas Water Heaters, Volume III, Storage Water Heaters with Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous

Specific Standards

- Apply to residential and commercial/industrial appliances; natural gas or propane fired
- First standards developed in 1910's by gas utilities. In late 1920's evolved to national, consensus standards.
- First standards addressed safety and performance.

Specific Standards

- Today, standards primarily address safety although some performance tests still remain
- Efficiency requirements and test procedures are now addressed by U.S. federal regulations

Basic Elements of Safety Standards

- Several key considerations are applicable when addressing the safety of a gas appliance

Minimum Construction Criteria

- Specifications for some basic structural integrity and strength of the appliance.

  Examples:

  Gas carrying components must be made of metal with minimum melting point temperature of 800 ^{0} F.

  Gas controls and safety devices, must comply with the applicable standard for that component.

Control of the Fuel

- The gas controls and connections on appliances must be leak tight. Maximum leak rate:

  235 cc per hour internal leakage

  200 cc per hour external leakage

Control of the Fuel

- At normal U.S. gas system pressures 235 cc per hour represents about 6 Btus of natural gas or about 12 Btus of propane in a one hour period.

Safe Lighting

- Standards include a variety of tests to evaluate:
  - Burner lights safely and properly
  - Proper ignition system operation when ignition of main burner does not occur
  - Proper safety control operation when flame is lost while burner is on

Safe Lighting

- These test are conducted under a range of conditions
  - Different Gases
  - Reduced, normal and increased inlet pressure
  - Varying input rate
  - Under voltage and over voltage

Proper Combustion

- The standards address proper combustion in terms of a maximum allowable rate of carbon monoxide (CO) production. The CO limit for these appliances is 400-ppm air free
- Even though all these appliances are installed with venting systems, the CO production of the combustion process is covered by the standards

Proper Combustion

- There tests are also conducted under a range of conditions.
  - Increased input,
  - reduced and normal inlet pressure,
  - reduced voltage

Proper Combustion

- These standards presently do not include any tests for Nitrous Oxide (NO_x) emissions. Some states have regulations limiting NO_x emissions from gas-fired furnaces, boilers and water heaters but this is an outdoor environmental issue.

Fire Hazard

- Since the appliances are burning a fuel, the standards must address the heat produced by the appliances and concerns that the fire does not escape outside the appliance
- Tests to evaluate the minimum clearance required from combustible construction. The combustible construction is wood painted black to maximize the heat absorbing characteristics.

Fire Hazard

- Appliance is operated under extreme conditions
- High temperature limit devices are also evaluated to minimize likelihood of overheating
- Standards require safety devices to sense if flame rolls out of the combustion chamber .

Electrical Safety

- Basic requirements for wiring and electrical clearances. Otherwise, reference electrical standards for more detailed requirements of electrical components
- Safety circuit analysis required for controls

Test Gases and Pressures

- Standards include requirements to conduct most tests with a set of test gases and test pressures

Test Gases and Pressures

- The test gases for a natural gas appliance are:

	Heating Value	Specific Gravity
Natural	1075 Btu/ft^3	0.65
Butane-Air	1400 Btu/ft^3	1.42

Test Gases and Pressures

- The test gases for a propane gas appliance are:

	Heating Value	Specific Gravity
Propane	2500 Btu/ft^3	1.55
N-Butane	3200 Btu/ft^3	2.00

Test Gases and Pressures

- Many tests are conducted at the following test pressures:

	Natural	Propane
Reduced	3.5” w.c	8” w.c
Normal	7” w.c	11” w.c
Increased	10.5” w.c	13” w.c

Test Gases and Pressures

- Test gases evaluate the burner's ability to handle gases of varying Btu value and characteristics
- Test pressures recognizes that the pressure of the gas distribution system varies across the U. S. and that pressure excursions do occur occasionally

Manufacturing and Production Tests

- The standards include requirements for tests that the manufacturer must conduct to check that production units match the certified design.
- Some basic tests are specified to be done on every unit; more complex tests are required on an audit basis

Unique Requirements

- While all standards have the same basic set of requirements, each of these standards have some unique requirements

Unique Requirements- Furnaces

- This standard includes a test to evaluate the integrity and durability of the heat exchanger
- As more efficient furnaces were developed, issues came up regarding increased wetting of the combustion chamber and the introduction of new materials used to construct heat exchangers

Unique Requirements- Furnaces

- Standard includes a test to categorize the venting system required for the furnace based on the pressure in the vent and likelihood of condensation occurring

Unique Requirements - Boilers

- The boiler standard also includes the test to categorize the venting system
- Requires that the boiler construction comply with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code
- Includes specifications for safety controls on the pressure vessel of the boiler

Unique Requirements –Water Heaters

- Includes requirement for controls to prevent the water temperature from reaching 212^0 F .
- This distinguishes water heaters from boilers.

Unique Requirements –Water Heaters

- Include safety controls to limit the pressure of the heated water in the storage tank
- Include requirements regarding control of the water temperature to address concerns of scalding from water that is too hot

Unique Requirements –Water Heaters

- Recent change, residential storage water heaters must not ignite flammable vapors outside the water heater

- Added in response to information from the U.S. Consumer Product Safety Commission concerning accidents where gasoline or other flammable liquid is spilled in a home

Unique Requirements –Water Heaters

- These gas water heaters now employ designs that prevent the water heater from lighting any flammable vapors that may be generated outside the water heater