Utility Emergency Response Procedure

April 25, 2012

Overheated Boiler Policy - Emergency Response

Issue:
An “Overheated Boiler” condition is created when a heating unit reaches an exceedingly high temperature and pressure, and will not shut off. This condition, also commonly referred to as a “Runaway Boiler”, is considered unsafe and very hazardous to both emergency responders and building occupants. This condition is primarily caused by coincidental failures of redundant safety controls that maintain safe temperature, pressure, gas supply, and water supply.

Description:
Although an “Overheated Boiler” is an uncommon condition because it requires multiple control failures to occur simultaneously, the potential hazard does exist. According to the National Board of Boiler and Pressure Vessel Inspectors, more than 30,000 boiler and pressure vessel accidents have taken place in the U.S. since 1990.

When boilers or furnaces experience an overheated condition, catastrophic damage to the heating unit, safety controls and components is likely. **This emergency condition should be treated with a similar response to an inside gas leak with open air gas readings 1% or greater. In these cases, service technicians are expected to evacuate all occupants (including themselves) from the premises, and keep the public a safe distance away from the building.** Dispatch should be notified to report the situation to supervision and request assistance, as required.

Review of basic operation and explosion/fire risks associated with various types of heating systems:

**Hot Water Heating (Hydronic) System**

A hot water boiler is filled with water and maintains a cold pressure of 12 – 15 PSI by means of a pressure reducing valve connected to the domestic water supply. It is connected to a closed piping system that allows water to be circulated via a pump through radiation connected to the distribution loop. Circulation of the heated water may be impacted by accumulations of air, frozen pipes, or a failed circulator pump. The expansion tank absorbs expansion of the heated water in the system and maintains the boiler pressure under the operating range of the pressure relief valve (30 PSI for Residential).
During operation, the thermostat initiates a sequence that sends a signal to start the hot water boiler. The gas valve opens and the ignition system lights the burners. The burners heat the water contained inside the boiler vessel. The circulator pump turns on with the boiler and circulates the heated water through the system. The aquastat control wired in series with the gas valve will maintain the water temperature between its design temperature settings (normally 180 - 200 degrees). Some boilers may be equipped with a secondary temperature limit and / or a low water cutoff control (LWCO) for additional protection. The circulator pump will run until the thermostat shuts off the boiler.

A total failure of the gas valve, temperature controls, low water cutoff (LWCO), water circulation, pressure reducing valve, and/or the expansion tank can result in a rapid increase in boiler pressure that will be relieved by the pressure relief valve. The mechanical condition of the relief valve is critical for maintaining safe boiler pressures in the face of these potential failures because it is the last line of defense to prevent an over-pressurized boiler from exploding. Pressure relief valves must be carefully inspected and tested to make sure that the valve opens as designed when lifting the handle, and that the outlet piping is clear and installed in accordance with all applicable building codes. The set pressure of the relief valve must not exceed the Maximum Allowable Working Pressure (MAWP) of the boiler. The relieving capacity must equal or exceed the Btu input of the burner. Note: Customer permission is required to test the relief valve. If customer does not wish to have this test made, enter appropriate remarks in Work Management System. To make check, pull lever on relief valve and observe if water flows through the relief valve and valve reseats without dripping water. Advise customer if repairs are necessary.”

Explosion/Injury Risk:

1. Hot water boilers are at risk of over-pressurization when there is a failure of the relief valve and at least one other control described above.

2. Modern hot water heating boilers are connected to closed piping systems with potential to build up excessive pressure when water temperatures rise without control beyond the safe operating range (250 degrees). The typical maximum operating pressure of a residential boiler is 50 PSI; a commercial boiler is 80 PSI. (Manufacturers may design and mark boilers with higher MAWP ratings). Pressures that continue to rise above these ratings can result in a violent explosion when the boiler vessel fails. Technically, operating pressures must never exceed the marked MAWP.

3. Previous boiler failure incidents in the industry have occurred when safety controls failed to operate as designed due to mechanical failure (i.e., aquastat shorting out, damaged wiring, or failed gas valve) or human intervention. Some examples of human intervention include opening a gas valve in bypass (manual) mode, wiring errors, or removing or plugging a pressure relief valve to stop water from dripping.

4. Heating controls exposed to floodwater can fail even though they tested OK after being dried and placed back in operation. This is especially true for electromechanical components that may short out or fail after internal corrosion develops. Any controls exposed to flood water must always be replaced.
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5. A dangerous condition can occur when burners fail to shut off and the relief valve opens to relieve the excessive pressure that develops. The remaining water in the system can boil away if the water supply to the pressure reducing valve is shut off or the reducing valve is stuck closed. Without water, the boiler can reach extreme temperatures. If cooler water is introduced, it flashes into steam as it reaches the overheated surfaces inside the boiler. “Flash Steam” significantly increases the pressure in the boiler as the steam energy is released. This reaction can result in a cracked boiler or violent explosion. Never introduce water into an overheated boiler.

Steam Heating System

A steam system boiler is filled with water to a design level that is normally indicated half way up the gauge glass. The system pressure control safety (also known as a “pressuretrol”) maintains the steam pressure design for the system and is typically set to a range between ½ PSI and 3 PSI for normal residential operation. Note that the maximum pressure setting should be set to the minimum PSI required to supply adequate heat to the furthest radiator. Some boilers are equipped with a secondary pressure limit control set higher to prevent pressure from exceeding 15 PSI. The boiler distributes steam through an open piping system connected to radiators. These boilers are rated at a maximum 15 PSI pressure design per ASME Code. Steam boilers are equipped with a low water cutoff control that shuts off the burner if the water level falls below the design level, and a pressure relief valve that opens at 15 PSI. Steam boilers may also be equipped with controls that feed fresh water automatically when the water level falls below the design level and activates the LWCO control.

During operation, the thermostat initiates a sequence that sends a signal to start the steam boiler. The gas valve opens and the ignition system lights the burners. The burners heat the water inside of the boiler. The water starts to boil to produce steam. The steam exits the boiler through the piping system. As the steam pushes air out of the system piping through the radiator bleed vents, the boiler will continue to produce steam until the vents close and the steam pressure rises above the operating pressure control settings. The pressure control then cycles the burners to maintain steam pressure within the designed operating range. This cycle will continue until the thermostat turns off the steam boiler.

Commercial steam boilers operate at similar pressure and temperature levels as the residential units.

Explosion/Injury Risk:

1. Steam boilers are at risk of overpressurization when there is a failure of the relief valve and at least one other control described above.

2. Although a Steam Boiler is connected to an open piping system with radiators at the endpoints, the radiator air vents close at normal operating temperatures. This has the same effect as if the boiler was connected to a closed system. Excessive pressure will build up if the gas valve or any of the safety controls mentioned above fail. Boiler pressures that exceed 15 PSI due to a failure of the relief valve can result in a violent explosion when the boiler vessel fails.

3. Previous boiler failure incidents in the industry took place when safety controls failed to operate as designed due to mechanical failure (i.e., blocked siphon tube [“pigtail”], failed gas...
valve, defective LWCO or damaged wiring) or human intervention. Some examples of human
intervention include opening a gas valve in bypass (manual) mode, wiring errors, or removing or
plugging a pressure relief valve to stop water from dripping.

4. Heating controls exposed to floodwater can fail even though they tested OK after being dried
and placed back in operation. This is especially true for electromechanical components that may
short out or fail after internal corrosion develops. Any controls exposed to flood water must
always be replaced.

5. A dangerous condition can occur when burners fail to shut off and the relief valve opens to
relieve the excessive pressure that develops. The remaining water in the system can boil away if
the water supply to the automatic water feed valve is shut off or the feed valve is inoperable or
stuck closed. Without water, the boiler can reach extreme temperatures. If cooler water is
introduced, it flashes into steam as it reaches the overheated surfaces inside the boiler. “Flash
Steam” significantly increases the pressure in the boiler as the steam energy is released. This
reaction can result in a cracked boiler or violent explosion. Never introduce water into an
overheated boiler.

Warm Air Furnace

A Warm Air Furnace heats air that is circulated through an air handling system.

For operation, the thermostat closes a switch that sends a signal to turn on the furnace. The gas
valve opens and the ignition system lights the burners. The burner flame heats up the heat
exchanger. The fan control switch or fan timer circuit board turns on a blower fan after
approximately 1-1/2 minutes. The furnace will operate until the thermostat shuts the furnace off.
The burner shuts off immediately, and the fan continues to run to cool down the heat exchanger.
The fan shuts off after approximately 2 to 3 minutes. An air temperature limit control monitors
the air temperature in the heat exchanger and cycles the burner off and on to maintain the ideal
temperature design (150 degree maximum). Failure of any of these controls can result in
excessive temperatures within the heat exchanger and nearby duct work.

Fire/Injury Risk:

1. A Warm Air Furnace is at risk for overheating when gas controls failures produce
temperatures exceeding the maximum design.

2. An overheated Warm Air Furnace is a fire hazard and may crack, allowing carbon monoxide
to enter the building through the duct work.

Technician Procedures:

The procedures described below must be followed when investigating and shutting down an
“Overheated Boiler” or “Overheated Furnace”.

The initial customer complaint may be received as a Gas Emergency Notification for “Appliance
(Heating) Won’t Shut Off”, which requires a 60-minute emergency response. Key words in the
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notification may include the following descriptions: “Steam Leak, Rumbling Noise, Burning Smell, Red Glow, High Pressure, High Temperature and Overheated”.

**Important Note:** If at any time during the course of a heating service call, a technician notices that the pressure gauge displays a pressure higher than the boiler relief rating, they shall remove themselves from the building. Technicians shall move immediately to step 2 described below.

1. Evaluate the situation. Greet the customer and move the conversation outside. Ask the customer to describe the conditions inside the building by answering the following questions:
   a. What type of system do you have? Where is it located?
   b. Did you smell smoke or a burning smell?
   c. Is there excessive heat being produced in the basement or living areas?
   d. Is the emergency switch in the off position?
   e. How long has the unit been running out of control? What did it look like last? i.e. – “cherry red” color, paint peeling off, position of temperature or pressure gauges, leaking water or steam?
   f. Did you or anyone else touch any part of the heating system before it started overheating? i.e. – disturbed the wiring, installed a thermostat, lit a pilot, started the unit, turned a valve, repaired a water leak, etc.
   g. What steps have you or others taken so far to control the situation? i.e., shut off thermostat, shut off emergency switch, shut off the gas, etc.
   h. Has the heating system ever been exposed to flooding?

2. Based on the customer’s responses, and your best judgment, initiate an evacuation of occupants if the conditions meet the criteria of an overheated boiler or furnace. Instruct occupants not to re-enter the building for a minimum of 8 hours for a residential boiler or furnace, and up to 24 hours for a commercial boiler. Commercial boilers take longer to cool down due the size of the boiler and amount of water in the system. Dispatch should be notified immediately to report the situation to supervision and request Fire Department assistance to keep the public away, secure the building and monitor for fire.

3. Shut off the gas supply outside at the gas meter or curb valve. Stopping the flow of gas from outside will allow the heating unit to begin cooling off safely. If there is no curb valve available, contact Dispatch to request a Gas Distribution crew to disconnect the gas service at the curb.

4. If the gas supply cannot be immediately shut off outside, consider shutting off the electric supply from the emergency switch or breaker located in a remote location or outside at the electric meter in an attempt to control the flow of gas.

5. After shutting off the gas supply to the heating equipment, the decision to discontinue the electric service is based upon the type of heating system involved in the incident:
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a. Hot Water Boilers – Leave Power “On” – to circulate the hot water and cool the boiler.

b. Steam Boilers – Disconnect Electric – to prevent automatic water feed from opening. If there is no access to an outside electric meter, notify Dispatch to request an emergency shut-off from the electric company.

c. Furnace – Leave Power “On” – to circulate the warm air and cool the furnace.

6. After disconnecting the gas service, lock off the meter (if outside) and issue a Class I Violation for the “Overheated Boiler” or “Overheated Furnace” condition. Place “Shut Off Overheated Boiler” remark in the Remark Screen. Contact the Dispatch Office to create an interaction memo on the customer account containing the time and date of the incident. A Municipal Notification will be provided for all Overheated Boiler or Furnace violations, regardless of whether a residential or commercial system is affected.

7. Before allowing access to the building, overheated boilers and furnaces should be given at least 8 hours (residential) or up to 24 hours (commercial) to safely cool down after the gas supply was shut off. After the building is evacuated, a supervisor will provide the customer with instruction and a letter that describes the dangers of re-entering a building evacuated due an overheated boiler or furnace. Heating system experts have indicated that the greatest risk for an explosion or fire will usually pass within 4 hours of shutting off the fuel source.

8. The technician shall caution any first responders (fire department) and others, including the homeowner, NOT to spray water on the surface of an overheated boiler in an attempt to cool it down at a faster rate. This caution should include the following safety reminders: “NEVER attempt to cool the boiler in any way. NEVER ADD WATER to an overheated boiler.” In both cases, water could flash into steam and cause severe injury or death.

9. Customers affected by the disconnected services must make arrangements to have [Gas Utility] return to evaluate the situation after allowing the equipment to cool down. Heating equipment manufacturers recommend that a unit should be condemned if the temperature and/or pressure during the overheat period exceeded the equipment rating for safe operation.

Overheated Boiler Fact Sheet for Customers

[Gas Utility] strongly urges you to review these Safety Warning Messages concerning the Overheated Boiler or Furnace located in your home or building:
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- An “Overheated Boiler” condition is created when a heating unit reaches an exceedingly high temperature and pressure and will not shut off. This condition is considered unsafe and very hazardous to both emergency responders and building occupants.
- The Fire Department will evacuate occupants and ask them to stay a safe distance away from premises containing an overheated boiler (at least 300 feet) in case of an explosion or fire.
- [Gas Utility] Service Technicians will shut off the gas and/or electric service to the house/building if they identify an overheated boiler to allow the heating system to safely cool down without causing significant damage or injury to anyone in the area.
- The premises may only be re-entered after a Fire Department representative has determined that the situation is safe to do so. Anyone re-entering a home/building prior to receiving clearance from the Fire Department may be exposed to severely hazardous conditions that could result in significant injury or death.
- Overheated boilers or furnaces must be replaced. When [Gas Utility] Service Technicians determine that an Overheated Boiler conditions exists, they will issue a Class 1 Red (Violation) Tag to indicate that a boiler or furnace has overheated, is defective and must be replaced.

These dangers are associated with Overheated Boilers or Furnaces:

- When a boiler or furnace overheats, the temperature and pressure reaches very unsafe levels and the heating unit is beyond repair. The result can be an explosion or fire.
- When a boiler or furnace overheats, shutting off the gas supply and allowing the heating system to cool down are the safest ways to control the situation.
- The danger of an explosion or fire will continue to exist hours after the gas supply is shut off. During the cooling off period, the heating unit may still be experiencing high temperatures and pressures that can cause an explosion or fire.
- Never attempt to cool down a hot boiler by spraying water on it. This could result in an explosion or cracked boiler.
- If hot water or steam gets released from a cracked boiler, it can cause a severe burn (scalding) injury.
- Never add water to a hot boiler. When cooler water touches hot water or the inside of a dry boiler, it can immediately flash into steam that will create high pressure and release energy, causing the boiler to explode or crack.
- A boiler or furnace that is overheating may appear “cherry red” when it reaches very high temperatures. Touching the heating unit may result in a severe burn injury.

If you have questions regarding the above Safety Warning Messages, contact the “[Gas Utility] Emergency line” at 1-800-XXX-XXXX.