



Preventing Overheated Boiler Incidents

PSE&G Appliance Service

October 2012

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Runaway Boiler Explosion



Review Items

- Hazard Background
- Past Incidents
- PSE&G Emergency Response
- Future Process Improvements



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What is an Overheated Boiler?

- “Overheated Boiler”: Heating unit reaches an exceedingly high temperature and pressure, and will not shut off.
- This condition, a.k.a. “Runaway Boiler”, is considered unsafe and very hazardous to 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.

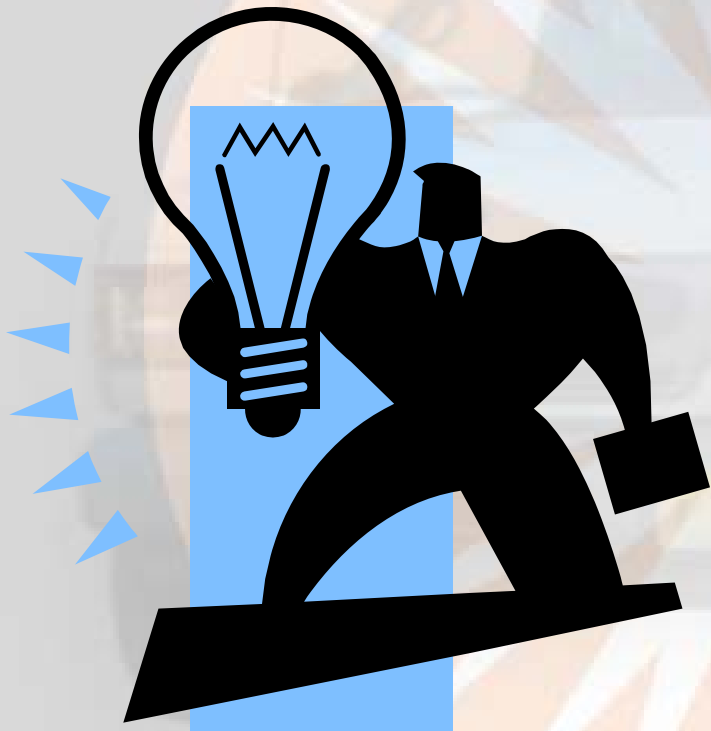
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Hazard Description

- When boilers or furnaces experience an overheated condition, catastrophic damage to the heating unit, safety controls and components is likely.
- PSE&G treats this situation with the highest degree of emergency response - similar to an inside gas leak with open air gas readings of 1% or greater.
- First Responders are expected to evacuate all occupants, and keep the public a safe distance away from the building.

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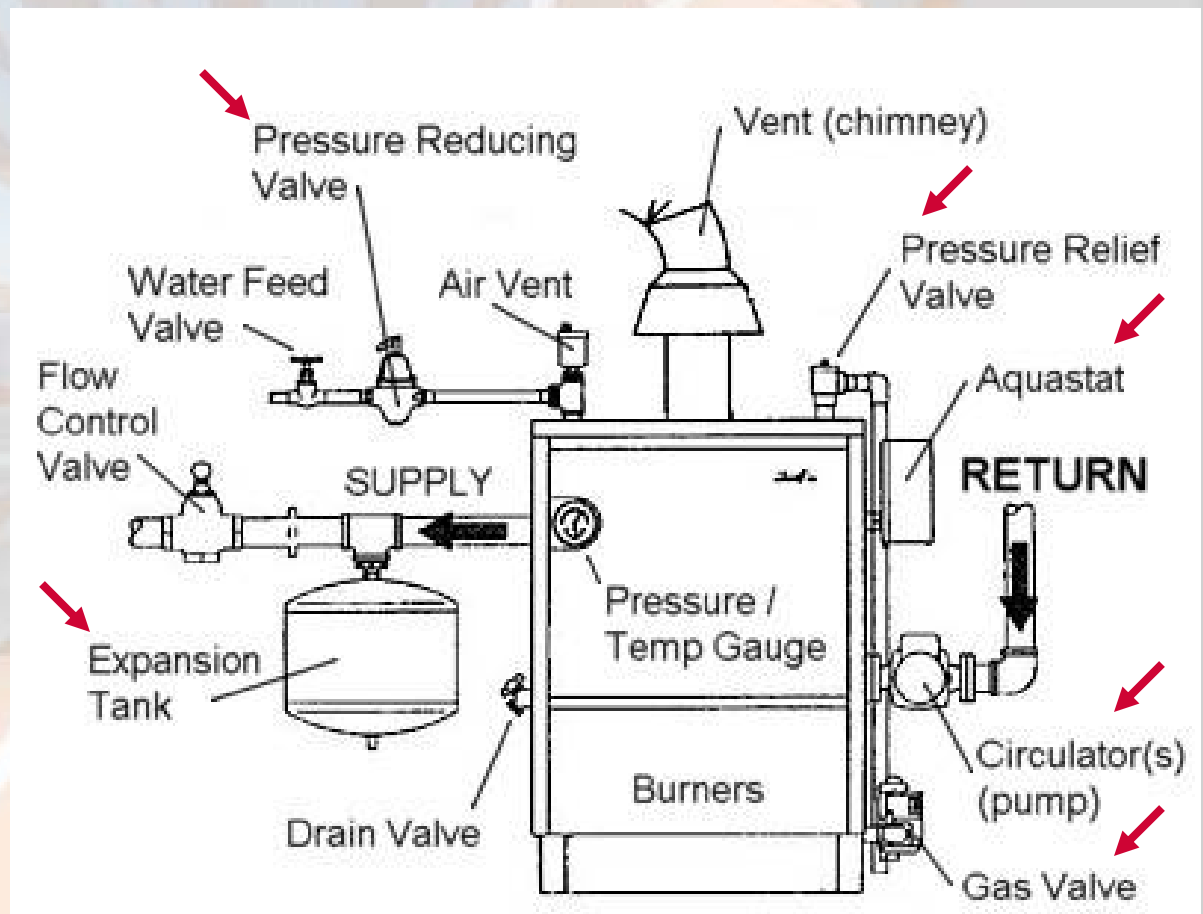
Input from Industry Experts



- Industry Associations
- Codes & Standards Groups
- Boiler Inspectors
- Appliance Manufacturers
- Utilities
- Emergency Responders (FD's)

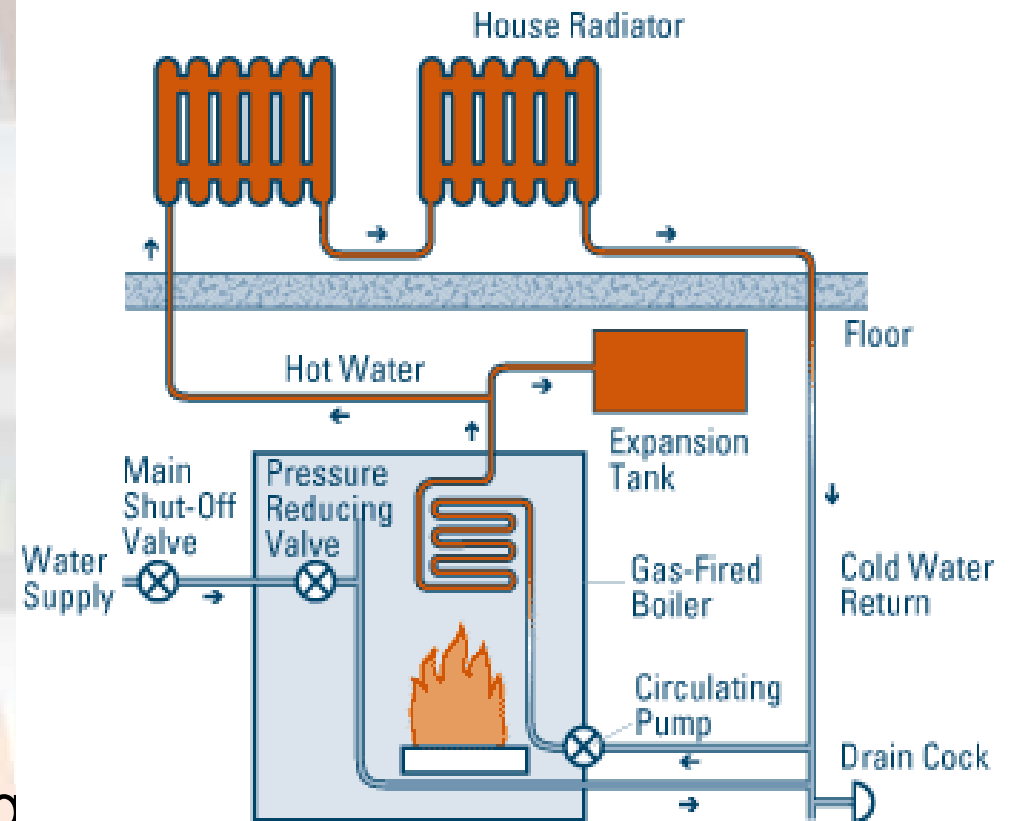
Hot Water Boiler

- Basic components:
 - Gas Valve
 - Water Feed (Pressure Reducing Valve)
 - Circulator Pump
 - Aquastat Control
 - Pressure Relief Valve
 - Expansion Tank



Hot Water Boiler

- Boiler is filled up with water and maintains 12 PSI water pressure.
- Air is bled out of the system zones. The circulator pump will not move water through the baseboard loops if air is in the system.
- Expansion tank maintains system pressure, and absorbs water expansion and contraction from heating and cooling.



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Explosion/Injury Risks – HW Boilers

- Hot water boilers risk over-pressurization when there is a failure of the pressure relief valve and at least one other control.
- 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).
- Typical max. operating pressure of a residential boiler is 20 PSI (industrial boiler - 50 PSI). Pressures that continue to rise above safety ratings can result in a violent explosion when the boiler vessel fails.

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Explosion/Injury Risks – HW Boilers

- Previous boiler failure incidents 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.
- Examples of human intervention:
 - opening a gas valve in bypass (manual) mode
 - wiring errors
 - removing or plugging a pressure relief valve to stop water from dripping

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Explosion/Injury Risks

– Boilers & Furnaces

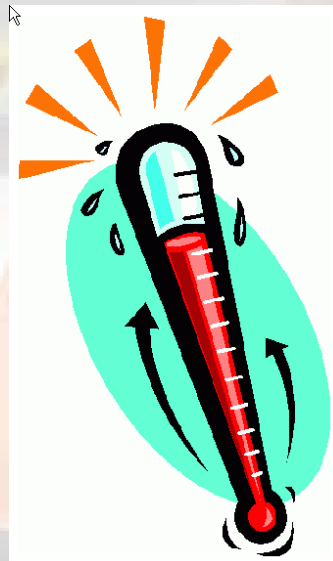


- Heating controls exposed to flood water can fail after being dried and placed back in operation.
- Any controls exposed to flood water must always be replaced.

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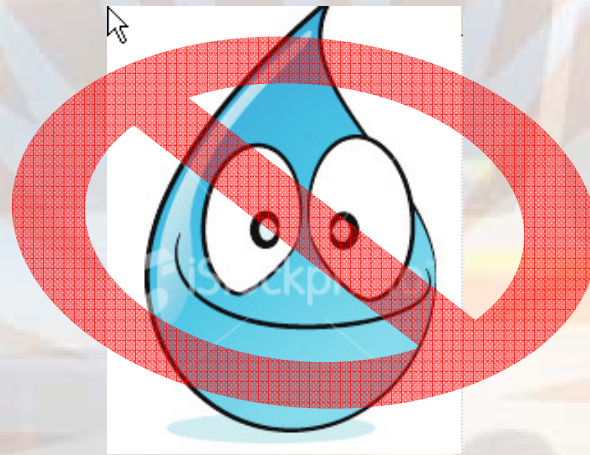
Explosion/Injury Risks – HW & Steam Boilers

- A “**Dry Fire Boiler**” condition can occur when burners fail to shut off and the relief valve opens to release excessive pressure.
- The remaining water in the system can boil away if 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.



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Explosion/Injury Risks – HW & Steam Boilers

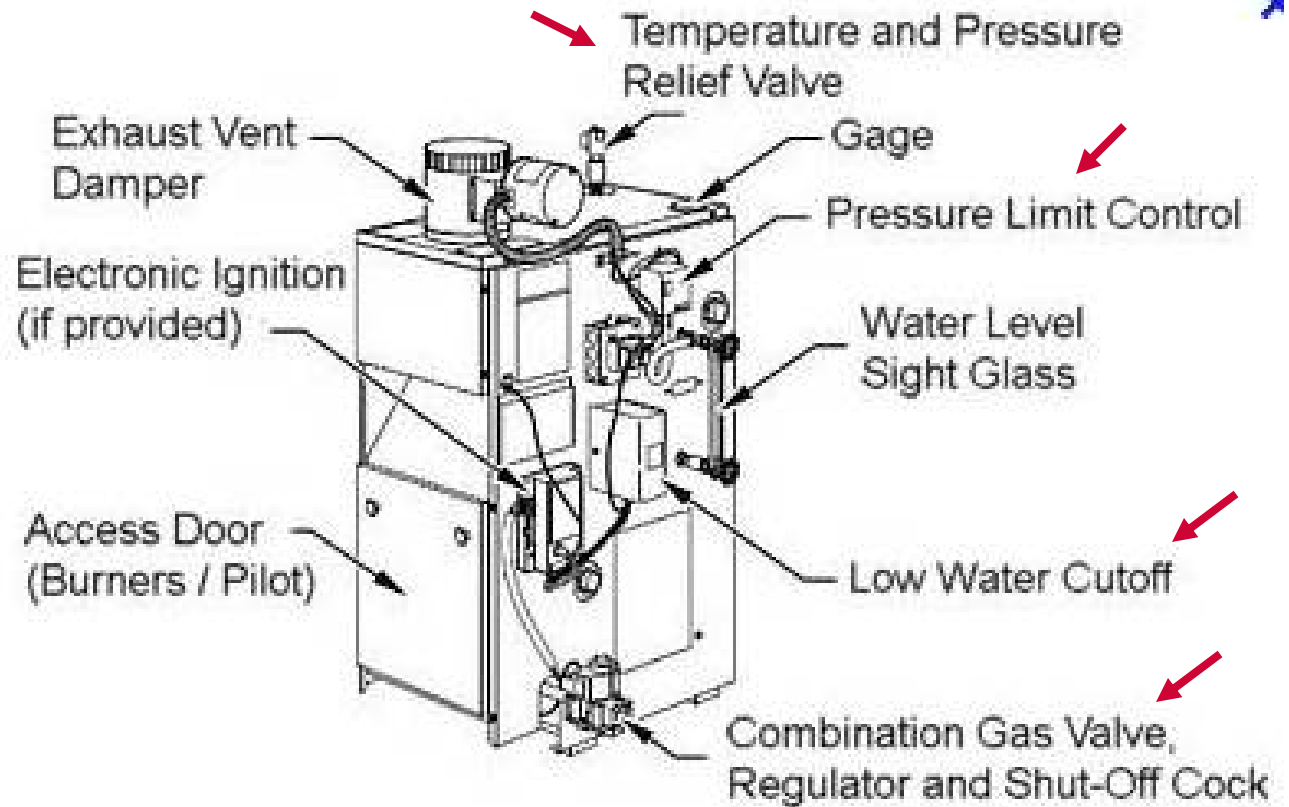


- **Never introduce water into an Overheated Boiler.**
 - If cooler water is introduced, it flashes into steam after touching heated surfaces inside the boiler.
 - “**Flash Steam**” significantly increases the pressure in the boiler as the steam energy is released.
 - This reaction can result in a cracked boiler or violent explosion.

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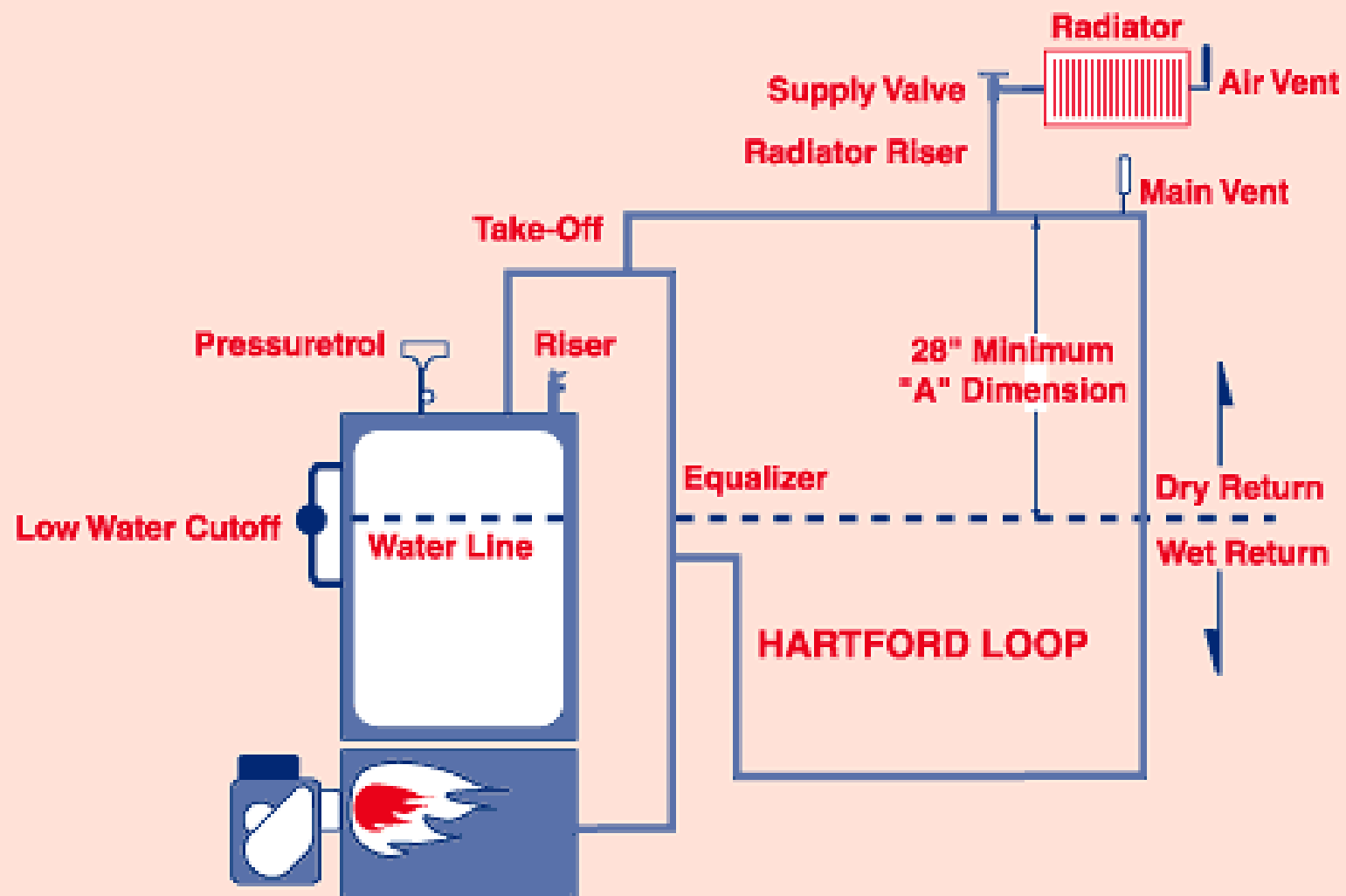
Steam System

- Basic Components:
 - Gas Valve
 - Pressure Limit Control
 - Low Water Cutoff
 - Temperature & Pressure Relief Valve



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Steam System



Explosion/Injury Risks – Steam Boilers

- Steam boilers can become over-pressurized when there is a failure of the pressure relief valve and at least one other control.
- 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.
 - Excessive pressure will build up if the gas valve or safety controls 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.

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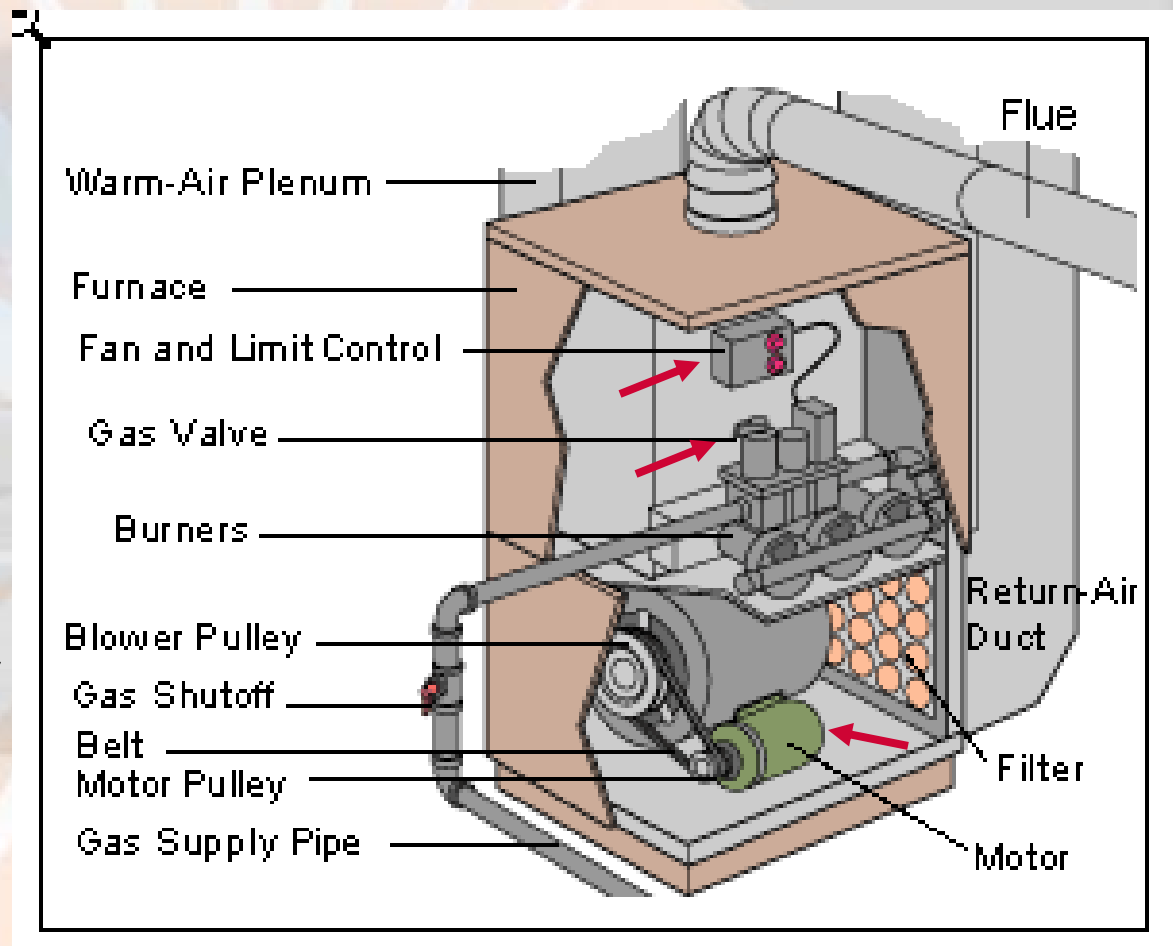
Explosion/Injury Risks – Steam Boilers

- Previous boiler failure incidents 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.
- Examples of human intervention:
 - opening a gas valve in bypass (manual) mode
 - wiring errors
 - removing or plugging a pressure relief valve to stop water from dripping

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Warm Air Furnaces

- Basic components:
 - Gas Valve
 - Heat Exchanger
 - Limit Switch
 - Fan Motor and Blower
 - Pilot Assembly or Hot Surface Ignitor
 - Thermocouple or Flame Sensor



Fire/Injury Risks – Furnaces

- A Warm Air Furnace is at risk for overheating when gas control failures produce temperatures exceeding the maximum design.
- An Overheated Furnace is a fire hazard and may crack, allowing carbon monoxide to enter the building through the duct work.
- For HVAC installations, if an A/C coil fails due to soft solder melting when high temperature or fire compromises the system, potentially lethal toxic gas can be created.
- Any controls exposed to flood water must always be replaced.

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Runaway Boiler Incidents

- In December 2011, PSE&G responded to a hot water boiler explosion in Cliffside Park, NJ.
- The customer was experiencing trouble with the boiler ignition system, and switched the automatic gas valve to “manual” operation.
- The constant flow of gas into the boiler led to a significant increase in temperature & pressure that caused an overheating (runaway) condition.
- The customer reported a boiler explosion less than 15 minutes after the heating unit was turned on.

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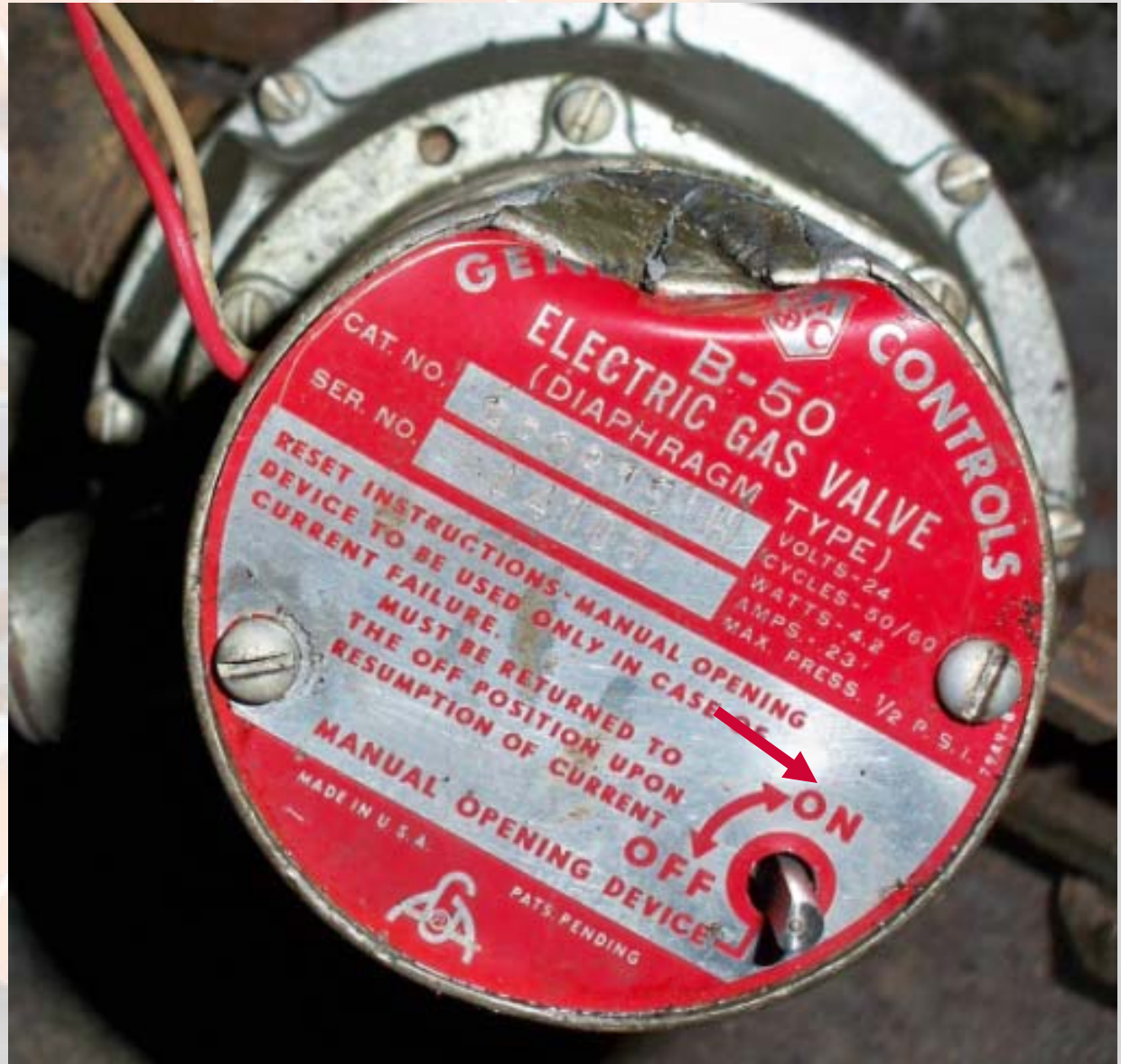
Runaway Boiler Lessons Learned

- Boiler dispersed sections throughout the basement.



Runaway Boiler Lessons Learned

- **Cause #1** - Automatic gas valve was switched "ON" to manual operation, feeding boiler with a steady flow of gas.



Runaway Boiler Lessons Learned

- **Cause #2** – Boiler had no means to relieve pressure after overheating.



Runaway Boiler Lessons Learned

- In prior months, the customer had a combination pressure reducing (water feed) valve and pressure relief valve control replaced.
- When the servicing company performed the repair, the combination valve was replaced with only a pressure reducing (water feed) valve.
- As a result, the boiler no longer had a relief valve to relieve excess pressure.

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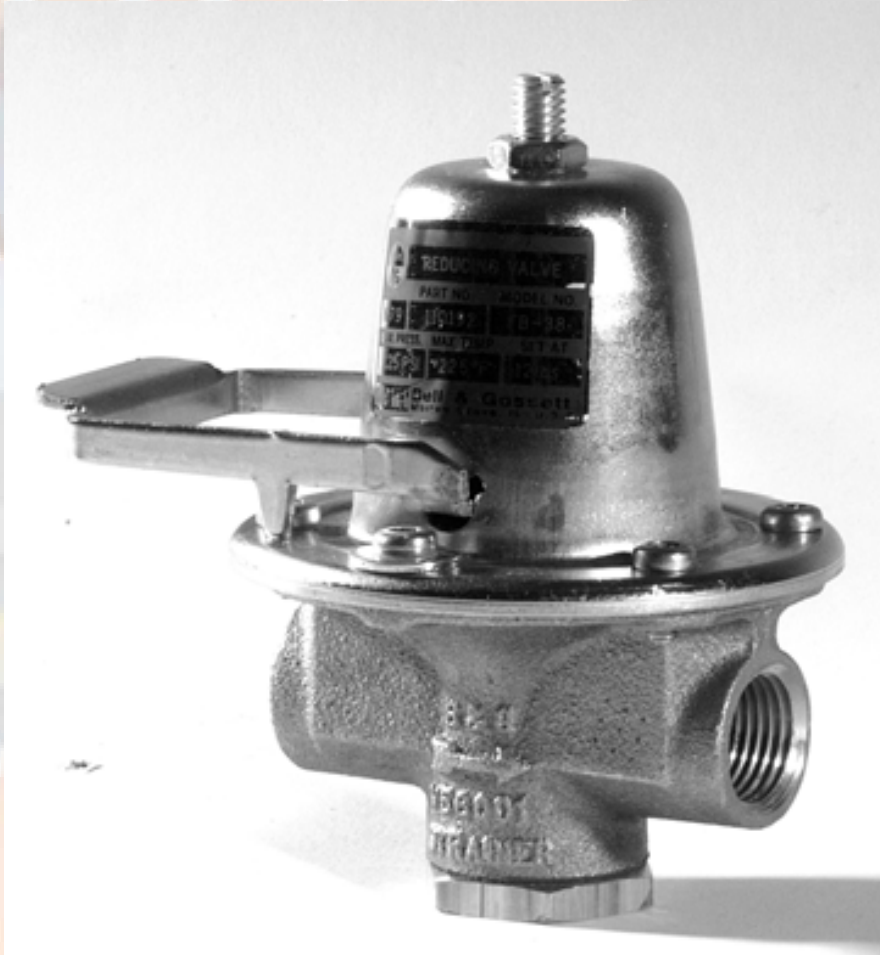
Runaway Boiler Lessons Learned

- Combination pressure reducing (water feed) valve and pressure relief valve.

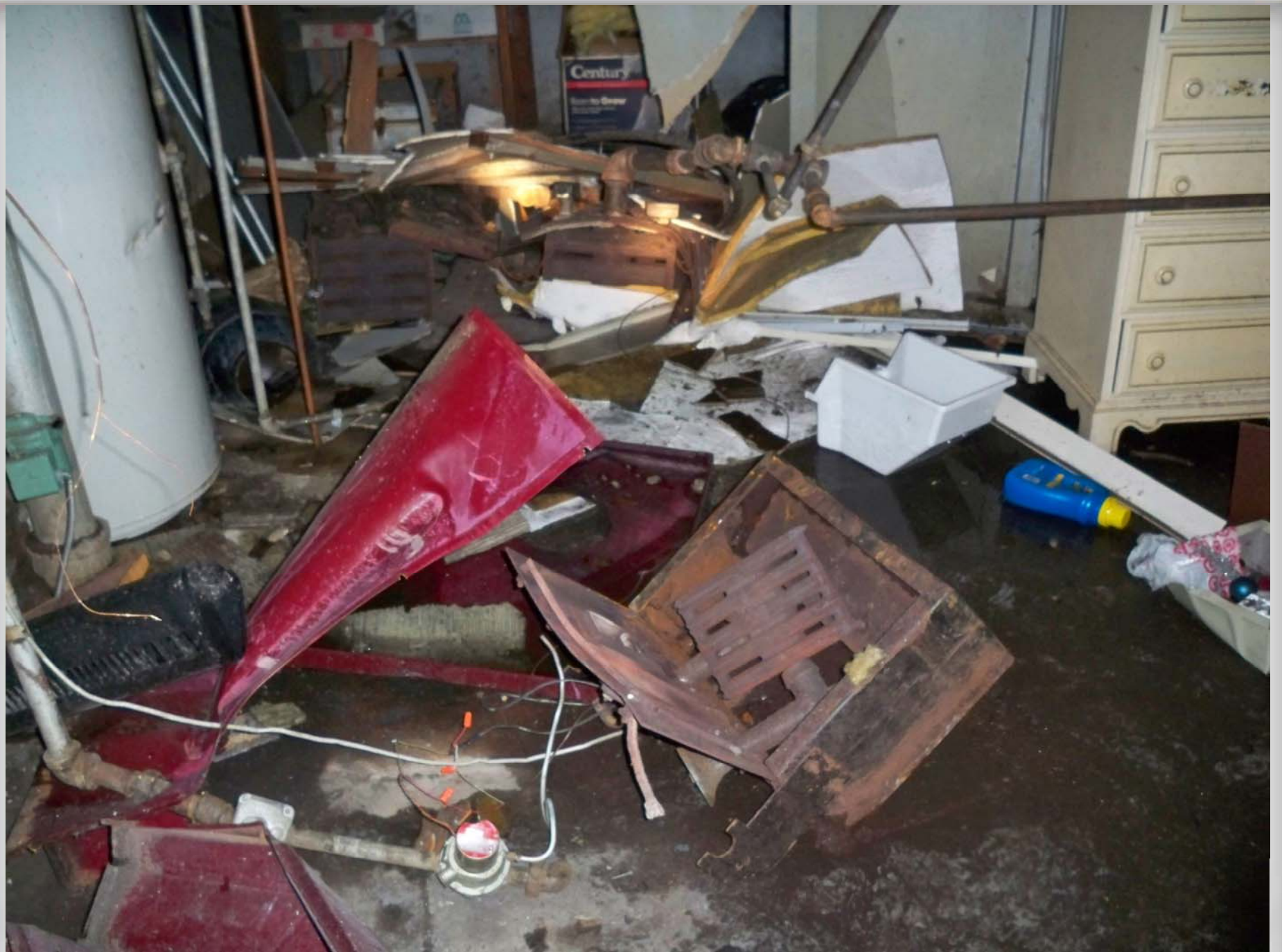


Runaway Boiler Lessons Learned

- Whenever a combination valve is replaced with a single pressure reducing (water feed) valve, a separate pressure relief valve **MUST** also be installed.
- Boilers are equipped with designated tap holes for inserting a separate pressure relief valve.



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Runaway Boiler Lessons Learned

- May 2006 - Hot Water Boiler explosion in Springfield, NJ.
- Customer had a Thermal Expansion Tank installed on the supply line to the Hot Water Boiler.
- New Tank was erroneously connected to outlet of the Pressure Relief Valve.
- Boiler had no way to relieve pressure and created a “runaway” condition.

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Runaway Boiler Lessons Learned

- **Cause** — Pressure Relief Valve outlet plugged by Thermal Expansion Tank connection.



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Runaway Boiler Lessons Learned

- The explosion launched boiler sections throughout the basement.







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Runaway Boiler Lessons Learned





Initial Notification for Overheated Boiler/Furnace

➤ Initial Notification – provided in 2 ways:

- 1) Initial customer complaint - “Appliance (Heating) Won’t Shut Off” - requires a 60-minute emergency response.

Technician arrives and evaluates situation.

- 2) During heating service call, a technician may recognize an Overheated Boiler or Furnace condition as the pressure gauge displays a pressure higher than the boiler relief rating.



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Emergency Response

- 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:
 - Smell smoke or something burning?
 - Type of heating system? Where is it located?
 - Excessive heat in the basement or living areas?
 - Emergency switch in “off” position?
 - How long has 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?
 - Did anyone 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.
 - Steps taken so far to control the situation? i.e., shut off thermostat, shut off emergency switch, shut off the gas, etc.
 - Heating system exposed to floodwater?

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Emergency Response

- 2) Initiate an evacuation of occupants if the conditions meet the criteria for an overheated boiler/furnace. Instruct occupants not to re-enter the building for a minimum of 8 hours.
 - a) Notify Dispatch Office immediately to report the situation to supervision and request FD assistance to keep the public away, secure the building and monitor for fire.



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Emergency Response

- 3) Shut off gas supply outside at the gas meter or curb valve. Stopping the flow of gas from outside will allow the heating unit to begin to cool off safely. If no curb valve is available, request a construction crew to disconnect gas service at the curb.



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Emergency Response

- 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.



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Emergency Response

- 5) Technician makes decision to shut off electric service based on heating system criteria:
- a) **Hot Water Boilers** – Leave Power “On” - to circulate the hot water and cool off the boiler.
 - b) **Steam Boilers** – Disconnect Electric – to prevent automatic water feed from opening.
 - c) **Furnaces** – Leave Power “On” – to circulate the warm air and cool the furnace.

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Emergency Response



- 6) After shutting off 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.

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Emergency Response

- 7) Before allowing access to the building, overheated boilers and furnaces should be allowed at least 8 hours to safely cool down after the gas supply was shut off.
 - a) After the building is evacuated, a Supervisor will provide the customer with instructions and a letter that describes the dangers of re-entering a building evacuated due to an overheated boiler or furnace.



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Emergency Response



- 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.

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Emergency Response

- 9) Technician will disconnect gas supply to appliance, lock off the meter (if outside) and issue a Class I Violation for the “Overheated Boiler or Furnace”.
 - a) Customers affected by the disconnected services must make arrangements to have PSE&G return to evaluate the situation after allowing the equipment to cool down.

NOTE:

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.

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Future Process Improvements

- **Engagement of NJ Utilities for Handling Emergency Response for Overheated Boilers**
 - Share Overheated Boiler training package with NJ utilities for implementation. NJDCA expressed a need to have all NJ utilities handle Overheated Boiler emergency response in a consistent manner so that municipal FD actions are unified.
- **Municipal Notification of Heating System Shutdown**
 - Notify Municipal Construction Official, who has authority over staff inspectors, that a heating system has been shut down for an Overheated Boiler condition, and that PSE&G will be disconnecting the gas supply to heating equipment.
 - This action will prompt a heating system inspection by a municipal inspector.

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Future Process Improvements

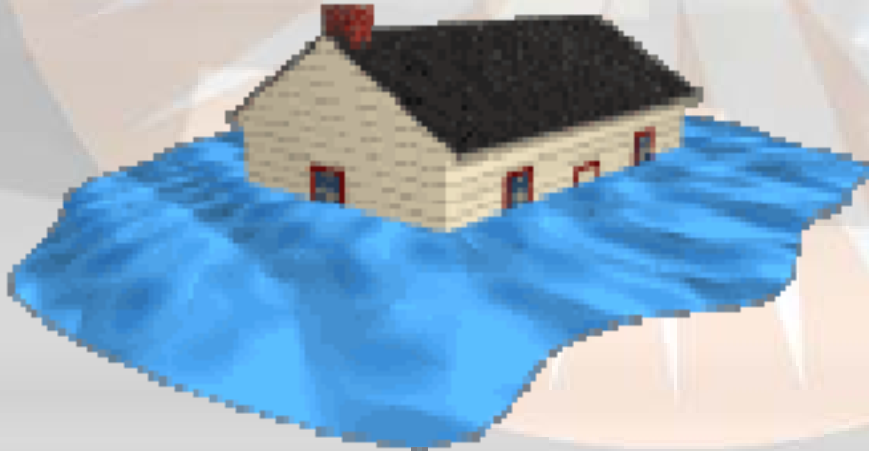
- **FD Monitoring of Imminent Hazard Condition**
 - Municipal FD's are equipped with a Thermal Imaging Camera (TIC) that can monitor the amount of heat generated in Overheated Boiler incidents.
 - “Imminent Hazard” is declared when there is a threat of fire due to high temperatures. FD will monitor location until they determine that the threat of fire is removed.
 - FD will leave location and may allow occupants to return once the Imminent Hazard is removed.
 - PSE&G is expected to return 8 hours after shutting off gas, and will disconnect gas piping to the defective heating system.

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Future Process Improvements

- **Post-Flood Inspections**

- NJDCA supports the process shared between PSE&G and municipal inspectors for performing post-flood inspections and gas appliance restorations simultaneously.
- NJDCA provides inspector resources to assist municipalities not having enough staff to support post-flood inspections.



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FOR MORE INFORMATION

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