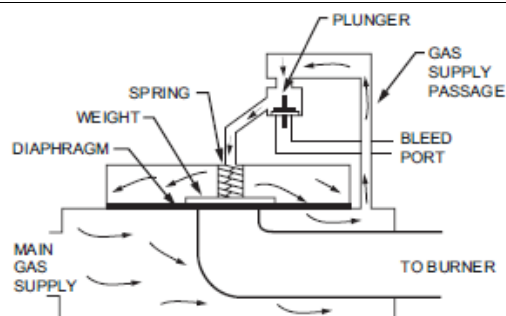


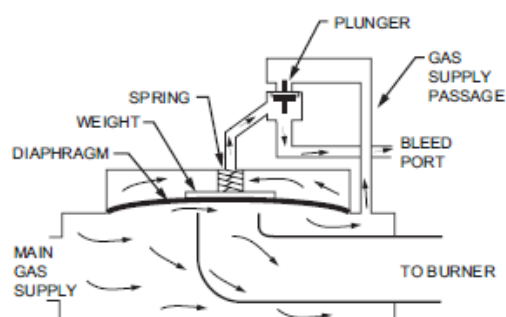
Incident Summary (Reference # 5611298)

SUPPORTING INFORMATION	Incident Date		January 21 st , 2017	
	Location		North Vancouver	
	Regulated industry sector		Natural Gas System	
	Impact	Injury	Qty injuries	N/A
			Injury description	N/A
			Injury rating	N/A
		Damage	Damage description	Damage sustained to system supply and return boiler water piping, boiler controls and gas valve.
			Damage rating	Moderate
		Incident rating		Moderate
	Incident overview		A gas valve serving a large hydronic boiler failed (stuck) in the open position, bypassing the systems electronic safety controls which caused an uncontrolled flow of gas to the boilers main burners. This condition allowed the boiler to overheat damaging the boiler supply and return piping system and boiler safety controls resulting in a release of steam and hot water into the boiler mechanical room.	
re INVESTIGATION CONCLUSIONS	Site, system and components		This boiler supplies the heating water to a multi-story residential buildings hydronic heating system. A circulating pump circulates water through the boiler, which is heated to the desired temperature (180 degrees F) and supplied to the heat emitters serving the buildings suites. The water temperature is controlled by a mechanical temperature sensor (aquastat) that controls power to the boilers single gas valve. The boiler utilizes a “standing pilot” type ignition system which maintains a small constant flame at all times in the combustion chamber, this flame is monitored by a thermocouple that will only allow gas to flow to the main burners if the standing pilot flame is present.	
			When the temperature of the water in the system drops below its set-point, the aquastat closes sending power to the main gas valve, which allows gas flow to the main burner. The proven flame from the standing pilot ignites the gas from the main burner. The gas valve stays energized (open) until the temperature of the water within the boiler meets the system’s desired temperature.	
			The gas valve utilized on this boiler is a Honeywell diaphragm gas valve. This type of valve is a normally closed valve which means when there is no electrical power applied to the valves bleed port solenoid (plunger) the valve remains in the closed position. With the solenoid/plunger in the closed position the bleed port is shut and gas is allowed to pass through a bypass line from the upstream side of the valve onto the top side of the main valve diaphragm forcing the valve closed. When power is applied to the gas valves bleed port solenoid the plunger opens, closing the bypass line and opening the bleed port, allowing gas to escape off of the top side of the main valve diaphragm. Once the gas pressure is relieved off of the top side of the diaphragm the main gas supply pressure is able to force the valve open. (See diagrams below).	

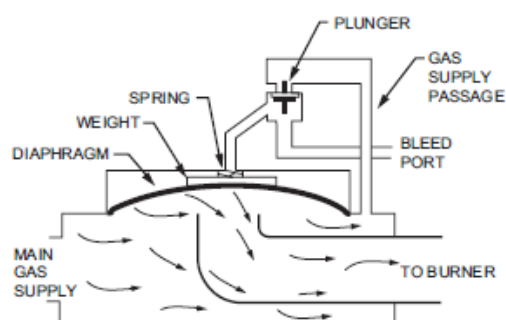
Incident Summary (Reference # 5611298)



VALVE CLOSED



VALVE OPENING



VALVE OPEN

M8489

**Diagrams courtesy of manufacturer installation manual*

Failure scenario(s)

The single gas valve controlling gas flow to the boiler became stuck in the open position, thereby bypassing all other electronic safety devices, allowing a constant uncontrolled flow of gas to the main burners.

This uncontrolled supply of gas to the burners caused the boiler to overheat and due to the valve being mechanically stuck in the open position the electronic high temperature safety limits were unable to shut down the system based on the high water temperature condition.

As the water temperature continued to increase, reaching/exceeding the boiling point of the water within the boiler (212 degrees Fahrenheit), the water pressure increased (due to thermal expansion) causing the boiler pressure relief valve to open. Once open to

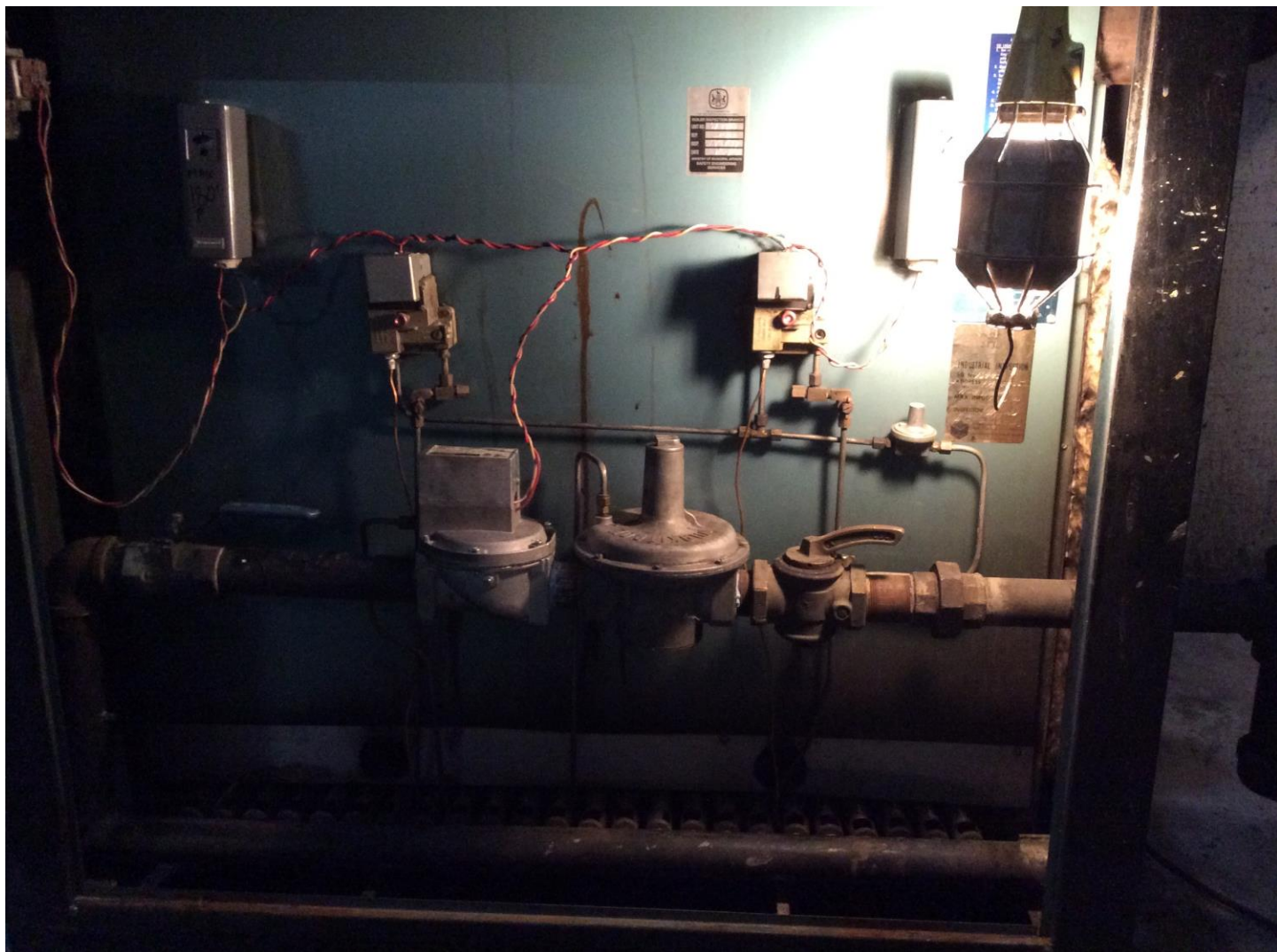
Incident Summary (Reference # 5611298)

		atmosphere the water within the boiler was able to flash to steam filling the mechanical room with steam. In addition to steam being released from the boiler this boiling process caused a large amount of force to be put on the boiler and its associated piping, breaking multiple solder joints on the supply and return piping serving the boiler allowing more steam and water to escape from the system into the mechanical room. The resident building manager identified the issue and contacted their mechanical contractor, once the contractor arrived on site they shut down the power, gas and water supply to the boiler system.
	Facts and evidence	1. The contractor who first attended the scene found that the boiler room was full of steam and the boiler was running. When he de-energized the boiler the unit continued to run even without electricity. In order to stop the flow of gas to the unit they had to close the manual gas shutoff valve. 2. Upon removal and investigation of the failed gas valve it was found that the valve was stuck in the open position. 3. After disassembling the valve it was found that the bleed port solenoid (plunger) shaft was stuck open and a buildup of fine metallic shavings were found within the solenoid.
	Causes and contributing factors	The most likely cause of the incident was the gas valve having been stuck in the open position allowing an uncontrolled supply of gas to the main burners. Additional contributing factor were: 1. The age of the gas valve, this valve appeared to be the original valve supplied with the boiler and over time the repetitive mechanical action of the valve opening and closing causes these components to wear out. 2. The lack of a second redundant gas valve serving the boiler valve train; Modern boilers of this size and type require the installation of two gas valves piped and wired in series. In the event of a failure of one gas valve the other would prevent the flow of gas to the boiler. In this situation the failure of the single gas valve bypassed all other boiler safety devices and allowed uncontrolled gas flow to the boiler.

Hydronic Heating Boiler



Boiler Valve Train With Single Gas Valve



Diaphragm Gas Valve Stuck in the Open Position



Gas Valve Bleed Port Solenoid Disassembled

