

Incident Summary #II-1000791-2020 (#16966) (FINAL)

SUPPORTING INFORMATION	Incident Date	April 3, 2020	
	Location	Chilliwack	
	Regulated industry sector	Boilers, PV & refrigeration - Boiler and pressure vessel system	
	Injury	Qty injuries	0
		Injury description	N/A
		Injury rating	None
	Impact Damage	Damage description	Physical damage includes melted Victaulic gasket, outdoor temperature sensor wiring and pressure/temperature gauge. Safety relief valve and boiler casing discolored due to exposure of higher than normal temperature. Expansion tank diaphragm loss of pressure. High temperature limit switch unable to manually reset.
			Safety feature damage includes the redundant safety features. The high temperature limit switch and temperature controller failed to shutoff gas supply to boiler, causing a release of water at high temperatures through the safety relief valve until power to boiler was shutoff electrically.
		Damage rating	Moderate
	Incident rating	Moderate	
Incident overview	A boiler located in the mechanical room of an apartment building went into an over temperature/pressure condition and a release of hot to boiling water occurred through the safety relief valve.		
INVESTIGATION CONCLUSIONS	Site, system and components	<p>The boiler is a means of providing heat to the apartment building by generating hot water that is pumped through piping to radiators.</p> <p>A transformer powers the low voltage safety circuit. The circuit consists of multiple safety components wired in series. The safety components are designed to trip and open the electrical circuit when the boiler reaches certain operating conditions that could become unsafe. In the event of such operating conditions, the burners of the boiler will then safely shut off. The components in this circuit consist of a low water cut-off switch, a water flow switch, an operating temperature switch, and a high temperature limit switch. The low water cut-off switch and the high temperature limit switch are both required to be manually reset when tripped to allow the boiler to operate again.</p> <p>There is a second transformer, separate from the safety circuit, which powers a digital controller. The digital controller is designed to regulate the water supply temperature based on the outdoor air temperature.</p> <p>There is a gas valve which is powered by an electrical solenoid which allows gas to flow to the boiler's burners. The operation of the gas valve is controlled by the digital controller.</p> <p>A Safety Relief Valve is a pressure relief device used as a last resort in the event of overpressure within the boiler. No other valves are installed between the boiler and the safety relief valve. The safety relief valve releases, discharging water when a certain pressure is reached.</p>	

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<p>Failure scenario(s)</p>	<p>A jumper wire was installed in the digital controller from terminal #3 to terminal #5. This was to power both the high and the low circuits of the two stage gas valve. The insulation of the jumper wire had been stripped back and exposed an excessive amount of bare wire past the terminal connection point on terminal #3. (See Image 1) The bare portion of the wire came into contact with the energized wire connected to the adjacent terminal (terminal #2). This created a separate circuit that powered the gas valve, and allowed the safety circuit to be bypassed and the boiler to operate continuously until the power was manually shut off to the boiler. (See Wiring Diagram in Images) The continuous operation of the boiler caused it to go into an over temperature/pressure condition. The safety relief valve released hot to boiling water and excessive internal temperatures damaged the boiler and components. (See Images 2 to 7)</p>
<p>Facts and evidence</p>	<p>Notification Statement from Maintenance Contractor</p> <ul style="list-style-type: none"> -A banging noise was heard by a resident of the apartment building -The pumps were still operating and burners were on -The safety relief valve was discharging in spurts -Expansion Tank was hot to the touch -Description of the heat damaged components -The high limit temperature switch was set for 200°F and was tripped <p>Maintenance Contractor's Report, Photos, Wiring Diagram</p> <ul style="list-style-type: none"> -A red jumper wire was installed in the digital controller, connecting terminals #3 and #5 -The jumper wire had an excessive amount of bare wire exposed -Confirmed boiler completely shut off when electrical power was disconnected <p>Digital Controller Installation Instructions</p> <ul style="list-style-type: none"> -Instructions specify that the installer should ensure that the wires from the power supply transformer are not touching each other, any other wires or ground. <p>Virtual Inspection with Third Party Independent Contractor</p> <ul style="list-style-type: none"> -The digital controller was powered by an independent transformer, separate from the safety circuit -Confirmed the heat damage to the Victaulic gasket, pressure/temperature gauge, boiler casing, safety relief valve, and outdoor temperature sensor wiring were not caused by excessively hot water, but by heat escaping through weak points of the boiler's internal insulation -Confirmed the bare portion of the jumper wire could have come into contact with the adjacent terminal wiring -Confirmed that the tripped low water cut-off switch could be manually reset -Confirmed that the tripped high temperature limit switch could not be manual reset -Expansion tank had a loss of diaphragm pressure

Causes and contributing factors

The probable cause of the incident was that the jumper wire was installed with the insulation of the wire stripped back far enough to expose an excessive amount of bare wire. The bare wire made contact with an adjacent terminal that was receiving constant power. With that contact, an unintentional circuit, powering the gas valve and bypassing the redundant safety features, was created.

Photos or diagrams (if necessary)

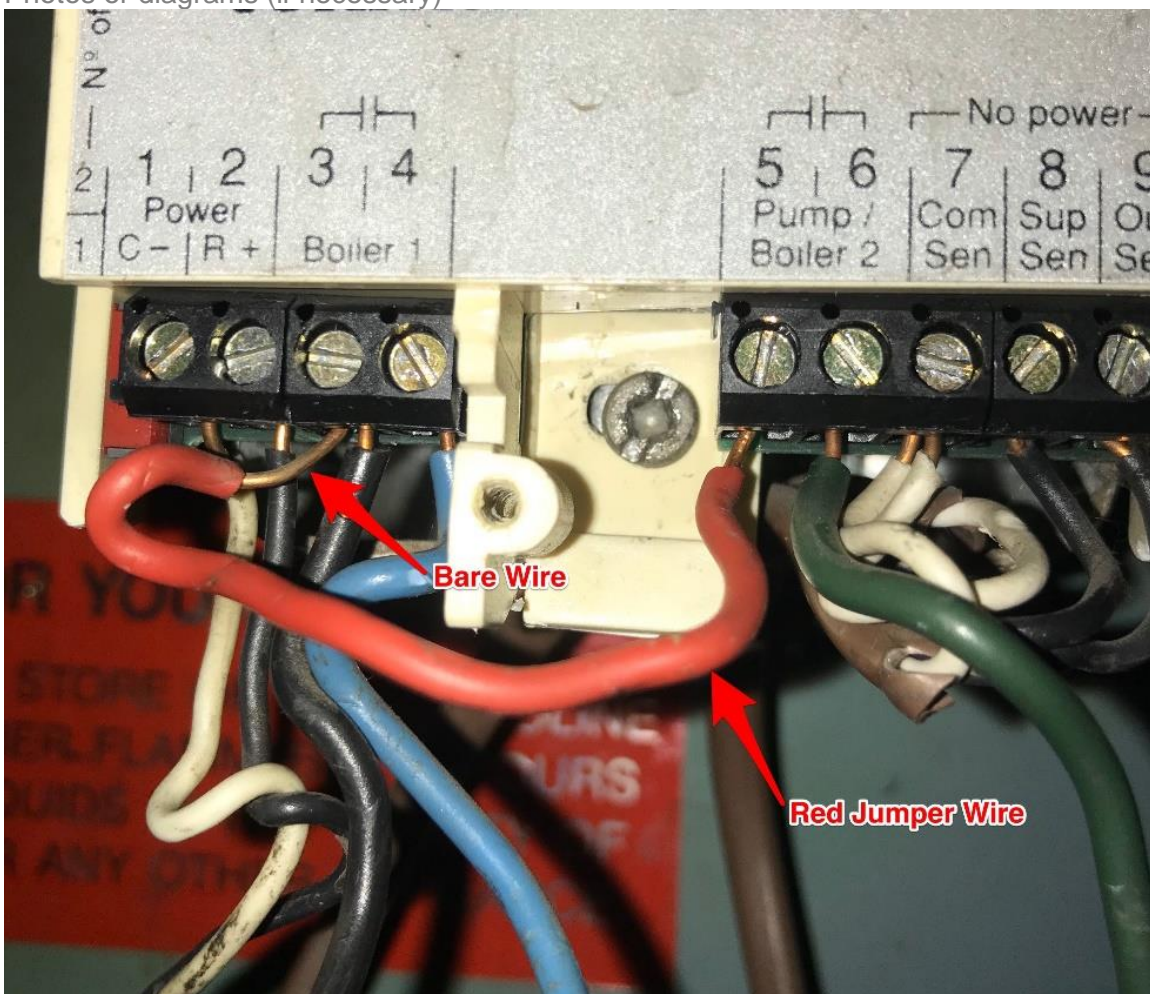
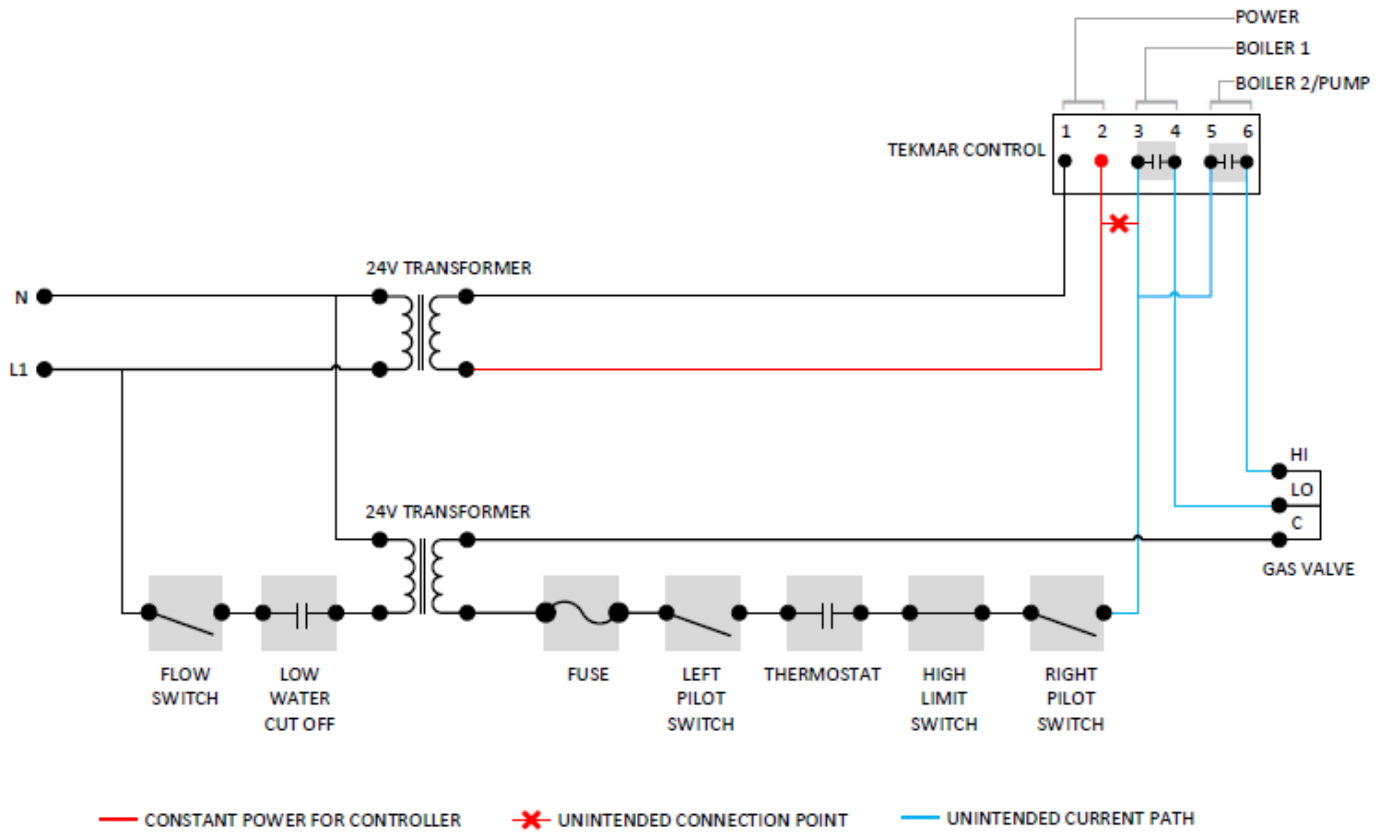


Image 1: Controller Wires, including Jumper Wire and bare portion (Note: Photo taken after jumper wire having been manipulated by maintenance contractor. Wire was disconnected to ensure the connection was broken and unsafe situation could not be re-created.)



Wiring Diagram: Shows the wiring layout of the boiler and power potential, including the unintended current path.

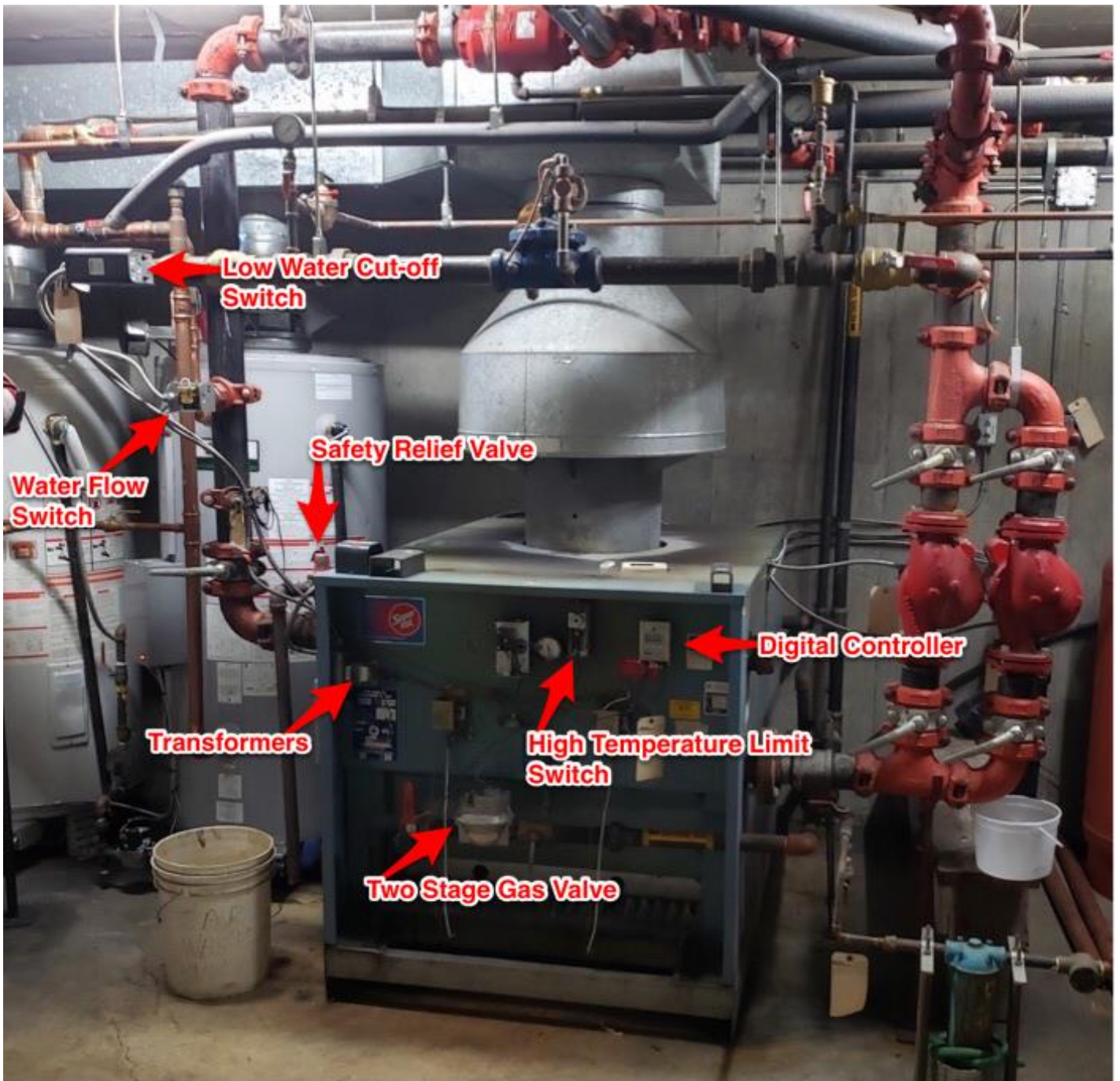


Image 2: Overall View of Boiler and Locations of Components

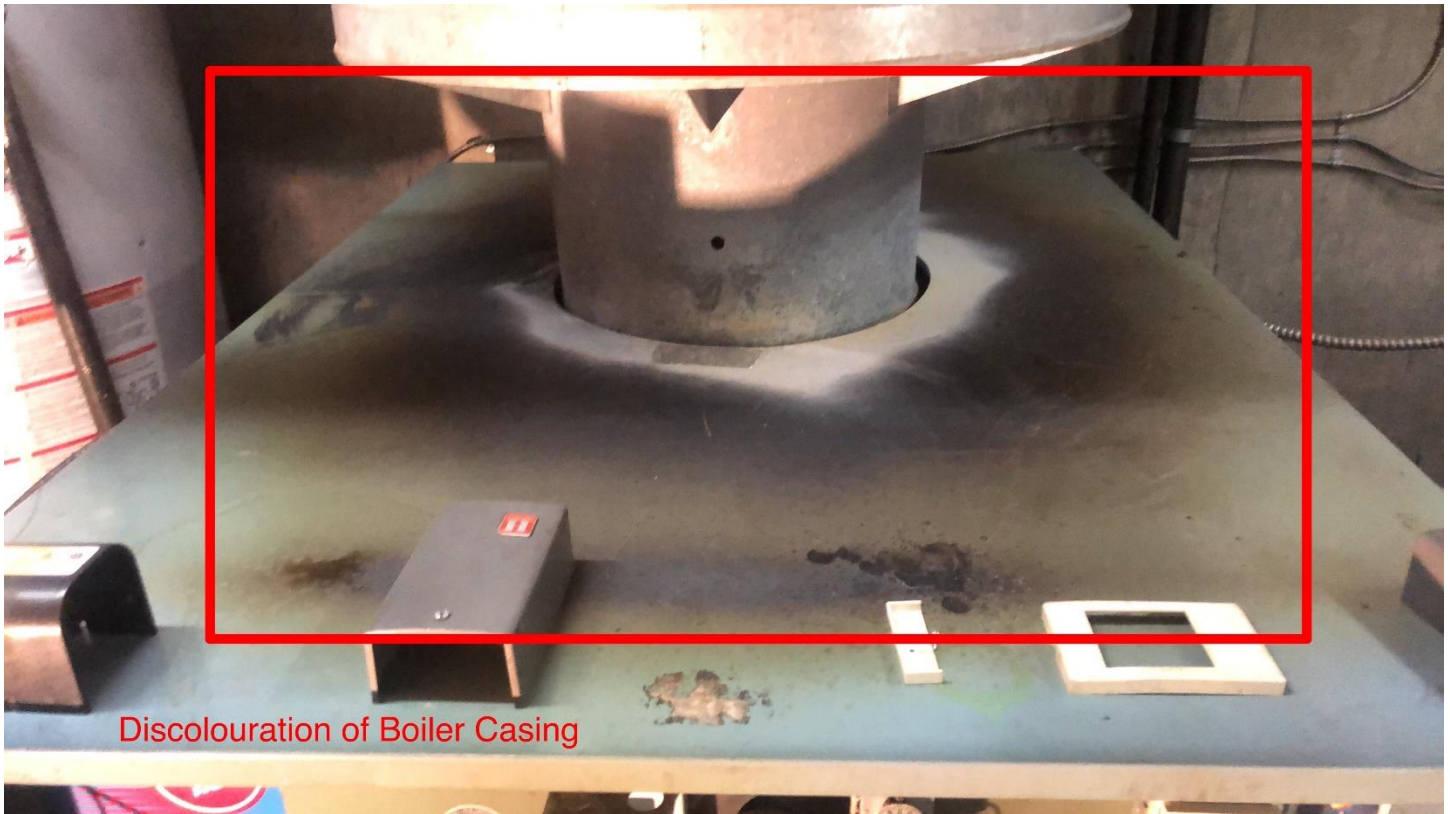


Image 3: Discoloration of Boiler Casing



Image 4: Damaged Pressure Gauge

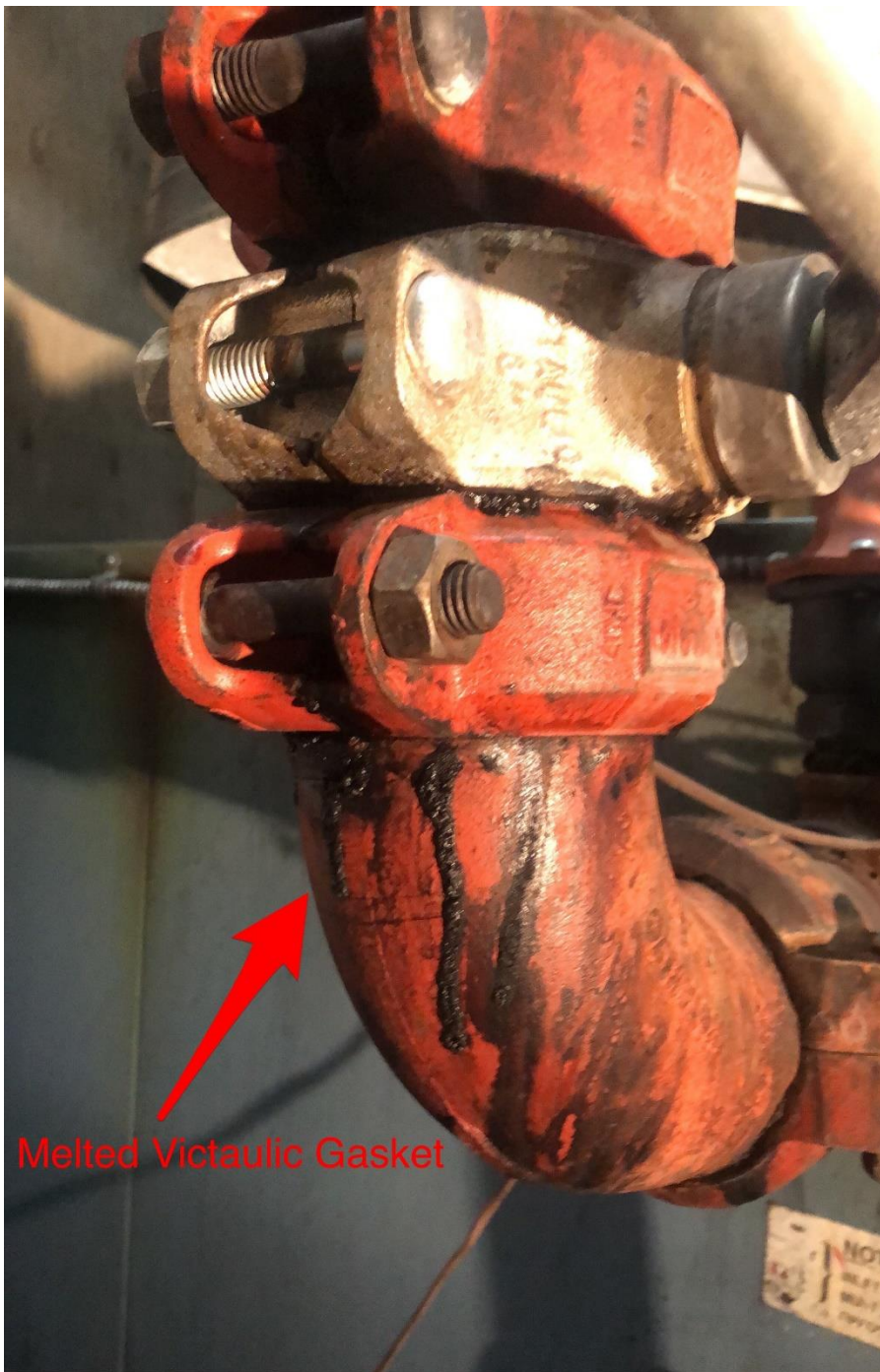


Image 5: Melted Victaulic Gasket on Boiler Outlet Piping



Image 6: Damaged Safety Relief Valve



Image 7: Damaged Outdoor Temperature Wires at base of Safety Relief Valve