Incident Summary #II-1525788-2023 (#33751) (FINAL)

SUPPORTING INFORMATION	Incident Date		March 24, 2023
	Location		Quesnel
	Regulated industry sector		Gas - Natural gas system
	Impact – Injury	Qty injuries	0
		Injury description	N/A
		Injury rating	None
	Impact – Damage	Damage description	Corrosion damage beyond repair to two boilers and their venting systems. Damage from corrosion to the existing brick chimney of the building.
		Damage rating	Moderate
	Incident rating		Moderate
	Incident overview		Two boilers with low inlet water temperature and corrosive condensate overflowing from their combustion chambers had heavy corrosion to their natural draft venting systems. Both boilers and venting systems were scheduled for replacement due to the damage.
INVESTIGATION CONCLUSIONS	Site, system and components		• Two natural draft boilers classed as Category 1 appliances were utilized to heat the publicly occupied space via radiators throughout the building. • Category 1 venting, single walled and double walled which must be run to the end/ top of the existing chimney. • Hydronic piping with bypass valve installed in the primary loop which is used to control the temperature of the boiler's inlet water within the manufacturer's recommended specification as per the operating manual. **Natural Draft Boiler**: A natural draft boiler is a mechanical device that utilizes the principles of combustion, draft and pressure to produce the airflow necessary to support the intended performance of the heater application. As the hot air rises, the fresh air required for combustion is continually drawn into the combustion chamber and burner. Normal operation of natural draft boilers should not experience condensate accumulations in either the venting or the combustion chamber when properly set up. **Venting**: is connected to the boiler and routed to an outdoor area via rigid material of the proper composition for the temperature and combustion gases created by the consumption of fuel. **Flue Gases**: will form and condense on any surface when it falls below its dew point, and this occurs when the return water temperature of the system is around 135 F. **Category 1 venting**: is a metal vent system that is used on Category 1 appliances to convey products of combustion safely to the outdoors. Typically, these appliance types have a draft hood and are more susceptible to down draft or spillage during a negative air pressure situation. There are two types of Category 1 venting; single-wall and double wall. Single-wall venting can be installed in interior heated spaces. Double-wall venting must be installed at the building wall where transition to outside spaces occur and must be insulated in outdoor spaces until the termination point. (Where the venting ends and is capped.)

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	By-pass valve: A device by which the flow of a fluid can be started, stopped, or regulated by a movable part that opens or obstructs passage. In a hydronic loop the valve is used to regulate the temperature of the return water to the boiler to maintain the manufacturer's recommended temperature. **Boiler "short-cycling"**: occurs when an oversized boiler quickly satisfies process or space heating demand and shuts down until heat is again required. Return water temperatures which are too cold can cause this issue. **Delta T -** difference between the inlet and outlet water temperatures. The boiler manual states for the Delta T - Adjustment of the manual bypass valve is critical to proper operation of the heater. The manual bypass valve should be adjusted to achieve a minimum inlet water temperature of 120°F (49°C) for Hydronic Heating.
Failure scenario(s)	Category 1 single wall venting failed due to condensation occurring inside the indoor venting. The indoor venting was found to be run up to the existing chimney wall only, and not within the chimney. The chimney is approximately 30 feet tall outdoors. The vapor running up in this space was condensing and running to the bottom of the chimney where the indoors venting was attached and was not able to escape the venting via a drip-leg/dirt-leg. The boiler insulating jacket was found to be dripping condensate. The gaskets at the top of the combustion chamber showed signs of failure. There was condensation found within the combustion chamber where only gases should be. The boilers, as stated by the on-site personnel, were running on the high limit for two minutes and then shutting off for another two minutes and were not found to be running on low limit at all. The bypass valve was found to be in the completely closed position causing the natural draft boilers to operate outside of the manufacturer's recommendations. The boilers had been noted to be short cycling as a result of return inlet water being too cold.
Facts and evidence	• Single wall venting from boilers was installed up to the wall of the existing brick chimney. The venting system was not installed within the existing chimney where it should have been run to the termination/end of chimney with approved material which would have been the double-walled venting. • Both boiler pumps had been replaced within the last few years. The bypass mixing valve was found to be in the completely closed position and not adjusted to the manufacturer's requirements of ½ open to ensure proper delta T of 16 to 39 F. The boiler operating manual advised this valve should be of the automatic type.
Causes and contributing factors	The cause of the incident was that the inlet water temperature was too low as the bypass mixing valve was left in the off position causing excessive condensate in the boiler combustion chamber and venting. Contributing factors: • The exhaust venting not running to the top end of the brick chimney creating a situation where condensation leaked back into the venting system. • The venting being thinner (26 gauge vs. 24 gauge) than required by code may have led to quicker corrosion.

Photo 1 – Both boilers rear-side view.

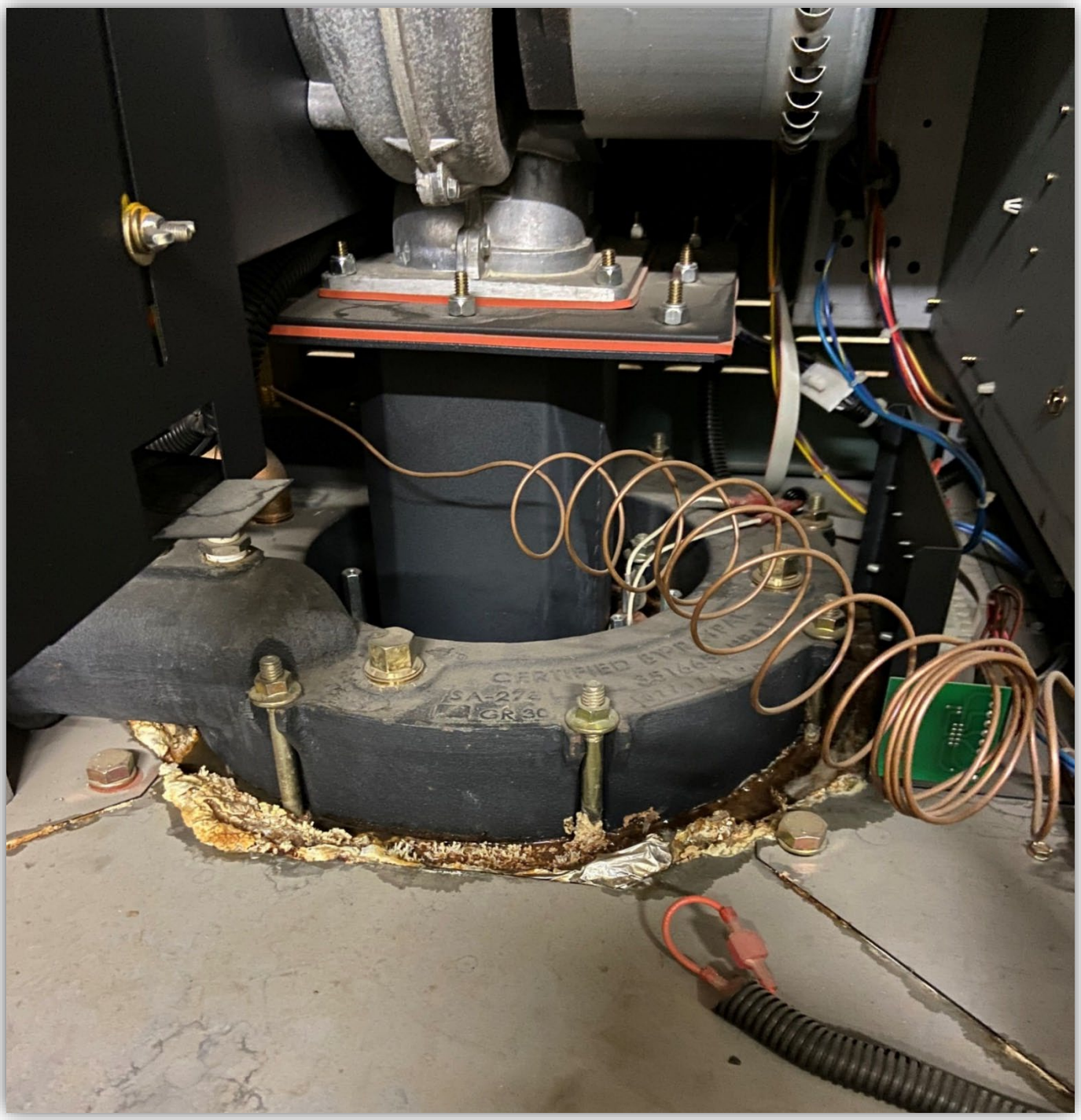

Photo 2 – Top of boiler 2 showing the leak from the gasket.

Photo 3 - Vent common header interior going into chimney with no pipe going upwards, concrete cinder blocks are visible.

Photo 4 – Venting common header with corrosion damage, photo taken after removal.

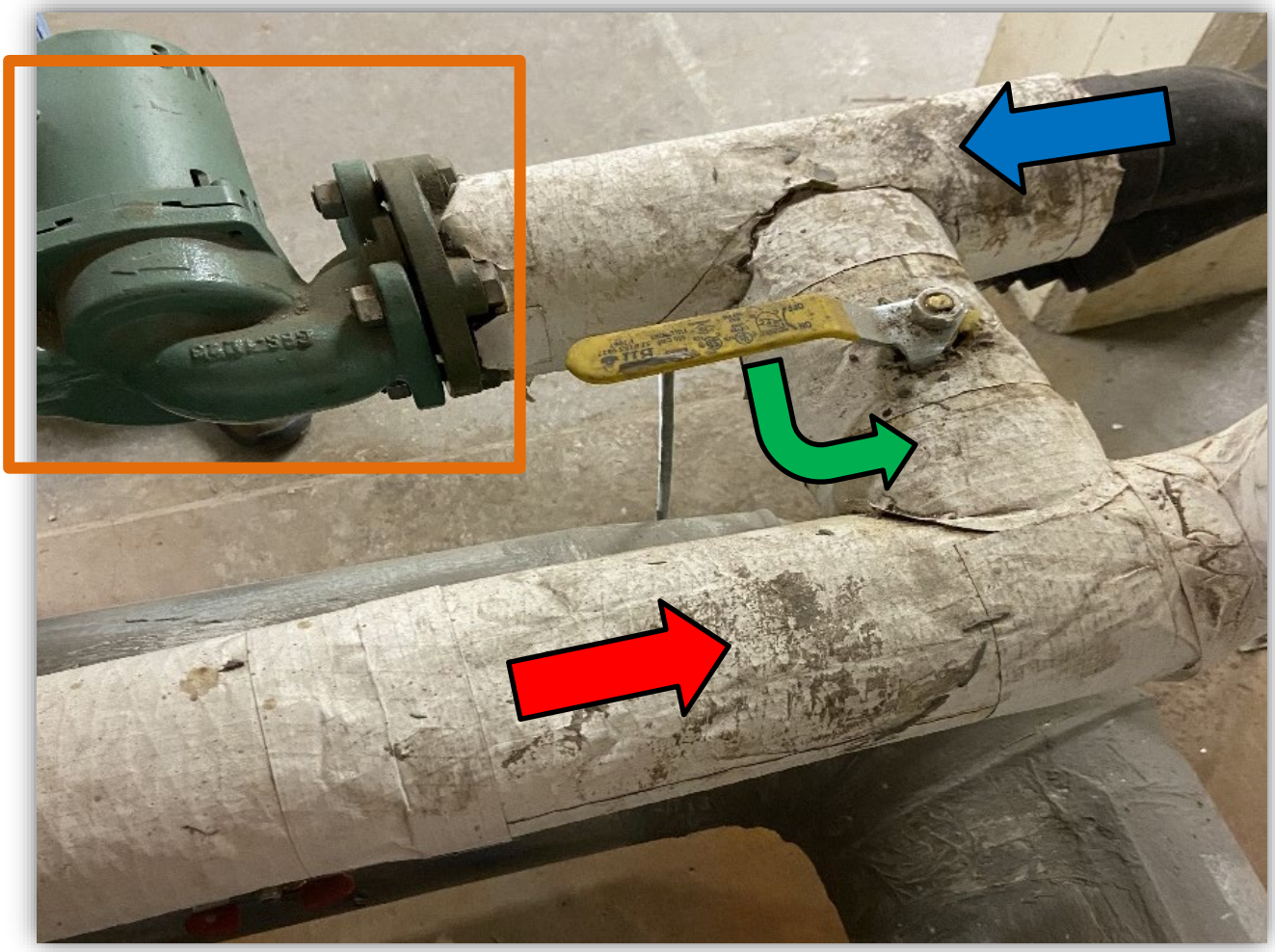

Photo 5 – Inlet temperature bypass valve. The valves for both boilers were left in the closed position as shown in the Photo. To mix the municipal water (**BLUE ARROW**) with the warmer boiler loop water (**RED ARROW**), the valve would be moved in the direction of the (**GREEN ARROW**),. This would allow for adjustment to the inlet temperature setting for the pump (**ORANGE**) to supply to the boiler.

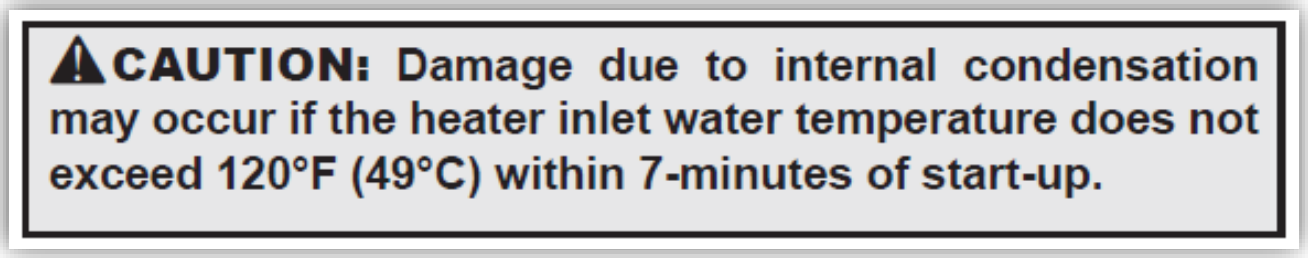

Photo 6 – Warning from boiler manual about inlet water temperature being too low.