Incident Summary #II-774658-2018 (#9731) (FINAL)

SUPPORTING INFORMATION	Incident Date		November 11, 2018
	Location		Delta, BC
	Regulated industry sector		Gas - Natural gas system
	Impact – Injury	Qty injuries	0
		Injury description	N/A
		Injury rating	None
	Impact – Damage	Damage description	Damaged unit heater and venting system, both are a total loss.
		Damage rating	Moderate
	Incident rating		Moderate
	Incident overview		A unit heater which was used to heat a garage bay, had a very hard light off (When the appliance attempted to ignite, rather than lighting off smoothly as designed, factors caused a small explosion in the combustion chamber), this blew off the bottom access cover and damaged the appliance.
INVESTIGATION CONCLUSIONS	Site, system and components		Direct vented appliances have their combustion air ducted directly into the burner chamber from the outdoors. Often a concentric venting kit, where a pipe installed within a second pipe, is used. The outer pipe draws the combustion air into the appliance, while the inner pipe conducts the products of combustion outdoors. This venting system is made out of materials which should resist corrosion from the elements which they are subjected to. This appliance employs a pre-purge prior to ignition. This means that the fan used to vent the products of combustion runs for a period of time before the pilot “Trial for ignition” starts. This is done to ensure that in the event of any leakage from the gas valve, raw gas is evacuated from the burner chamber prior to ignition. Once the pre-purge is completed the appliance starts its “Trial for ignition”. Since this appliance has an intermittent pilot, the pilot flame (The flame which ignites the main burner) is not constantly lit. Instead, the appliance enters a “Trial for ignition phase” in which it attempts to ignite the pilot flame, proves that it is lit, then attempts to light the main burner. Once the main burner is lit, the appliance enters the “Run cycle” where the appliance runs and heats the space, or preforms whatever task it is designed to do. Once the run phase ends the pilot is extinguished. During the “Trial for ignition” phase gas is supplied to the pilot burner, as is an ignition spark. The ignition spark is sent from the appliance ignition module through a heavily insulated wire to the ignition electrode on the pilot burner. The ignition module relies on the burner and burner area as a ground so that the ignition spark can jump from the ignition electrode to the pilot burner, this creates a source of ignition for the gas coming out of the pilot burner. Due to the way the spark ignition system grounds itself, any cracks or defects in the ignition wire insulation, or loose connections at the terminals, will cause the spark to occur between the defect and any close by metallic parts of the burner, instead of at the ignition electrode.

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	Should an appliance with an intermittent ignition fail to establish a pilot after 15 seconds it will stop trying to ignite the pilot, go into pre-purge mode, and depending on the type of ignition control it may try to light the pilot again. The ignition module for this appliance was a “continuous retry” module, meaning that it will continue to ignite the pilot burner, instead of locking out after one or several failed attempts. In this situation the appliance installation appeared to be compliant and installed correctly, and no technical non-compliances were identified.
Failure scenario(s)	Due to its placement within the combustion chamber, the wire running from the ignition module to the pilot ignition electrode was damaged by heat (see Figures 2 & 3 below). This caused the appliance to spark between the burner piping and the wire rather than at the ignition electrode. Every time the appliance attempted to light gas was released from the pilot burner. The inner pipe of the concentric vent kit serving the appliance had corroded to the point where holes formed between the vent outlet pipe and the combustion air intake pipe. This allowed any gas that was being purged during the pre-purge, to recirculate back into the burner chamber. Eventually an explosive mixture of natural gas built up within the burner chamber. Finally this gas found the spark between the charred ignition wire and the burner piping and ignited causing an explosion within the unit, ejecting the bottom access panel from the unit, and warping the bottom of the appliance.
Facts and evidence	-Assessment of the vent pipe within the concentric venting kit found the vent pipe was extremely corroded. Although a hard light off may have perpetuated the damage to the venting system. - Signs of charring were found on the ignition wire at the point where it passes very close to one of the appliance burners. -The ignition module for this appliance was a “continuous retry” type, so every time the pilot flame failed to ignite, the appliance purged the chamber, and attempted its “trial for ignition” again.
Causes and contributing factors	-It is very likely that the cold air being drawn in for combustion caused the warm flue products to condense in the vent pipe, corroding the inner piping of the vent kit -It is very likely that the burnt ignition wire caused the appliance to spark somewhere other than the ignition electrode. Since the appliance was recycling back into itself, the gas would have been able to build up until it found the spark elsewhere in the appliance, igniting the explosive mixture. -It is very likely that during pre-purge cycle the appliance was cycling gas back into the combustion chamber, when the appliance attempted to operate the explosive mixture ignited damaging the unit. -It is possible that a lack of inspection of the venting system during routine maintenance of this appliance may have contributed to this failure. This highlights the importance of not only servicing and inspecting the appliance, burner, and ignition system, but also the venting system which serves the appliance.

Figure 1. Picture of appliance showing damage

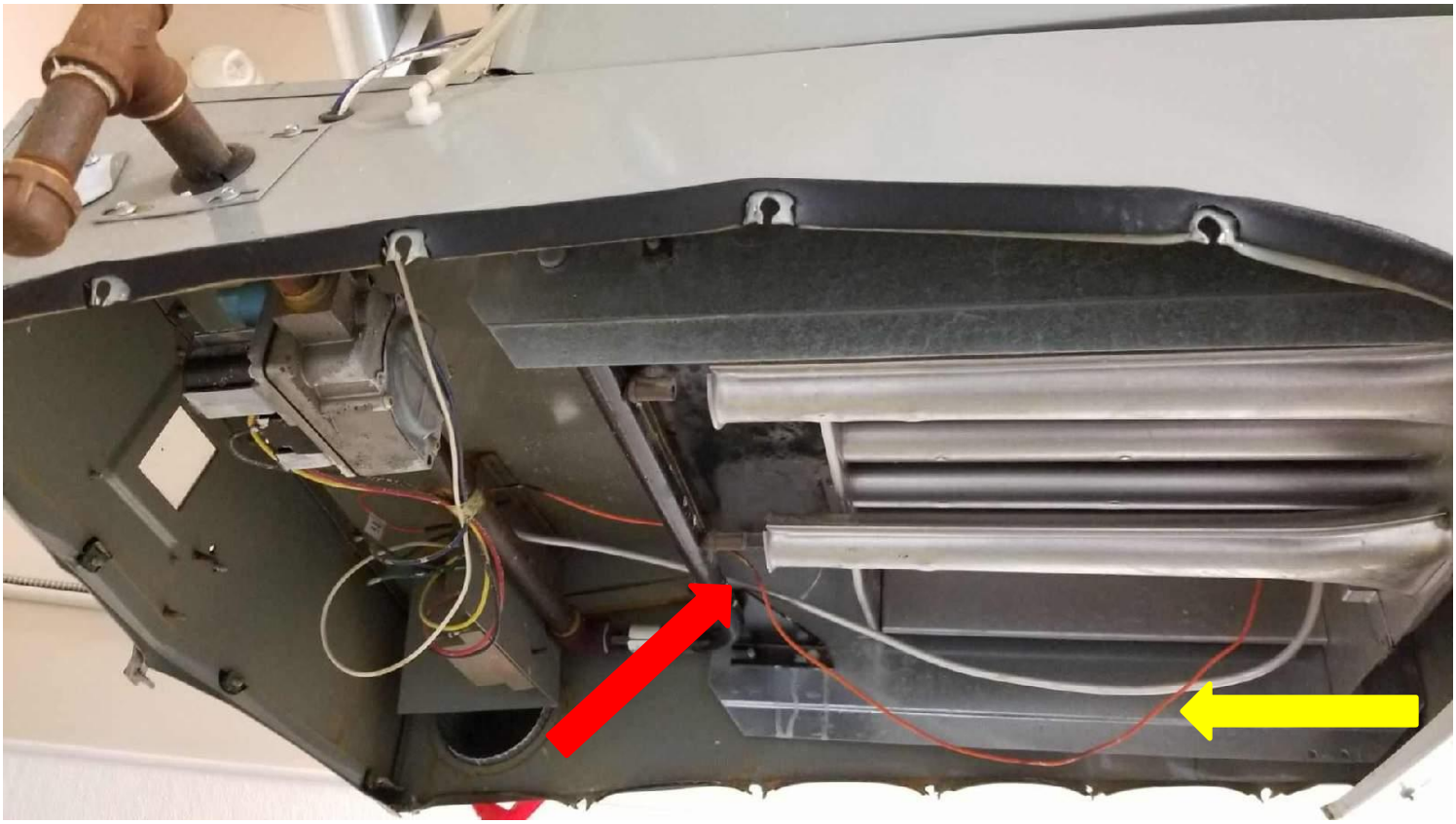

Figure 2. Picture of appliance underside showing ignition wire (yellow arrow), and burnt section of wiring (red arrow). Ignition wires are almost always solid red, and generally wouldn't have any black markings on them.

Figure 3. Close-up picture of burnt ignition wire.

Figure 4. Appliance concentric termination. The top cap vents products of combustion. The bottom cap brings in fresh air for combustion.

Figure 5. Picture of the vent cap.

Figure 6. Picture of disassembled concentric termination showing corrosion damage

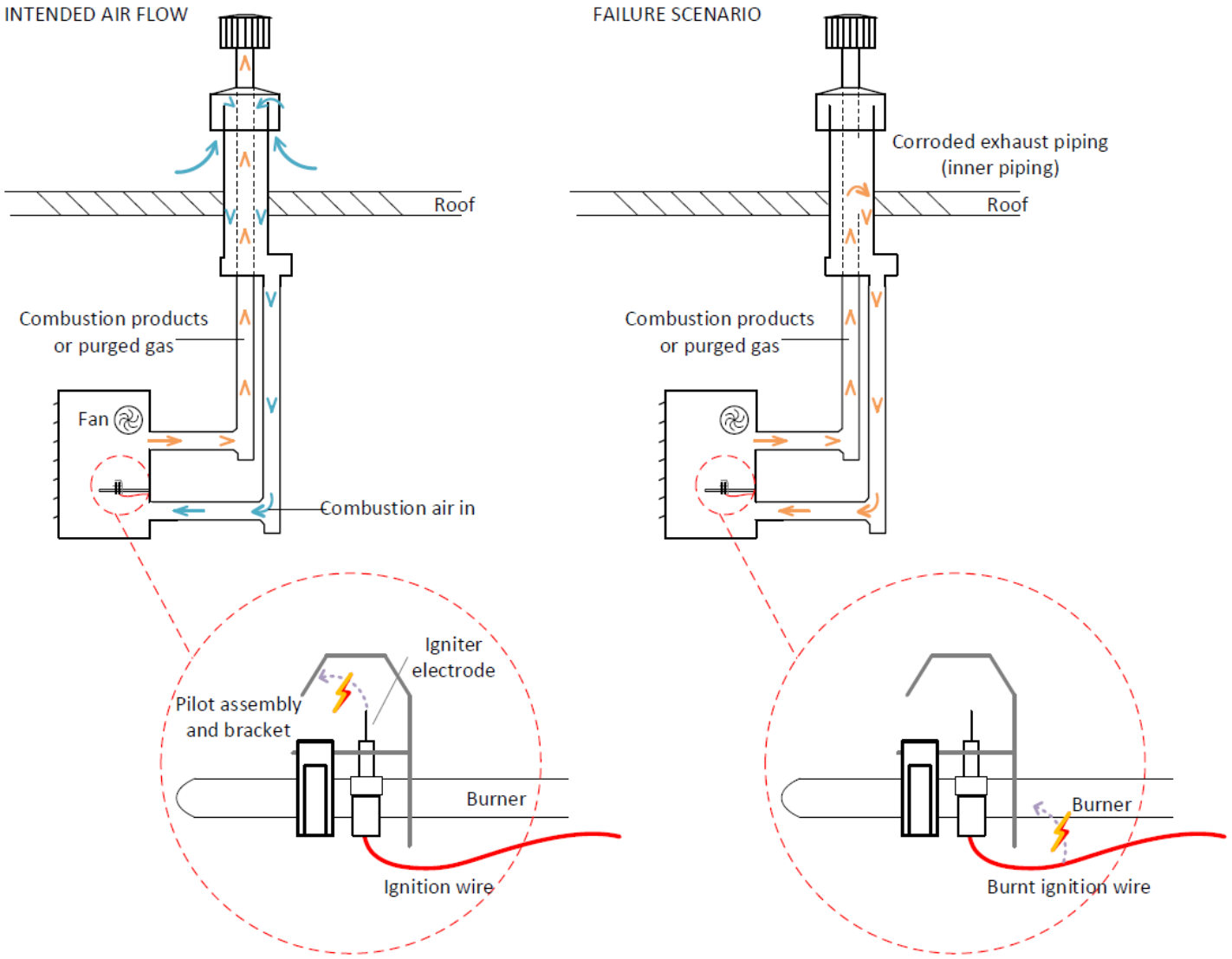

Figure 7. Illustration detailing failure scenario.