Incident Summary #II-917149-2019 (#15557) (FINAL)

SUPPORTING INFORMATION	Incident Date		October 5, 2019
	Location		Chilliwack
	Regulated industry sector		Gas - Natural gas system
	Impact – Injury	Qty injuries	0
		Injury description	NA
		Injury rating	None
	Impact – Damage	Damage description	The damage was contained to the furnace in a single family residential house. The top front cover of the furnace had been blown off. The plastic housing containing the inducer fan had broken away from multiple attachment points and was hanging from the front of the furnace by the tubing and wiring. There were burn marks at the upper right hand corner of the furnace on the interior insulation and some melting of the plastic venting that was inside of the furnace cabinet. There were also some wires that had burnt and melted insulation.
		Damage rating	Minor
	Incident rating		Minor
	Incident overview		An explosion and small fire occurred inside a residential natural gas furnace in a single family detached home built in 2018.
INVESTIGATION CONCLUSIONS	Site, system and components		Natural gas travels from the outlet of the gas utilities' meter to appliances in the home via a piping and tubing system. Gas piping and tubing systems are made to be gas tight so the combustible gas cannot escape to atmosphere. The tubing used in this system is copper tubing and is sealed to the valves and appliances using flared fittings. The fittings are made of brass and have a male threaded portion with a beveled sealing surface and a threaded flare nut that screws on to the male portion of the fitting. The flare nut is first placed over the end of the copper tubing then the end of the copper tubing is flared out using a specialized tool so the nut can slide over the flare but not come off of the tube. The flared copper meets up with the beveled sealing surface on the fitting, then the nut is threaded over the fitting and tightened, compressing the copper to the sealing surface on the brass fitting generating a gas tight seal. (See picture #1) The high efficiency gas furnace incorporates a draft inducer fan. The draft inducer fan is sealed to the inside of the furnace heat exchanger and is driven by a small electric motor. The purposes of the draft inducer fan are to purge any combustion gases that remain inside of the combustion chamber after the previous heating cycle, and to ensure heat is distributed evenly inside of the heat exchanger to maximize its efficiency. The fan does this by first starting 15-30 seconds before the gas burners ignite, running while the burners are operating, then continuing to run for 15 seconds after the burners shut off. This draws air from inside the cabinet area of the furnace, across the burners, through the heat exchanger and out the venting system to the outdoors.

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Failure scenario(s)	The house was new when the owners moved in December 2018. The furnace had been used for the winter months without incident. In the spring the owners hired a contractor to add an air conditioning unit to the furnace. The gas line to the furnace was removed by the contractor so an air conditioning coil could be added to the top of the furnace. When the air conditioning job was complete the gas line was reinstalled to the flare fitting on the gas valve inside of the furnace cabinet. The flare nut was left loose and not tightened to create a gas tight seal. The gas shut off valve to the furnace was not turned back on to the furnace so gas did not escape the loose connection. The furnace was used for air conditioning only through the summer months. On the date of the incident the outside temperature had dropped enough that the owner wanted to start the furnace to warm up the house. The thermostat controlling the furnace was turned up but the furnace failed to start heating the house. The owner went downstairs to investigate and found that the shut off valve supplying gas to the furnace was in the off position. The owner turned the valve on and went upstairs to try the thermostat again. When the shut off valve was turned on, gas started leaking from the loose connection inside of the enclosed furnace case and was not noticed by the owner. When the thermostat was turned on, the draft inducer fan started drawing the leaking gas from inside the furnace case filling the inside of the furnace heat exchanger with a combustible mixture of gas and air. The combustible mixture then found a source of ignition and ignited. The most probable source of ignition would be the electronic igniter for the furnace burners.
Facts and evidence	**Owner statement:** He moved into the new home last December and used the furnace without issue for the winter season. In the spring he had a company come and install an air conditioning system on the furnace. He had not used the furnace for heating after the air conditioning was installed until the day of the incident. On the day of the incident he turned up his thermostat and the furnace did not operate. He went to the mechanical room and noticed that the gas valve to the furnace was in the off position. He turned the gas valve on then went directly upstairs to turn the thermostat back up. Within a minute of turning the thermostat up he heard a loud bang downstairs. He went to investigate and observed that the upper front cover of the furnace had been blown off and there was a small fire at the front of the furnace. He reached around the front of the furnace and turned the gas shut off valve off to the furnace and the fire stopped. He said that two technicians were on site to complete the work. He did not remember if the air conditioning coil on top of the furnace was there before the air conditioning company installed the air conditioning or not. He did not hear or smell gas leaking when he turned the gas shut off valve to the furnace on. Nobody had touched or altered the gas line other than the air conditioning contractor since they had moved in. He notified the gas utility and a technician for the gas utility had been onsite after the incident. The only thing that was touched or altered on or around the furnace after the incident was the gas utility technician had closed two other gas shut off valves in the mechanical room and affixed a red tag to the gas shut off valve handle to the furnace.

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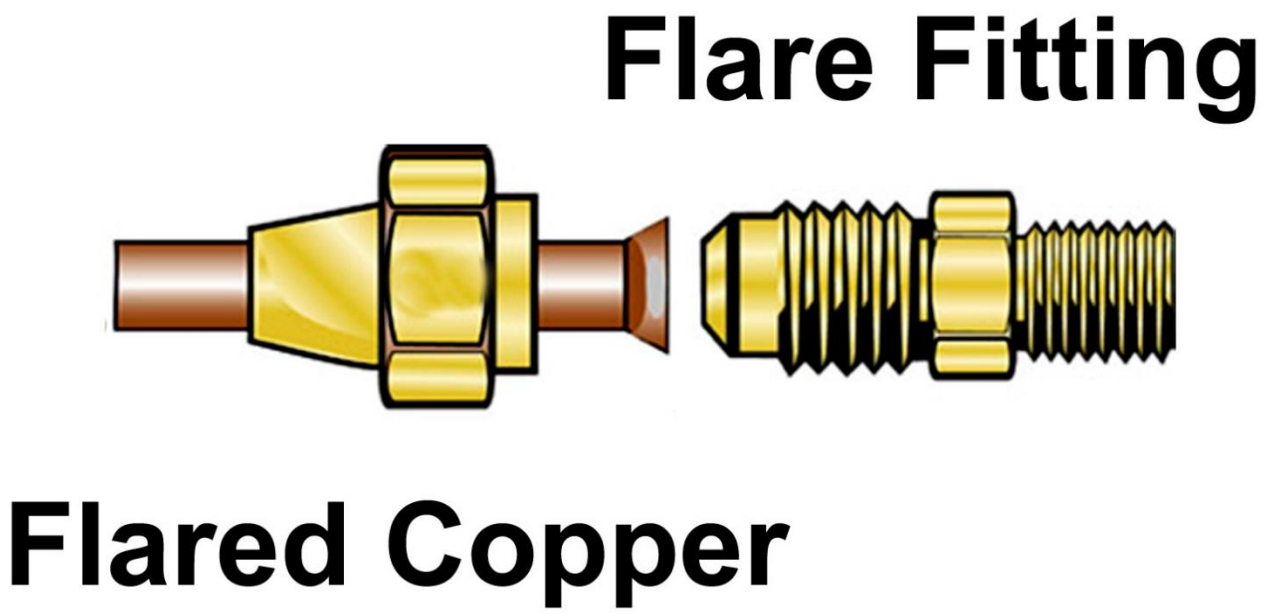
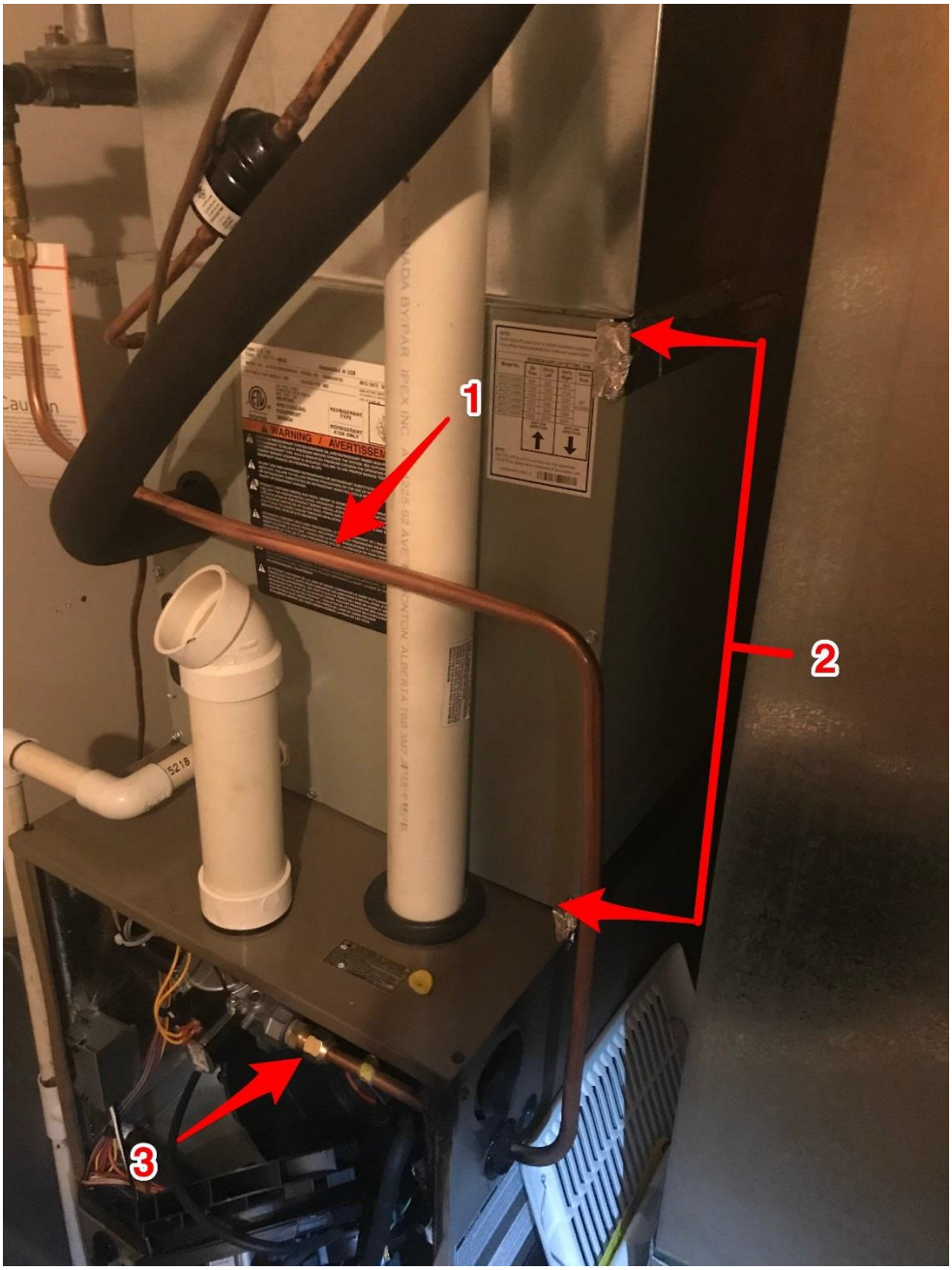
	Gas utility technician statement: The owner called the gas utility to report the incident. He was dispatched to the house and when he arrived he noticed that an explosion had occurred in the furnace and the inducer fan had blown apart and there was signs that a small fire had occurred and was contained inside of the furnace. In the mechanical room he closed the gas shut off valves to the gas manifold and to the additional gas appliances in the house. He affixed a red tag to the valve handle of the gas shut off valve to the furnace. **Site observations (Photos) (Video)** The gas tubing ran across the middle of the air conditioning coil that was installed on the top of the furnace. **(Picture #2)** The gas was run to the furnace from the gas manifold in the mechanical room with flexible copper tubing with brass flare fitting connections on either end. The flare nut attached to the furnace gas valve inlet inside of the furnace case was loose and the fitting had four exposed threads. It took four full turns in of the flare nut to begin to tighten. **(Picture #3) (Video)** The top front cover of the furnace was off. The plastic housing containing the inducer fan had broken away from multiple attachment points and was hanging from the front of the furnace by the tubing and wiring. **(Picture #4)** Burn marks were observed at the upper right hand corner of the furnace on the interior insulation and on a portion of the plastic venting that was inside of the furnace cabinet. Some wiring had burnt and melted insulation. **(Picture #5)** **Air conditioning installing technician statement:** He did install air conditioning at the home in the spring. The furnace did not have an air conditioning coil installed on it originally. He installed the coil on top of the furnace and the compressor outside. He has been a certified gas fitter for over nine years and holds an active gas contractor's license. He hires out to a refrigeration technician to connect the AC lines from the compressor to the coil and commission the system. He doesn't remember removing the gas line to install the coil, leaving the gas line loose or leaving the furnace gas valve off but he said that it was possible that he may have.
Causes and contributing factors	It is highly likely that the cause of the incident was that the air conditioning installing technician did not tighten the gas line on the furnace, turn the gas valve on or test for leaks after installing the air conditioning coil on the furnace. The owner not hearing or smelling the gas leak when he turned on the gas shut off valve was a contributing factor.



Picture #1

Example of a flared copper connection to a brass flared fitting

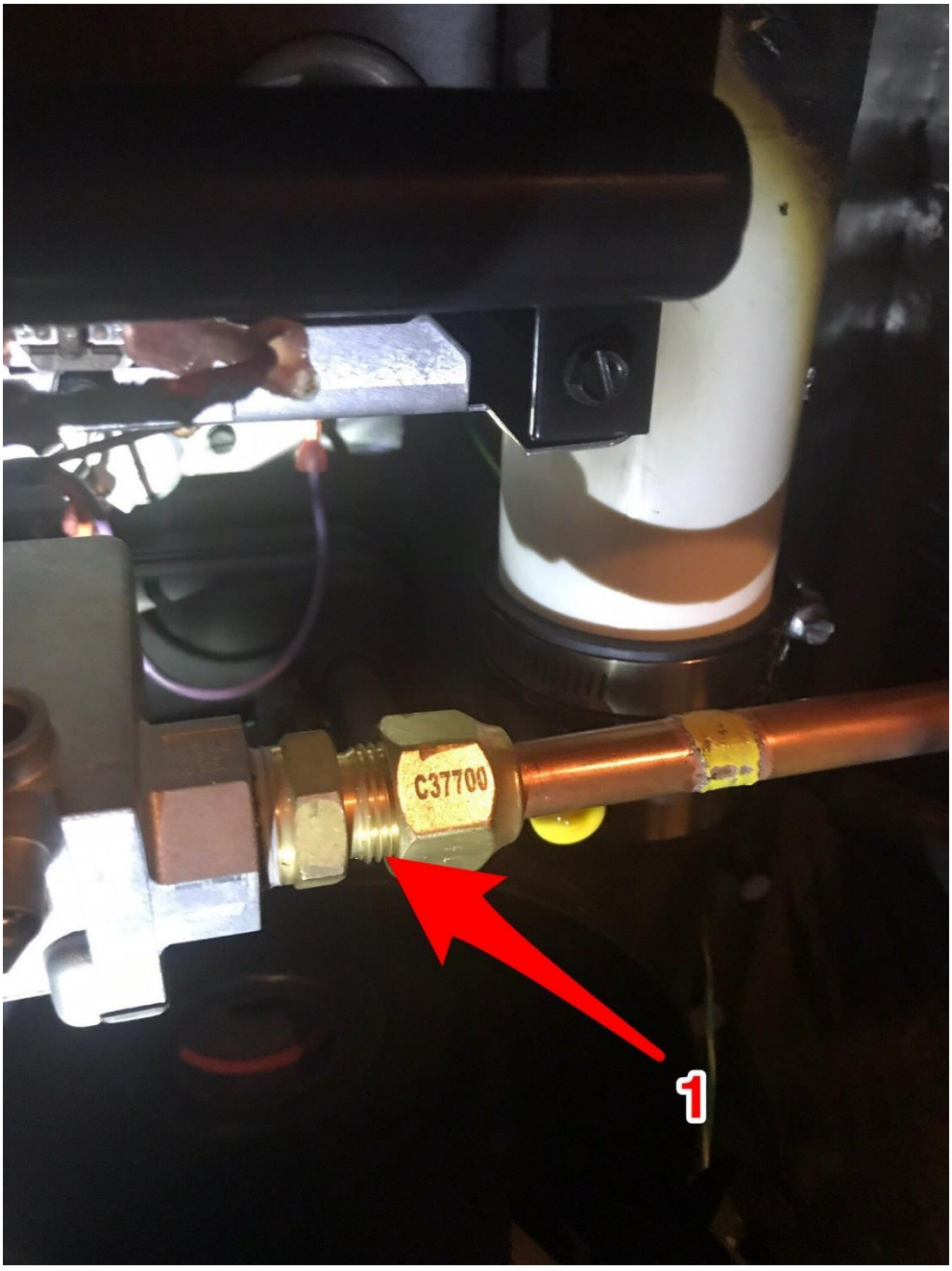


Picture #2

Arrow #1 – Copper gas line to furnace

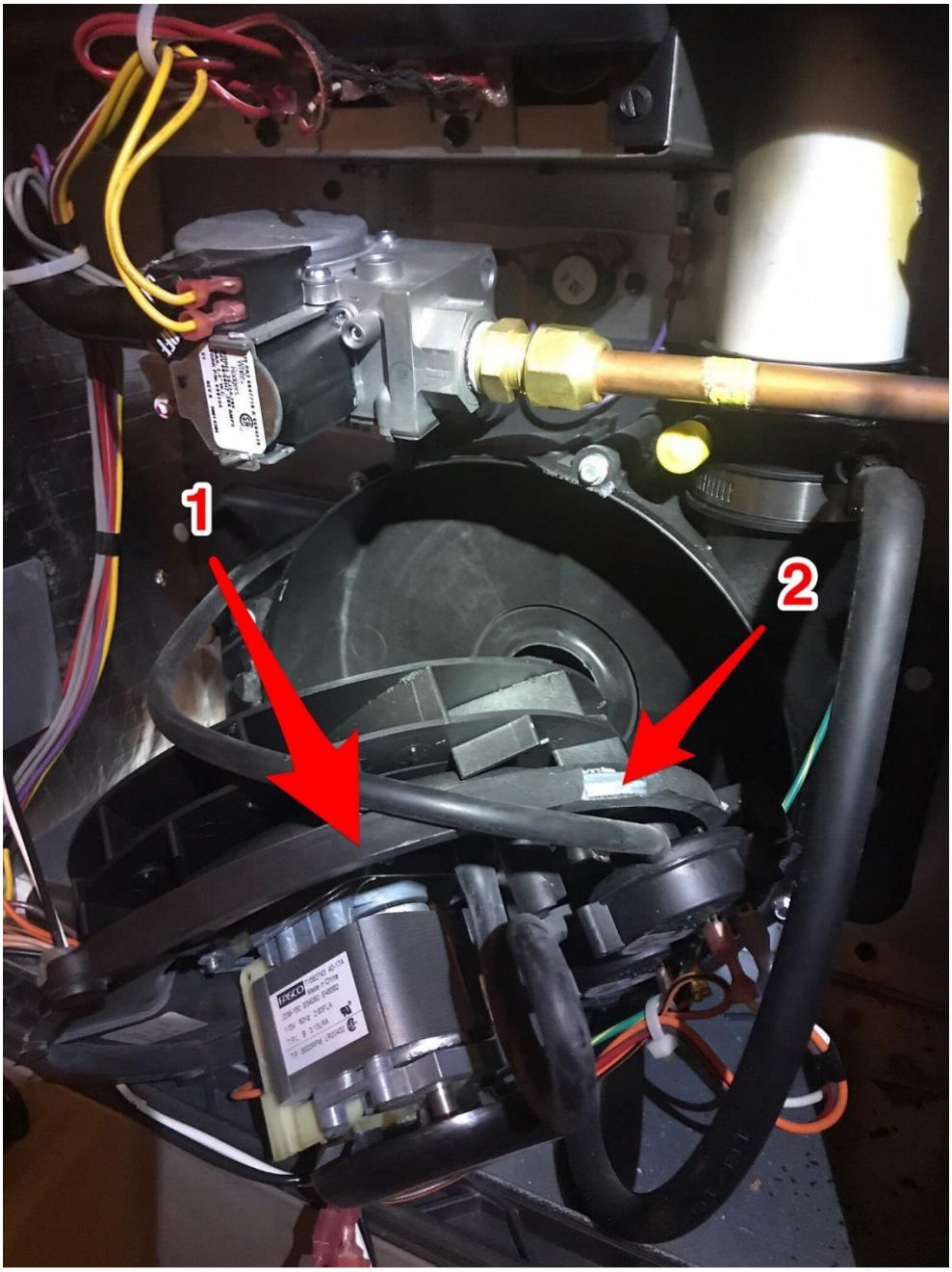
Arrow #2 – New air conditioning coil added to furnace

Arrow #3 – Loose gas connection



Picture #3

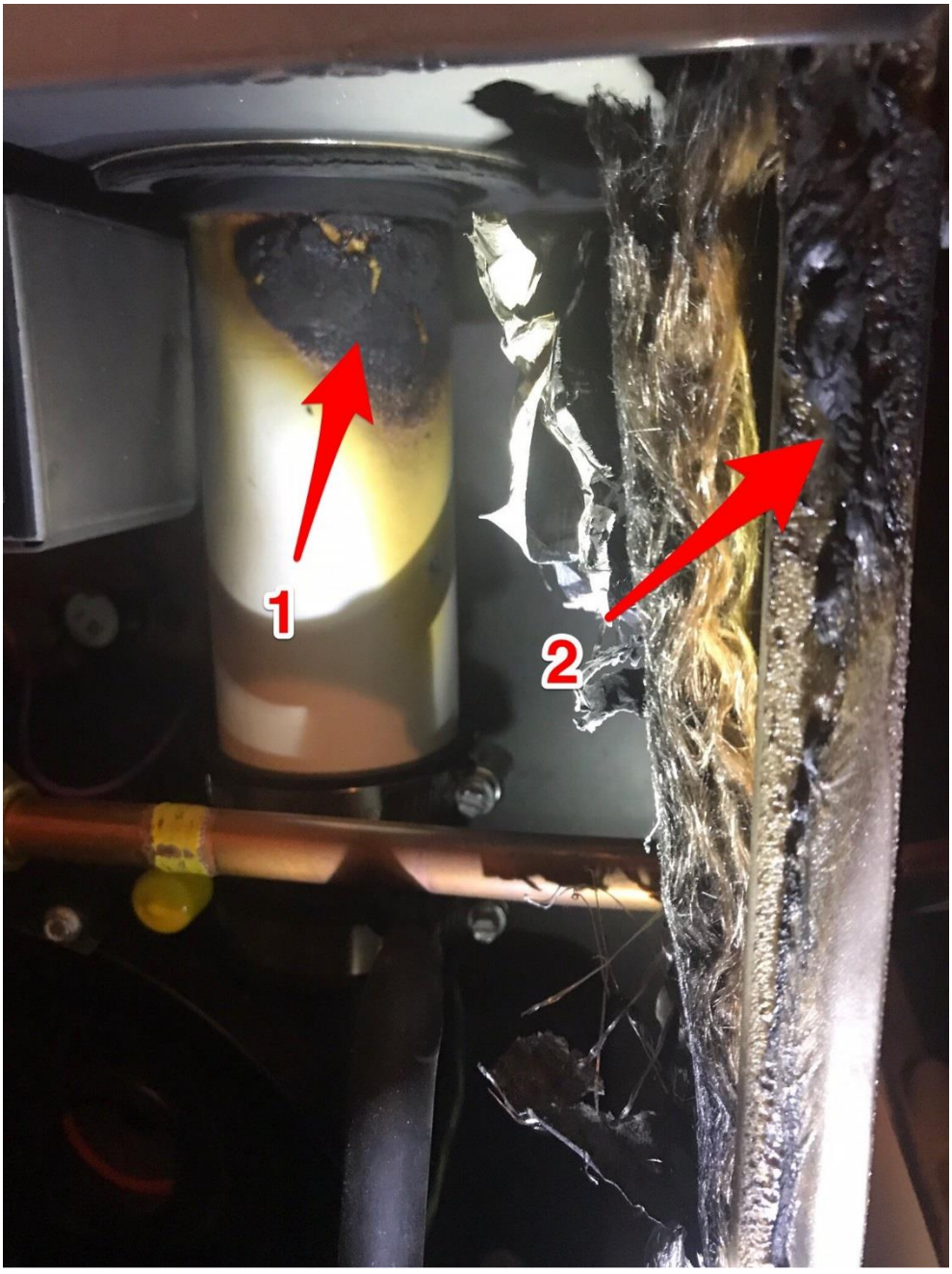
Arrow #1 – Exposed threads on the loose flare connection



Picture #4

Arrow #1 – Furnace inducer fan motor

Arrow #2 – Broken mounting tab



Picture #5

Arrow #1 – Fire damage to plastic vent piping

Arrow #2 – Fire damage to interior furnace insulation

Video #1: Gas connection video. Clicking image above will direct you to the video on Technical Safety BC’S YouTube channel.