

Incident Summary #II-1639122-2023 (#41742) (FINAL)

SUPPORTING INFORMATION	Incident Date			November 21, 2023
	Location			Chilliwack
	Reg	Regulated industry sector		Gas - Natural gas system
		Injury	Qty injuries	0
			Injury description	NA
	Impact		Injury rating	None
		Jamage	Damage description	An electrical connection just below the plastic air filter overheated, burning off approximately three (3) inches of insulation from the wire and then igniting the plastic air filter.
		Δ -	Damage rating	Moderate
	Inci	cident rating		Moderate
	Incident overview			There was a fire inside an approximately 30-year-old furnace.
				A "push on" electrical terminal connection that is part of the electrical power circuit for the furnace fan became resistive over time, resulting in the wire becoming hot enough to burn away approximately four (4) inches of the wire insulation jacket and then ignite the plastic air filter mounted above the wire on fire. The resulting smoke and fumes from the burning filter entered the living space of residence and was detected by a carbon monoxide alarm which alerted the single resident of a hazardous situation.
INVESTIGATION CONCLUSIONS	Site, system and components		stem and nents	The function of the furnace fan is to move air from the living space of the home, through the heat exchanger inside the furnace, and then distributed back to the rooms of the home through a supply air duct system (Image 1). The air that will enter the furnace must be filtered to remove dust and debris before passing through the components of the furnace (Image 2). The filters are held in place with brackets holding three (3) sides of the filters above the fan assembly. The fan draws air through the filters to the fan, pulling the filters downward with the airflow to hold them against the support brackets. The electric fan motor in this model of furnace requires a capacitor for the motor to run. The capacitor alters the current to one or more windings of a single-phase alternating-current induction motor to create a rotating magnetic field. The capacitor in this model is mounted to the top of the of the fan housing (Image 1 and Image 2) just below the air filter, by the manufacturer. The electrical wires connect to the capacitor using common "push on" terminals. A "push on" terminal (Image 3) is a commonly used electrical connector that is pushed together using friction between a flat or spade shaped male connector and a corresponding female connector. These terminals are commonly used where wires need to be frequently disconnected and connected for diagnosis and replacement of electrical components. If a terminal becomes loose or corroded it may not make enough of a connection to transfer electricity as required. This poor connection can



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	generate heat that may further compromise the connector and the associated wire or component (<u>Image 6</u>).
	The furnace was approximately 30 years old. The homeowner described that he had performed the maintenance for the furnace annually since 1990. The furnace filters the homeowner installed were reuseable aftermarket plastic foam furnace filters. The homeowner said he had just vacuumed the reusable plastic furnace filters to remove any dust or debris collected. The homeowner re-installed the filters, then turned the power to the furnace on to restore normal operation.
Failure scenario(s)	A short time after the furnace was turned back on, a carbon monoxide detector inside the home went into alarm. The homeowner saw smoke coming from the furnace, shut the furnace off, and called the contractor who had recently repaired an unrelated ignition problem with the furnace. The contractor instructed the homeowner to exit the building and open doors to ventilate. The contractor was nearby and immediately went to the residence. Upon arrival the contractor opened the fan compartment, found the furnace filters to be on fire and extinguished the flames. The contractor then immediately contacted the Gas Safety Officer for the area to report the incident.
Facts and evidence	 Site observations: A wire connecting to the fan motor capacitor shows evidence that it had become hot. The insulation has burnt off the wire completely for approximately 4 inches back from the "push on" terminal connection to the capacitor (Image 6). The left side filter appears to not have been fully seated into the channel that holds the filter in position away from the fan housing and capacitor. It is possible the filter may have sagged as it was not properly installed in the lower filter bracket and was pulled down to the capacitor by the airflow and contacted the hot wire, resulting in the plastic filter catching on fire (Image 5). The furnace filters may not have been properly placed into the filter mounting bracket that holds the filter in place. A photo of the remaining portion of the left-hand filter shows it is not completely seated into the filter bracket (Image 4). This could have resulted in the plastic air filter coming into contact with an overheating electrical wire, causing it to melt and ignite. Homeowner statements: The homeowner has been maintaining the air filters in the fan compartment for approximately 30 years and declared he had removed and cleaned the filters. The homeowner said the incident occurred just after cleaning the filters.
Causes and contributing factors	The resulting fire appears to be a combination of an existing electrical component ongoing failure and a possibility that the left side filter was not placed fully into the lower filter bracket resulting in the plastic filter being drawn down with the airflow to make contact with the heated electrical wire. The design of the filter brackets and fan assembly places the filter in close proximity to the electrical connections of the fan capacitor. An error in properly installing the filters, or poor maintenance resulting in plugged filters can result in the filters being drawn down toward the fan assembly with the airflow and making contact with the energized terminals of the capacitor.





Image 1 – This is a cut away view of the furnace from the installation manual for this model of furnace and shows the parts of the furnace. The cooler air from the home is drawn through the return air duct connecting to the top of the furnace, then down through the air filters, through the fan assembly, and then pushed through the heat exchanger and then down to the supply air duct which distributes the heated air back into the rooms of the home. **This diagram is from the Lennox G20RE service manual.*





Image 2 - The filters are positioned over top of the fan housing as illustrated in this diagram. There are 2 filters required, one installed horizontally above the fan assembly on the right, and one installed at an angle on the left above the capacitor and the associated wiring. **This diagram is from the Lennox G20RE service manual.*





Image 3 – This is a generic view of a fan capacitor installed with the manufacturers wiring method of using "push on" terminal connectors. **This photo is from https://m.youtube.com/watch?v=CXzrSpuLJI0.*





Image 4 - The furnace filters after the fire with the fan assembly removed. The area with the most damage is located above where the capacitor and associated wiring would be located. The filter does not appear to be fully seated inside the lower filter bracket which may have resulted in the filter making contact with the damaged wire as shown in <u>Image 5</u>.





Image 5 - The angle of the left filter is illustrated in [**A**] to show how it sits in relation to the fan assembly. The complete filter would sit in the lower filter bracket and lean against the upper right-side filter as shown by [**B**] lines. The filter normally sits close to the fan assembly and the capacitor wiring, but if the filter is not seated into the lower filter bracket properly it is possible the filter could sag and make contact with the live electrical connections and wiring of the capacitor.





Image 6 - The wire without insulation. The insulation is completely removed without any fragments or residue which is an indication that the wire was hot enough to burn the insulation away completely from the wire. There is also a discoloration of the "push on" terminal connector where you can see the brown coloured metal underneath the burnt filter material that dropped onto the capacitor. Normally a terminal connector will have a shiny silver colour as shown in <u>Image 3</u>.