Incident Summary 5584191

SUPPORTING INFORMATION	Incident Date		March 11, 2016
	Location		Surrey
	Regulated industry sector		Gas - Natural gas system
	Impact – Injury	Qty injuries	1
		Injury description	Fatality
		Injury rating	Fatal
	Impact – Damage	Damage description	Heat scorch on the insulation of the wiring located above the furnace burner section and soot on the inside of the lower furnace burner section cover panel.
		Damage rating	Moderate
	Incident rating		Severe
	Incident overview		Fire department personnel responded to a 911 call indicating an infant in medical distress. As they entered the home they were alerted to the presence of carbon monoxide by their personal gas monitors. The air in the home was tested and found to contain low levels of carbon monoxide. The natural gas forced air furnace was examined and found to be the source of the carbon monoxide spilling into the home.
INVESTIGATION CONCLUSIONS	Site, system and components		A natural gas forced air furnace was located in a room adjacent to the front entrance into a split level designed home. The unit was designed with burners firing into a combustion chamber, heat exchanger and a venting system. The natural gas burner flame produces heated products of combustion (flue gases). The heated products of combustion create draft, or flow, upwards through the heat exchanger flue gas passages towards the venting system.
	Failure scenario(s)		Incorrectly adjusted burners likely created residue (soot) to build up on the inside of the heat exchanger (Image 4). Restriction in the flow from the combustion chamber to the venting system lead to a condition where the burner flame and products of combustion found another pathway to exit the combustion chamber. This resulted in what is termed “flame roll out” causing heat damage to the controls, wiring and furnace panels and carbon monoxide being produced which subsequently migrated throughout the home.
	Facts and evidence		**Witness statements** • When the first responders entered the home they were alerted to the presence of carbon monoxide in the home by their personal gas monitors. • No other occupants of the home reported experiencing symptoms of carbon monoxide poisoning. **Site observations** • The service tag on the furnace indicated that the natural gas forced air furnace had not been serviced by a qualified individual since 2010 (6 years). • The furnace air filter was old and found to be plugged.

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	• The gas valve feeding the furnace had been partially closed restricting the amount of gas supplied to the furnace. • The furnace wiring had been repaired with electrical tape where it had been exposed to the heat from the burners, which supports the “flame roll out” condition. • There were large soot particles on and around the burners and draft hood. • The furnace flue passages were heavily crusted with some kind of material. The inside of the lower furnace cover panel showed signs of soot build up. **Furnace testing** • During operation the furnace burner flame came out the front of the combustion chamber and up the front of the furnace. • When the furnace was put into operation testing indicated high levels of carbon monoxide being produced by the furnace and spilling into the occupied space. **Medical reports** • Elevated level of carboxyhemoglobin was measured in the infant’s bloodstream indicating exposure to carbon monoxide. • The level was below a range considered toxic to an adult. • An underlying medical condition was identified which increased the victims susceptibility to carbon monoxide poisoning. • Carbon monoxide was identified as a secondary contributing factor to the infant’s cause of death. **Note:** Technical Safety BC limits its investigation scope to the technical equipment failure. Technical Safety BC does not diagnose medical conditions and does not determine cause of death. Medical information and conclusions are included to contextualize the health effects and consequences related to equipment failures.
Causes and contributing factors	It’s very likely that the restriction in gas supply to the furnace caused incomplete combustion creating blockages in the flue gas passages. Incomplete combustion allowed the flue products (that contained elevated levels of carbon monoxide) to enter the home. The absence of furnace maintenance and carbon monoxide detectors in the home were contributing factors to the incident.

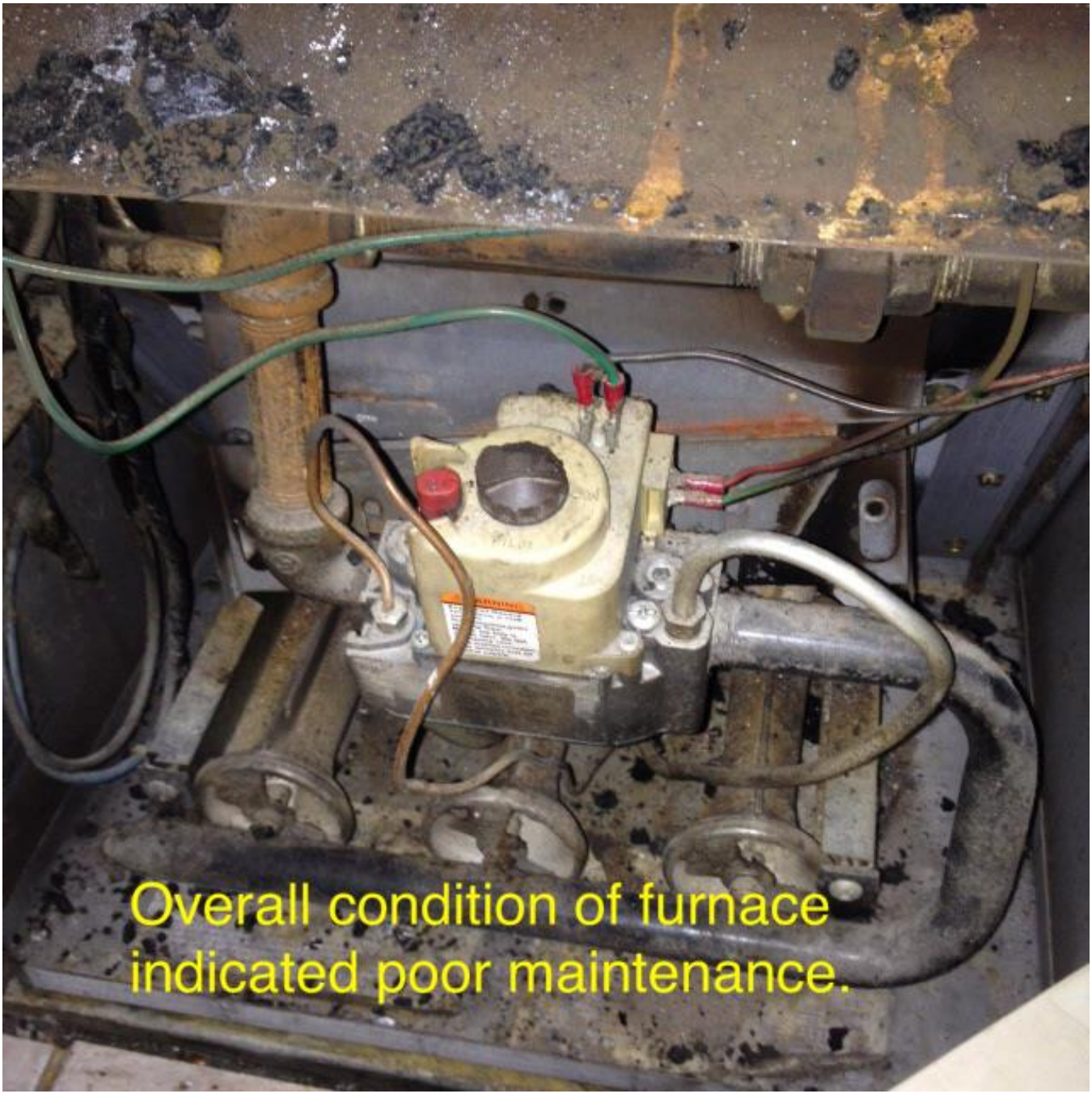

Image 1 – Dirt, debris and carbon deposits indicate extended furnace operation without service and maintenance. The last indication of furnace service by a qualified individual was six years prior.

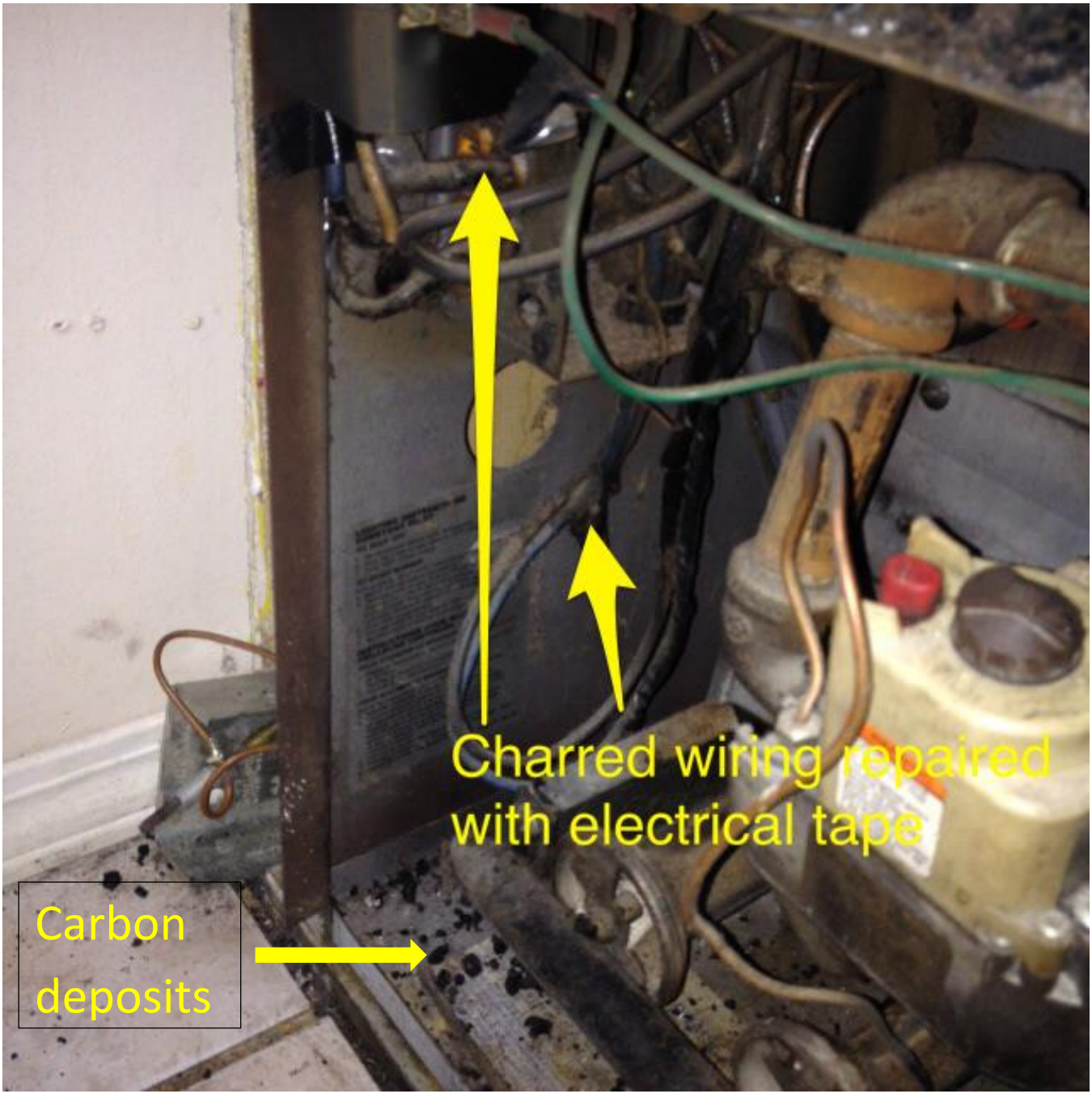

Image 2 – Charred wiring is an indication of flame rollout usually caused by restrictions or blockages in the heat exchanger flue passages. Presence of carbon deposits indicate flame impingement and incomplete combustion that can produce elevated levels of carbon monoxide.

Image 3 – A partially closed valve can restrict the amount of gas required by the furnace and lead to incomplete combustion and the production of elevated levels of carbon monoxide.

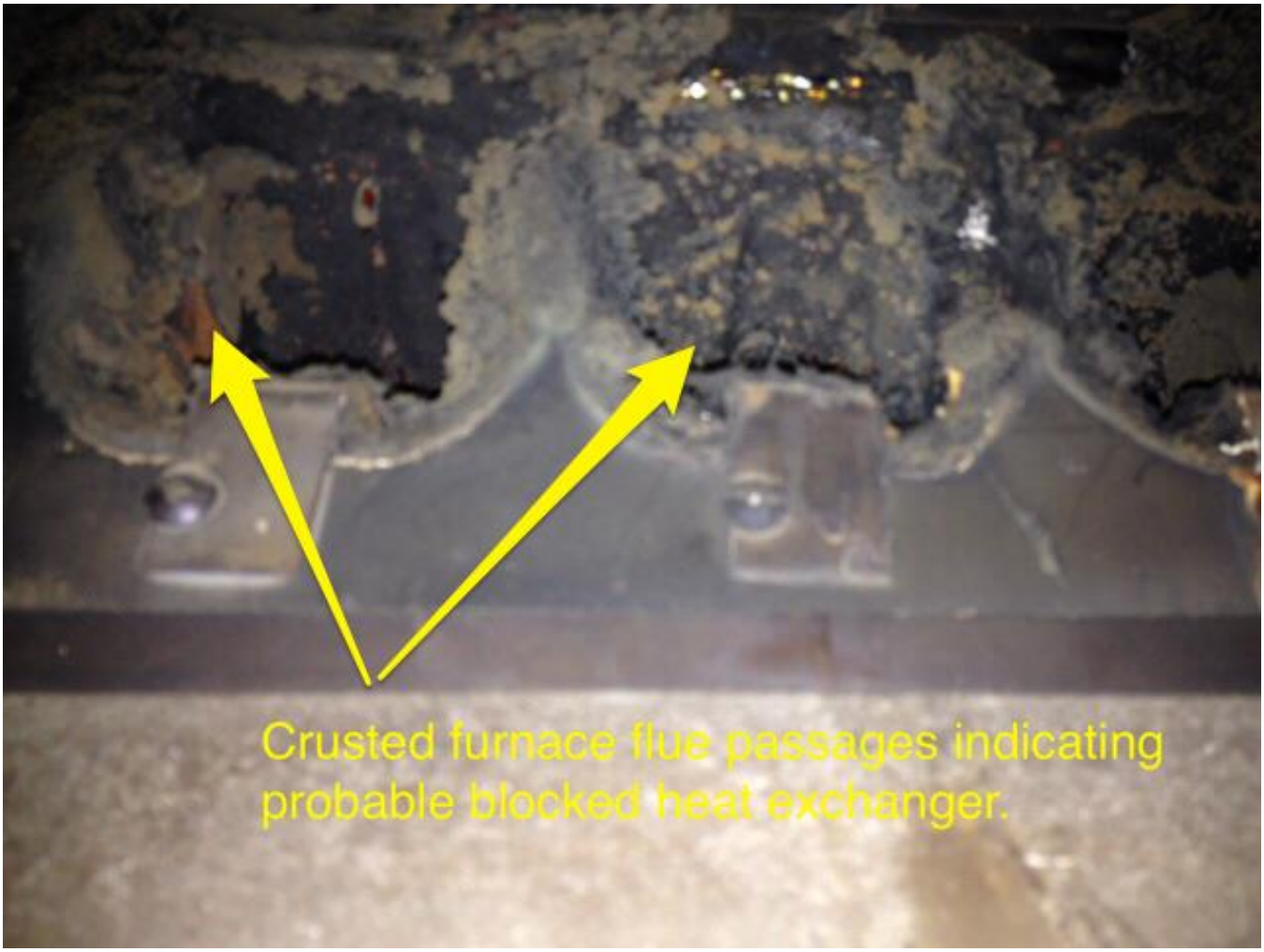

Image 4 – Deposits found at the outlets of the heat exchanger passages indicate incomplete combustion and the possibility of restricted or plugged flue passages that can allow the flue gas containing carbon monoxide to spill into the home.