

Incident Summary (Reference # 7296-II 690544-2018) (Final)

SUPPORTING INFORMATION	Incident Date		May 19, 2018	
	Location		West Vancouver	
	Regulated industry sector		Gas Propane System	
	Impact	Injury	Qty injuries	None
			Injury description	None
			Injury rating	None
	Damage	Damage	Damage description	The heat exchanger, 18" flue pipe, draft hood, duct work and casing of the air handling unit was damaged together with an Internal wall.
			Damage rating	Moderate
Incident rating		Moderate		
Incident overview		There was an explosion within the mechanical room of a day lodge, which resulted in property, building and the air handling unit itself being damaged.		
INVESTIGATION CONCLUSIONS	Site, system and components		The Air handling unit is used to bring in outdoor air into the building, heating the air by the means of a heat exchanger (a cylindrical metal barrel heated by a flame on the inside allowing the outdoor air to be heated as it passes over the outside of said barrel) to a comfortable room temperature. The heat is generated by a burner (comprising of a fan, fan damper, pilot, Spark ignitor, flame sensor, burner, gas valve and fan actuator known from now on as the actuator, linkage attaching the actuator to the fan damper and main gas valve) which has a sequential set of start-up steps to ensure the safe operation of the burner this process is carried out by the way of the controller (a set of electrical components, timers and switches) that uses the flame sensor (a metal rod that is positioned in a flame that utilises the effects of a flame on an electrical current to prove a flame) The air handling unit sequence is as follows:- 1. The thermostat sends a signal to the controller that heat is needed (This is referred as call for heat) 2. The controller starts the burner fan and opens the gas valve and fan actuator enough to open the fan damper but without opening the gas valve this will continue by the means of as timer until the fan has cleared the heat exchanger of any unwanted gases (This is referred as pre-purge) 3. Once the pre-purge is complete the controller will ignite the pilot 4. The controller will then detect the pilot flame by the flame sensor (if the controller does not sense the flame on the first try it will stop the process until someone physically presses the reset button of the controller) 5. Once the controller senses the pilot flame it will open the gas valve by further opening the actuator 6. The burner main flame is now running.	
	Failure scenario(s)		There a some key factors which play a pivoting role within the incident which require highlighting to fully explain the failure scenario • The incorrect setup of the pre-purge timer for 15 seconds instead of the 6 minutes 30 seconds as per the certified manufactures installation instructions, which did not give sufficient time for the burner blower to clear the combustion chamber of gases	

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	- Over time and without any scheduled maintenance the linkage set screw between the actuator and the air damper loosened reducing the amount of air the burner blower could deliver, this had to two detrimental affects the first further reducing the amount of air the burner blower could deliver when the pre-purge cycle was activated and secondly it effected the gas and air ratio for a strong and clean flame. - Also over time and without any scheduled maintenance the nut which is used for single stage burners (not needed in this application and should always be loose to allow the damper free movement) on the air damper tightened due to friction on the damper further reducing the movement of the air damper the effect of this also had two detrimental effects first further reducing the burner blower ability to deliver the amount of air required for pre-purge cycle and secondly further effecting the gas and air ratio for a strong clean flame. - The resulting weak, dirty flame together with no scheduled maintenance allowed two further detrimental events firstly the weak flame burnt the flame sensor wire to the point it intermittently sent false flame signals to the controller secondly the dirty flame produced soot within the heat exchanger restricting the air flow within the heat exchanger further reducing the effectiveness of the burner blower to clear the combustion chamber of gases. All the factors leading up to the incident did not happen in one day they evolved over time and at different rates of failure finally effecting each other until the conditions where correct so when there was a call for heat the controller started its pre-purge sequence, due to the defective per-purge timer and restricted movement of the fan damper their wasn't enough air to clear the heat exchanger of all the unwanted gases. Next the controller went to ignite the pilot and was getting an intermittent false flame signals from the faulty flame sensor instead of the controller stopping the process until someone physically resets the controller it went to ignite the pilot again. This would cause a buildup of propane gas in the heat exchanger until the pilot finally ignited causing the explosion inside the heat exchanger and spreading into the mechanical room causing all the damage within the building.
Facts and evidence	People interviewed and assisted - Operations Manager for Site confirmed time of incident and that the reset button on the controller had not been reset. - Building Maintenance Manager for the Site (on site after the incident but same day) able to confirm by documents and or verbally the time line, purpose of the equipment and that a format maintenance schedule was not setup or documented. - Assistant Chief-Fire Prevention for West Vancouver Fire Department. Confirmed any fire damage caused by the incident - Division Manager For Manufacture of the air handling unit. Supplied original documentation for the air handling unit including pre-purge times - Technical Service BC for Manufacture of the air handling unit. On site testing Visual indicators - Part of the flue and draft hood had been forcibly removed by the explosion from the air handling unit. - The heat exchanger was distorted outwards. - Portions of the heat exchanger had been disconnected and pushed out of their original position proving the explosion emanated inside the heat exchanger.

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- There was a lot of soot in and around the air handling unit itself indicating poor combustion (incorrect mixture of gas and air which makes a flame that craters in part excessive soot) within the air handling unit.
- The outer portion of the burner tube was discolored due to heat exposure proving a flame was present where a flame was not designed to be.
- When taking the burner apart the insulated wire from the flame sensor had been damaged. The insulation had been melted and the exposed wire was stuck to the grounded portion of the burner.

Testing (Conducted by the Manufacture of the air handling unit for and on behalf Of Technical Service BC Under supervision of the Gas Safety Officer for

West

Vancouver)

- Physically moved the linkage from the actuator to the air damper and found a connecting rods set screw was loose reducing the air dampers movement, also a nut was binding the air damper further impeding the free movement of the air damper there by reducing the air delivered for the correct gas and air mixture to achieve a stable clean flame.
- Checked the setup of the pre-purge timer and found it to be set for 15 seconds instead of the 6 minuets 30 seconds as per the certified manufactures instructions for the air handling unit. Also we confirmed the pre-purge time by physically timing the pre-purge.
- On testing the gas valve we found that no gas was able to pass into the burner if the gas valve was closed
- On removal of the actuator hydraulic fluid had visibly leaked from the actuator reducing the movement of the air damper further
- On testing the controller (electrical power restored but gas still shutoff) the following was observed (Please note the flame indicator was showing presence of a flame then not showing presence of a flame throughout the start-up sequence technically termed as an intermittent flame signal)
 1. The flame indicator was showing presence of a flame before any start-up sequence had started the controller should have stopped the process until someone physically pressed the reset button on the controller (as per the certified manufactures instructions), it did not.
 2. The pre-purge sequence started and ran the fan for 15 seconds instead of the 6 minuets 30 seconds detailed in the certified manufactures instructions indicating the pre-purge timer had been setup incorrectly.
 3. The burner controller opened the Pilot valve and waits a maximum of 10 seconds for the flame rod to prove that there was a flame present. (as the gas was turned off the flame rod should not prove that there was a flame present as there was no gas to ignite)
 4. The flame indicator came on indicating to the controller to open the main gas valve then the flame indicator went off the controller should have stopped the process at this time until someone physically pressed the reset button of the controller, it did not instead it shut the main gas valve and opened the Pilot valve, waited a maximum of 10 seconds for the flame to prove that there was a flame present this continued unit eventually the controller stopped the process waiting for someone to physically press the reset button of the controller.
- On further observation of the defective sensor wire the proximity of the wire to the grounding surface allowed the controller to be fooled into sensing a flame where no flame was present.

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	- If the gas was energized there would have been a buildup of unburnt propane gas (which is heavier than air and would have settled in the lower portion of the heat exchanger) mixed with air inside the heat exchanger which only needed a spark or flame to ignite the mixture. Documentation - No evidence of servicing to the heating portion of the air handling unit could be provided when requested. - In 2010 an invoice for an adjustment to the gas system but no indication of maintenance - In 2011 an invoice for work on an combustion issue but no indication of maintenance
Causes and contributing factors	It is likely that the incorrect setup of the pre-purge timer, failure of the controller, lack of maintenance of the gas components, mechanical linkage and controller together with the poor combustion issue caused this incidence,

Photos, Images or diagrams



Baffle dislodged and
pushed towards the flue
collar

Bottom of the flue collar

Carbon buildup indicating poor combustion



Discoloration on the outside of the burner indicating a flame was inside this portion of the burner which was not designed for a flame.

This Joint is loose reducing the movement of the arm to the air shutter causing incorrect gas air mixture ratio for good combustion and safe ignition

This nut impaired the free movement of the air shutter also increasing the incorrect gas air mixture ratio for good combustion and safe ignition



The residue shown here is where the sensor wire was attached to the support arm of the burner causing the ground fault with enough resistance to cause a false flame reading.



Burnt Electrical leads indicating flames present in an area where there should be no flames.

Damaged Internal Wall Side View



Damaged Internal Wall Front View



Damaged Duct Work

