

## Incident Summary #II-1656625-2024 (#43037) (FINAL)

SUPPORTING INFORMATION	Incident Date	January 3, 2024	
	Location	Surrey	
	Regulated industry sector	Gas - Propane system	
	Impact	Qty injuries	0
		Injury description	N/A
		Injury rating	None
	Damage	Damage description	An uncontrolled release of approximately 1500 litres of liquid propane resulting in an evacuation of neighboring homes.
		Damage rating	Major
Incident rating	Major		
Incident overview	While filling a propane cylinder at a fueling station, A propane cylinder fill nozzle was removed from a cylinder while the valve remained open causing liquid propane to leak from the underground storage tank. Integral propane safety features failed to stop the leak and resulted in an uncontrolled release of approximately 1500 litres of liquid propane into the atmosphere and evacuation of neighboring homes.		
INVESTIGATION CONCLUSIONS	Site, system and components	<p>Propane is typically used as a vapour but stored and transferred as a liquid. Liquid propane expands 270 times in volume when it vaporises. The propane cylinder fill system uses a pump to draw liquid propane from an underground 1999 US Water Gallon (USWG) storage tank, pumping it through a system of piping and valving to a delivery hose and cylinder fill nozzle which transfers the liquid propane into propane cylinders to fill them.</p> <p>The liquid propane outlet in the storage tank used to supply liquid to the pump has an internal safety control (ISC) shutoff valve installed in it. The operation of the ISC valve is controlled remotely using switches to activate an electronic solenoid that controls flow of inert nitrogen gas from a compressed gas cylinder to a pneumatic actuator that opens and closes the valve. Gas code requires that ISC valves serving propane dispensing systems shall remain closed except when the dispensing system is activated.</p> <p>Excess flow valves are safety valves used in propane filling systems. They are meant stop the flow of fuel and to protect against leaks if a pipe breaks or a hose ruptures. They are piped inline, are directional, and permit flow of liquid or gas in both directions but only protect against excessive flow in one direction. They use a spring-loaded disk that closes when excessive flow is sensed closing off the main flow of fuel (Image 5-6). The discs have a small hole to allow for pressure to equalise if the valve activates. When pressure is equalized on both sides of the valve the spring will reset the disc allowing for flow again. Excess flow valves come in a variety of flow rates and must be properly sized to protect against the anticipated flow rate of the downstream piping or hoses. Gas code states that any line utilized for propane flow shall have a flow rate greater than the design flow rate of the excess-flow valve protecting the line.</p>	

## Incident Summary #II-1656625-2024 (#43037) (FINAL)

	<p>The propane cylinder fill hose uses a threaded nozzle and a quick acting valve which allows flow of fuel when the valve handle is raised. When the handle is raised it remains open on its own until it is manually closed.</p> <p>Two types of propane meters had been used at the site. The first was a mechanical meter which measures flow using a positive displacement oscillating piston measuring chamber. These meters incorporate an internal differential valve which only opens to allow liquid flow when at least 15-psi pump pressure is established. These meters will not allow liquid flow when the pump is not operating.</p> <p>The second is a digital liquid meter which uses a flow-through turbine housing. Liquid flows through the turbine housing causing an internal rotor to spin. As the rotor spins, an electrical signal is generated in the pickup coil. This signal is converted into measuring units (gallons, litres, etc.) on the local digital display. These meters will always allow liquid flow regardless of if the pump is running or not.</p> <p>Container refill centers are required to be equipped with a <i>clearly identified</i> and readily accessible means to shut off the propane system and electrical power to the propane pump and propane dispenser during an emergency.</p> <p>Gas code states that propane shall only be transferred from one container to another by a person who is the holder of a certificate recognized by the authority having jurisdiction.</p>
<p>Failure scenario(s)</p>	<p>When the propane dispensing system was originally built, it incorporated a mechanical meter in the cylinder fill cabinet. 17 months before the incident, the mechanical meter experienced operation issues and was changed out by the propane supplier with a flow-through digital meter. The mechanical meter only allowed fuel to flow through it when it sensed differential pressure from the operation of the propane pump, the replacement digital meter did not require the pump to be operating to allow fuel flow.</p> <p>The excess flow valve downstream of the digital meter was incorrectly installed directly into the body of the meter when it was required to be installed at least 3.75" away. The excess flow valve had been physically altered by removing the shaft, spring, and sealing disk, rendering it completely ineffective of operating in an emergency excess flow condition.</p> <p>The propane dispensing system at the fueling station had an emergency stop button installed under the cashier counter inside the store. The emergency stop button was labelled "EMERGENCY FUEL PUMP SHUTOFF". The button was wired to shutdown all of the fuel pumps at the station, including propane, gasoline, diesel, and the electronic nitrogen solenoid that actuates the underground propane tank's ISC valve shutting off the main liquid valve from the tank. A propane operation switch was also installed under the counter which was labelled "PROPANE SHUTOFF". It only controlled power to the propane pump but when turned off would not shut off the main ISC valve and would allow liquid propane to flow from the tank.</p> <p>The day of the incident an employee of the fueling station went out to the cylinder fill station to fill a customer's 30# propane cylinder. The employee had been working at the station for approximately four months but did not hold a valid training certificate for dispensing propane. The employee connected the nozzle and filled up the cylinder. When the cylinder was full, they turned off the propane pump and removed the nozzle from the cylinder without shutting off the quick acting valve on the hose. When the nozzle released from the cylinder, it began leaking liquid propane to the atmosphere. The digital flow-through meter and altered excess flow valve did not</p>

## Incident Summary #II-1656625-2024 (#43037) (FINAL)

	<p>stop the leak of liquid propane to the atmosphere. The employee dropped the nozzle and ran into the store and switched off the “PROPANE SHUTOFF” switch but did not engage the “EMERGENCY FUEL PUMP SHUTOFF” button. This ensured the propane pump motor would not activate but failed to close the nitrogen solenoid holding open the propane storage tank ISC valve. With the dispensing valve, and the tank ISC open, liquid propane continued to leak into the atmosphere. Emergency services were contacted, and the fire department attended the scene and evacuated the immediate area. The liquid propane continued to leak for around 2 hours, releasing approximately 1500 litres of propane, until the electrical utility company was able to disconnect power to the site. The disconnection of power de-energized the nitrogen solenoid closing the storage tank ISC valve, stopping the leak.</p>
<p>Facts and evidence</p>	<p><b><u>Site observations and photos</u></b></p> <ul style="list-style-type: none"> <li>• The propane piping in the cylinder fill cabinet had a digital flow through meter with an excess flow valve installed immediately downstream into the meter body.</li> <li>• The markings on the excess flow valve identified it as a Fisher model F101 with a rated max flow of 20 GPM and a manufacturing date of 1997.</li> </ul> <p><b><u>Interviews</u></b></p> <p><b>Station manager:</b></p> <ul style="list-style-type: none"> <li>• The employee who was filling the tank was a new employee who had been working there for 4 months.</li> <li>• The employee did not have a certificate for filling propane.</li> <li>• Tank level readings showed that approximately 20% of the fuel in the 1999 USWG storage tank leaked out equating to approximately 1500 litres.</li> </ul> <p><b>Station employee:</b></p> <ul style="list-style-type: none"> <li>• They had filled the customers propane cylinder then turned the pump switch off.</li> <li>• When they removed the cylinder fill nozzle, propane sprayed out.</li> <li>• They threw the nozzle on the ground and ran into the store, turned off an emergency switch and called 911.</li> </ul> <p><b>Cylinder fill customer:</b></p> <ul style="list-style-type: none"> <li>• One employee came outside to fill their empty 30# propane cylinder.</li> <li>• The employee connected the hose and filled the cylinder, then turned the pump switch off.</li> <li>• He never saw the employee turn off the cylinder fill nozzle before he removed it from the cylinder.</li> <li>• When the nozzle was removed, propane started leaking out and the employee ran into the store to shut off the emergency switch.</li> </ul> <p><b>Propane supplier regulatory and technical specialist:</b></p> <ul style="list-style-type: none"> <li>• They arrived at the site while the leak was still occurring, and the fire department had control of the scene.</li> <li>• There was a cloud of propane coming from the cylinder cabinet.</li> <li>• The area had been evacuated by the fire department.</li> <li>• When power was cut to the station by the electrical utility company, the leak stopped.</li> <li>• The customer owns the equipment, hold an operating permit and is responsible for employee training.</li> <li>• The propane supplier sold the customer the equipment, completed the initial installation, was the main service contractor for all propane repairs, service, maintenance, and completed annual inspections of the system.</li> </ul>

## Incident Summary #II-1656625-2024 (#43037) (FINAL)

### Propane supplier technician #1:

- They were the first to arrive on the scene while the leak was occurring.
- The cylinder fill nozzle was leaking liquid propane when they arrived on the site.
- The “EMERGENCY FUE PUMP SHUTOFF” switch inside the store had not been activated.

### Propane supplier technician #2:

- They attended the site after the incident and removed the excess flow valve from the cylinder fill piping system and found the internal components of the valve had been removed rendering it non-functioning.
- The missing components of the excess flow valve were not found inside the piping where they would have been trapped if the components mechanically broke off the valve.
- The mechanical meter at the site had not been functioning so they swapped in out with a flow through digital meter.
- Excess flow valves would not typically be installed directly into a digital meter as the excess flow closing disc may contact the internal components of the digital meter.

### Documents

- An electrical contractor inspected the wiring and operation of the “EMERGENCY FUEL PUMP SHUTOFF” and “PROPANE SHUTOFF” switches and produced an electrical drawing of the switches as wired at the time of the incident. The drawing shows that the “EMERGENCY FUEL PUMP SHUTOFF” would shut down all of the fuel pumps at the station including the propane pump and deenergizing the ISC nitrogen solenoid closing the valve. The “PROPANE SHUTOFF” switch would only disconnect the power to the propane pump but would not deactivate the nitrogen solenoid for the ISC actuator leaving it open. With the “PROPANE SHUTOFF” switch left on, the ISC valve would remain open 100% of the time and not close in between propane dispenser operation.
- The manufacture’s manual for the digital meter identifies that any flow altering devises such as elbows, valves, and reducers (This includes excess flow valves) should be installed after minimum straight pipe length of 5 internal pipe diameters downstream of the meter. For a ¾” meter this would be a minimum of 3.75” of straight pipe.

### Propane supplier installation, service order and annual inspection documentation.

- The mechanical cylinder fill meter was changed out for the digital meter July 2022.
- Annual dispenser inspection report forms have checklist items for emergency shutdown, storage tank remote shutdown and excess flow for auto propane dispenser. The form does not have a checklist item for excess flow for the cylinder filling system.

## Incident Summary #II-1656625-2024 (#43037) (FINAL)

### Causes and contributing factors

#### Summary

An employee without the required training certificate mistakenly removed the cylinder fill nozzle from the cylinder without first closing the quick acting cylinder fill valve. A leak began and the nozzle was dropped, and the employee ran into the store and unclear switch labeling may have led them to shut off the incorrect switch. The leak continued until power was shut off to the entire station due to the ISC valve remaining open, the digital meter allowing propane to flow through it while the pump was off, and the excess flow valve not activating due to its alteration.

Contributing factors to the incident and severity of the propane leak were:

#### **Training:**

- The employee was filling the cylinder without receiving certified training and was unfamiliar of the propane filling procedure and emergency protocols.

#### **System design:**

- The orientation, wiring and labeling on the emergency stop and propane operation switch likely caused confusion of which one to shut off in an emergency.
- The operation and wiring of the nitrogen solenoid allowed the ISC valve to remain open allowing the fuel to escape until power was disconnected from the station. If the nitrogen solenoid was wired to only operate when the dispensing system was activated, the leak would have stopped after the pump was turned off.
- The replacement of the mechanical meter to the digital cylinder meter allowed fuel to flow through it without the need for increased pressure differential from an operating propane pump. A mechanical meter would have stopped fuel flow and only allowed fuel downstream of the meter to leak after the pump was shut off.
- The physically altered excess flow valve was ineffective and failed to activate. The full flow leak may have activated the excess flow if it had not been altered and reduced the leak to only the fuel which was in the cylinder fill hose.



Image 1 – Propane cylinder fill cabinet (White) at fueling station.



Image 2 – Emergency Fuel Pump Shutoff button was not shut off (Left) and the Propane Shutoff switch that was shut off when the propane leak occurred (Right).



Image 3 – The previously installed mechanical propane cylinder fill meter (Left) and the replacement digital flow through meter (Right).



Image 4 – The cylinder fill nozzle with quick acting cylinder fill valve.



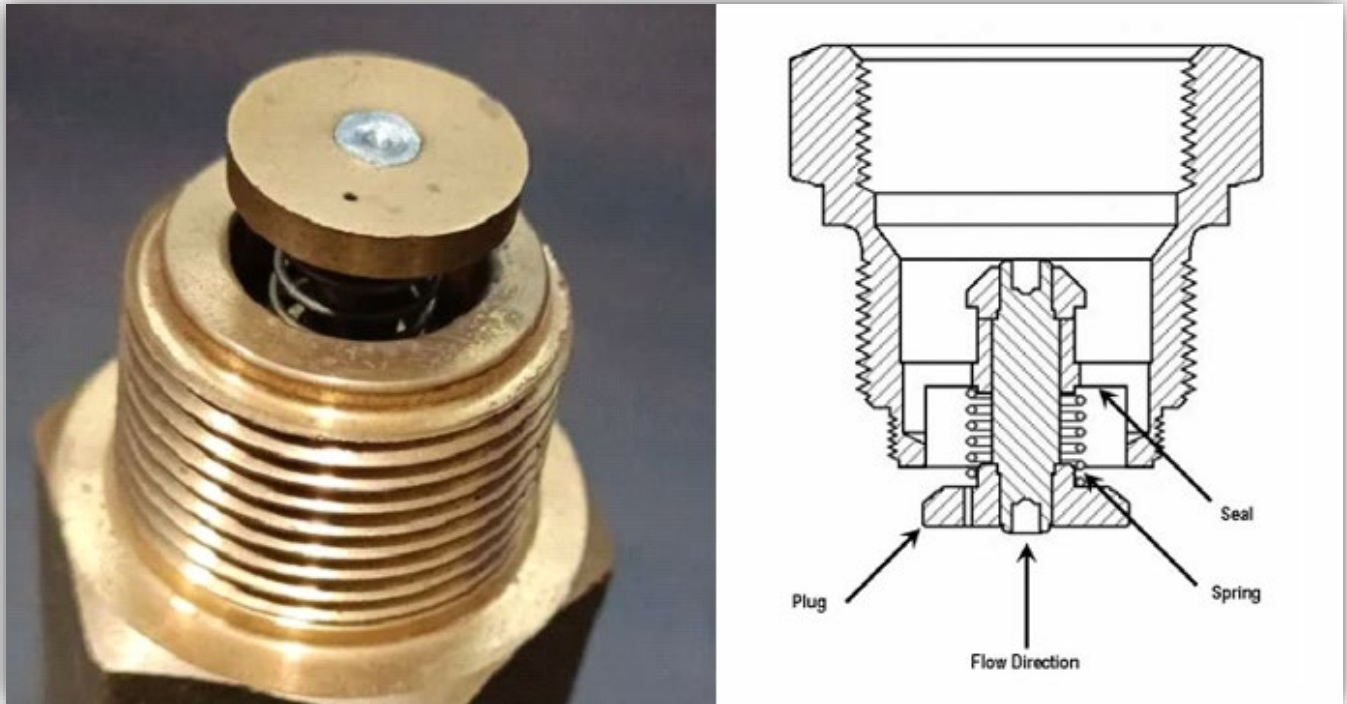


Image 5 – Exemplar excess flow valve and drawing showing spring loaded disc and pressure equalization hole.

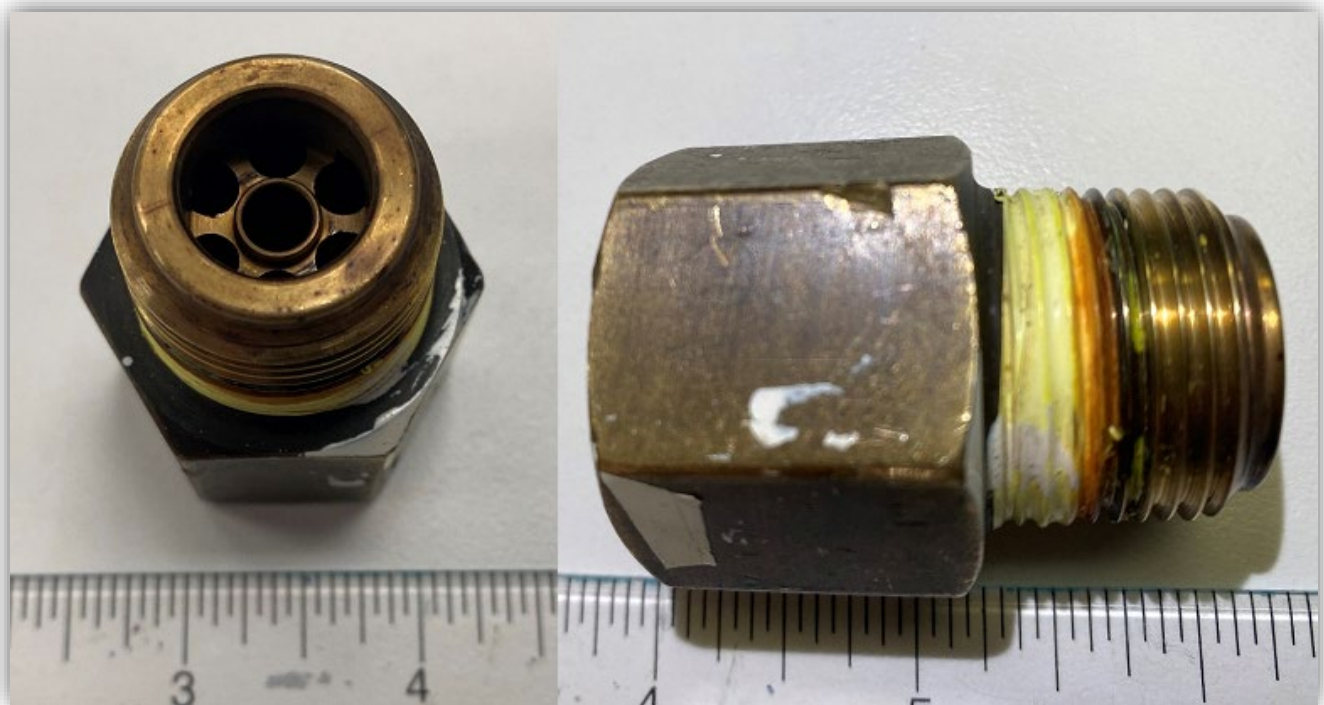


Image 6 – Altered excess flow valve that was installed in the cylinder fill piping system at the time of the incident with the internal shaft, spring, and disc removed.

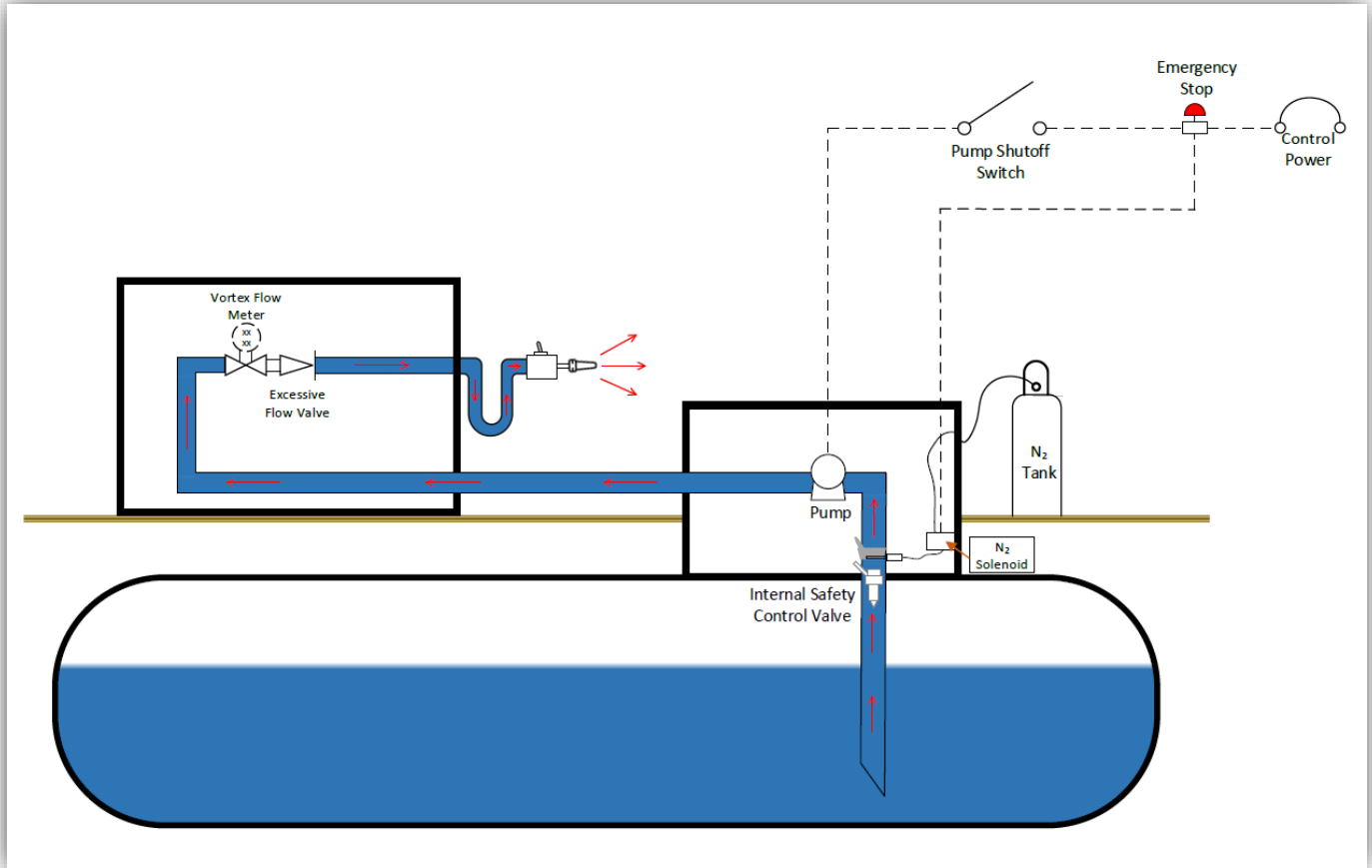


Image 7 – Diagram showing piping and valving system from underground propane storage tank to cylinder fill dispenser and operation of the “EMERGENCY STOP” and “PROPANE SHUTOFF” switches.