

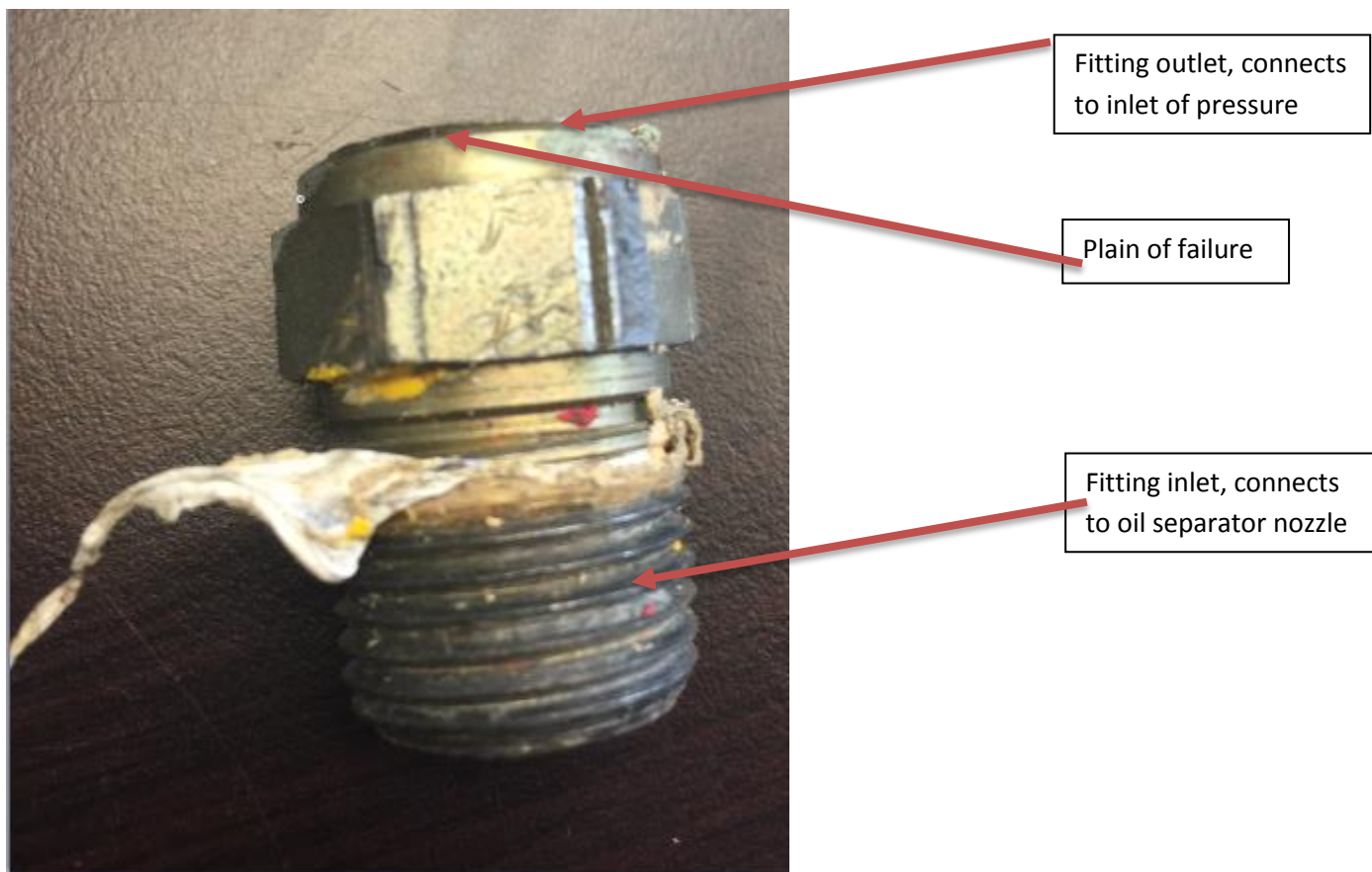
Incident Summary (Ref # 5623079)

SUPPORTING INFORMATION	Incident Date		Sep 4, 2017	
	Location		Aldergrove	
	Regulated industry sector		Refrigeration system	
	Impact	Injury	Qty injuries	0
			Injury description	None
			Injury rating	None
	Damage		Damage description	A piping fitting failed resulting in release of approximately 5 pounds of ammonia (NH3) in the machinery room
			Damage rating	Minor
	Incident rating		Minor	
	Incident overview		Nipple (fitting) between oil separator and its relief valve cracked and failed to hold ammonia in the piping which resulted in the exhaust ventilation system to be activated.	
INVESTIGATION CONCLUSIONS	Site, system and components		<p>Ice rink facility has a mechanical room separate and self-contained from the ice arena.</p> <p>In an ammonia refrigeration system, ammonia in a gaseous state is compressed through the compressor to high pressure high temperature ammonia gas. The compressed gas heats as it's pressurized. The hot gas enters an oil separator where the ammonia gas and compressor oil is separated so that oil is not carried over with the ammonia gas to the coils and other components. The hot ammonia gas is directed to through coils where the refrigerant gas dissipates its heat. The ammonia gas condenses into ammonia liquid at high pressure. The high pressure liquid flows through the expansion valve where the ammonia immediately boils and vaporizes which causes the refrigeration effect. The low temperature low pressure ammonia gas is directed back to the compressor to complete and repeat the cycle.</p> <p>The sensors are programmed to detect an ammonia release and activate an exhaust ventilation system. The exhaust system is capable of exhausting 18 room air changes per hour.</p> <p>The pressure vessel (oil separator) is fitted to a pressure relief valve via a threaded fitting. The fitting (nipple) has external threads at both ends. One end is screwed to nozzle on oil separator while other end is screwed to inlet of pressure relief valve. This screwed connection makes leak free seal so that refrigerant (NH3) cannot escape.</p> <p>During the whole refrigeration cycle, ammonia is contained within pressure boundary by pressure piping, associated fittings and pressure vessels. If there is a breach in the pressure boundary, it will cause ammonia to leak out in machinery room.</p>	

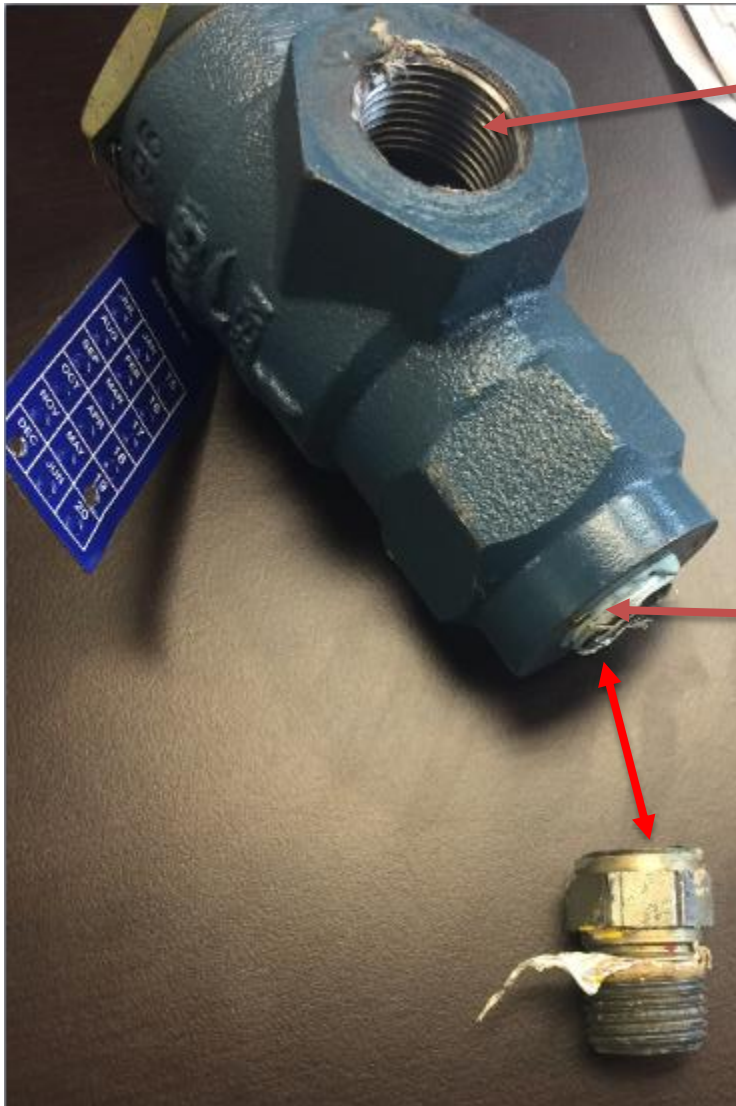
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	<p>During refrigeration cycle, compressor starts automatically and stops when enough compression is accomplished. This cycle goes on. This continuous cycle generates vibration, which is transferred to piping system and fittings. If there is a slight crack developed at any of piping component, the vibration will increase its propagation until the component fails completely.</p> <p>Fittings made of certain materials are incompatible with ammonia and degrade quickly in its presence. For example Copper and its alloys. Presence of vibration in the system, further increases chances of initiation and quick progression of any crack type discontinuity, leading to failure of fitting.</p>
Failure scenario(s)	<p>Pressure relief valve and nipple were installed December 12, 2014. Within 3 years of installation, the nipple cracked at inlet of pressure relief valve.</p>
Facts and evidence	<p>Ammonia release report</p> <ul style="list-style-type: none"> • at start of shift, arena worker smelled ammonia inside machinery room. Ammonia detector read 25 parts per million (ppm) and emergency alarm was activated at 7:43 am. Exhaust fan was activated. • arena worker called refrigeration contractor to site. Contractor pinpointed the leak, isolated the oil separator and compressor and changed cracked fitting and pressure relief valve. <p>Pictures</p> <p>-picture # 1 – close-up view of failed hexagonal fitting (1/2 inch nipple) -Pictures # 2 – cracked nipple and associated ammonia relief valve -Pictures # 3 – replaced fitting and pressure relief valve</p> <ul style="list-style-type: none"> • Witness statements confirmed that; <ul style="list-style-type: none"> ○ cyclic service caused vibration in the piping system, ○ incompatible fitting used
Causes and contributing factors	<p>It is likely that a combination of vibration induced cracking and incompatible fitting material caused it to crack open.</p>

Picture # 1: Close-up view of failed fitting (1/2 inch nipple)



Picture # 2: cracked nipple and associated ammonia relief valve



Pressure relief
valve outlet, 3/4

Pressure relief
valve inlet, 1/2 inch.
Broken threaded
portion of nipple
can be seen inside

Picture # 3: replaced fitting and pressure relief valve



Pressure relief valve outlet

Pressure relief valve inlet

Forged steel fitting (nipple)
– correct type installed

Oil separator

Nozzle on oil separator