Incident Summary #II-743812-2018 (#8558) (FINAL)

SUPPORTING INFORMATION	Incident Date		September 13, 2018
	Location		Vancouver
	Regulated industry sector		Boilers, PV & refrigeration - Refrigeration system
	Impact – Injury	Qty injuries	0
		Injury description	Not Applicable
		Injury rating	None
	Impact – Damage	Damage description	Pinhole in evaporative condenser coil.
		Damage rating	Moderate
	Incident rating		Moderate
	Incident overview		Ammonia leaking through pinhole in evaporative condenser coil was smelled by operating engineer on duty.
INVESTIGATION CONCLUSIONS	Site, system and components		The refrigeration plant is in a public assembly site. Plant is an indirect closed loop vented single stage vapour compression refrigeration system with anhydrous ammonia in primary side and brine solution on secondary side. In primary side, 4 single stage reciprocating compressors compress low pressure ammonia vapour to high pressure vapour which is condensed to high pressure liquid at the evaporative condenser. High pressure liquid refrigerant is fed at the bottom of shell side of the Chiller (for main rink) through float controlled solenoid valve and hand expansion valve (ammonia pressure drops while passing through the orifice of the expansion valve) and liquid ammonia submerges all tubes in the chiller. Brine solution is circulated through tubes in the chiller (ammonia is on outside surface of tube and brine passes through inside the tubes. There is no physical contact between ammonia and brine) and coils underneath floor of the arena by brine circulating pump. Receiving heat from brine circulating through tubes ammonia turns into vapour and vapour pressure of ammonia in chiller is maintained low by compressors. Resulting cold brine circulating through coils produce ice surface in arena.
	Failure scenario(s)		The evaporative condenser with hot-dip galvanized coil was built in 1996. Complete loss of protective galvanized coating made the bare carbon steel tube susceptible to corrosion. Heavy localized pitting corrosion penetrated full thickness of metal and created a pinhole in the coil.

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Facts and evidence	People interviewed: • Plant Operations Manager confirmed date and time of incident. Also confirmed leak was from condenser. • Refrigeration mechanic (employee of Licensed Refrigeration Contractor), who attended the site, confirmed pinhole in the tube to be the source of ammonia leak. During physical assessment of evaporative condenser on September 14, 2018, the following was found: - No tube was found to have galvanized coating; - All tubes had wide spread surface corrosion and scale ; - Sporadic deep corrosion pits were noted on tubes; - Removed length of tube showed considerable loss of metal thickness at corrosion pits. Refer to the attached photographs.
Causes and contributing factors	It is highly likely that pitting corrosion caused the pinhole and consequent ammonia leak. Other likely contributing factors are as follows: - Wear and tear due to the age of the condenser (approximately 22 years) which contributed to complete loss of protective galvanized coating; - Lack of effective water treatment (Water treatment was used. But presence of wide spread surface corrosion and scale formation indicated water treatment was not effective).

Picture of evaporative condenser coil taken from top

Picture of length of tube which had the pinhole