Incident Summary (Reference #5585496) (Final)

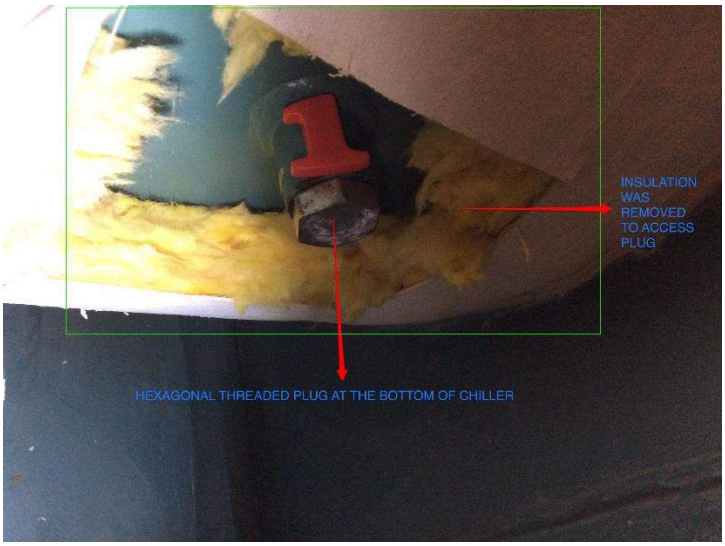
SUPPORTING INFORMATION	Incident Date			*March 31, 2016*
	Location			*Downtown Vancouver*
	Regulated industry sector			Refrigeration system
	Impact	Injury	Qty Injuries	*No injury*
			Injury description	*N/A*
			Injury rating	*N/A*
		Damage	Damage description	O-ring of hexagonal threaded plug at the bottom of condenser gave way.
			Damage rating	*Moderate*
	Incident rating			*Moderate*
	Incident overview			Refrigerant leak detector (AST-IRT-C-R134A) activated an alarm. The shift engineer verifying the amount of concentration below the threshold limit value (TLV) and the exhaust fan turned on, shutdown the unit. Concentration of refrigerant above the TLV and the potential total loss of refrigerant was avoided through timely action by the shift engineer.
INVESTIGATION CONCLUSIONS	Site, system and components			The refrigeration plant is in a public assembly site and comprises of three individual refrigeration units. Two units, each 740kW with 4900lbs of refrigerant, are identical in configuration and function as heat pumps. Another unit (235kw with 2300lbs of refrigerant) is only for cooling. All units are indirect closed loop systems with R-134A (Tetrafluoroethane) refrigerant. The plant is continuously attended by a 4th class power engineer. The system is monitored and managed by Direct Digital Control (DDC) system in addition to control and safety devices for each unit. The refrigeration unit involved in the incident has one condenser on the high pressure side and one evaporator on low pressure side and one intercooler.
	Failure scenario(s)			O-ring of the plug, which is located at the bottom part of the condenser and covered by insulated casing, was not replaced during major maintenance two years back. The O-ring became hard and brittle due to being subjected to constant heating and cooling thermodynamics, eventually failing under operating pressure when the chiller unit started (system pressure is high when compressor is running).

	Facts and Evidence	There were two witness accounts. The first was through a Service Specialist Technician (responsible for servicing and maintenance) who was informed of the leak and asked to attend the site at about 6:30am on the day of incident. Upon arrival the technician was shown possible location of the leak, which was indicated by the weeping of refrigerant and frost at the bottom of condenser. He was directed there by the shift engineer. Upon discovery the technician arranged for refrigerant evacuation from the system by connecting a recovery unit to system. 4465lbs of R134A was recovered out of 4900lbs resulting in total loss of 435lb of R134A refrigerant. Upon complete evacuation of the refrigerant and breaking the vacuum with nitrogen, the technician cut insulation to get excess to the plug. It was here that the O-ring of the plug was found to be hard and brittle with surface cracks when removed from the chiller. A segment of the O-ring broke and fell apart while being removed. The Technician pressure tested the system with nitrogen after replacing the O-ring, discovering that the system was gas tight. This confirmed the O-ring was the source of the incident. He confirmed regular testing and maintenance of system as per manufacture's instruction, the only aberration being the O-ring (which was not replaced during last major system maintenance two years back). Technician cited plug at the bottom and covered by insulated casing being the reason for inadvertent deviation in maintenance (due to the unusual location it was missed). The Second account was from the Facilities Operations and Maintenance Coordinator. He was informed of the leak by the shift engineer at 9:36am on Thursday, March 31, 2016. He visited the plant at about noon same day and confirmed that there was no personnel injury or any damage except loss of refrigerant.
	Causes and Contributing Factors	The condenser goes through temperature changes as it is used for cooling in summer and heating in winter. Major maintenance was carried out two years previous. All the O-rings but one for the plug (through which refrigerant leaked) were replaced. O-rings in the condenser are subject to heat and cold which makes O-rings hard and brittle over time and ceases to seal effectively and at some point over the time fails completely to seal. Aging is one of the most important reasons for failure in this incident. If the O-ring was replaced at the last service with the rest, this particular event would most likely not have happened.

Photos or diagrams (if necessary)

O-RING THAT FAILED

FAILURE OF O-RING OF HEXAGONAL PLUG (AT THE BOTTOM OF UNIT) RESULTED IN INCIDENT



DETECTOR (AT CLOSE PROXIMITY OF THE PLUG) WHICH ACTIVATED ALARM