Incident Summary #II-935026-2019 (#15793) (FINAL)

SUPPORTING INFORMATION

Incident Date			November 1, 2019
Location			Port Coquitlam
Regulated industry sector			Boilers, PV & refrigeration - Refrigeration system
Impact	Injury	Qty injuries	1
		Injury description	One person sustained ammonia burn in his right hand.
		Injury rating	Moderate
	Damage	Damage description	An apprentice refrigeration mechanic was injured by contact with liquid ammonia while replacing a leaking discharge valve for an ammonia compressor.
		Damage rating	None
Incident rating			Minor
Incident overview			A licensed refrigeration contractor's refrigeration mechanic was called in by a chicken processing plant's maintenance manager to provide service to compressor CU1 which had an error message of 'Oil Temperature Sensor' indicating a refrigerant flood back. The mechanic suspected the 2" check valve between the oil separator and the pipe discharge valve was leaking. He initiated pumping down the compressor by shutting off the power, closing the pipe discharge valve and having the compressor's suction open. This allowed the condensed ammonia in the compressor, oil separator and associated pipes to gradually evaporate under suction pressure. Ammonia liquid boils at -33 degrees C. The replacement for the leaky check valve was planned but unscheduled. At 10:00am on November 1, 2019 an apprentice refrigeration mechanic from the same licensed refrigeration contractor responded to replace the leaky check valve. He was working by himself in the machinery room without any licensed refrigeration mechanic providing direct supervision on site. He checked that the pipe discharge valve had been closed and the new check valve matched the leaky one. He neglected to check that the compressor's suction valve was open. Also he did not check the compressor's pressure gauge to identify whether or not the compressor was still in the process of pump down. In order for him to check for the pressure in the compressor and the associated pipe, he removed the plug off the oil drain valve and gradually opened the valve. This resulted in releasing ammonia to the atmosphere in the machinery room. As he continued to open the valve more, mixture of oil and ammonia suddenly gushed out and spilled on his hand. Ammonia has a very high coefficient of thermal expansion. At its boiling point 1 volume of liquid will yield 800 volumes of gas. The machinery room was quickly filled with ammonia vapor which triggered the ammonia alarm. He was not able to close the valve. He escaped the machinery room and sustained minor burn in his hand.

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INVESTIGATION CONCLUSIONS

Site, system and components	The machinery room has five compressors for the direct refrigeration system. Low pressure and low temperature ammonia vapor from an evaporator is drawn by a compressor and compressed to high pressure and high temperature ammonia vapor. Lubricating oil from compressor pumps tends to contaminate the ammonia over time during normal operations. The high pressure ammonia vapour containing some oil mist is discharged from the compressor through an oil separator and check valve to a condenser. The oil separator is used to separate oil mist from ammonia vapor. Oil is collected at the bottom where a float directs the oil back to the compressor's crankcase. High pressure ammonia vapor condenses to subcooled ammonia liquid and travels at high velocity to evaporators where refrigeration cooling is required. An ammonia check valve is a fitting connected downstream, adjacent to the oil separator. It allows high pressure, high temperature compressed ammonia to travel in only one direction. As a compressor is running, it compresses low pressure ammonia vapour into high pressure vapor. The high pressure ammonia vapor enters at the bottom of the valve, lifting disc off the valve seat. Thus, the check valve is open. Conversely, as the compressor is not running or at rest, high pressure ammonia vapor form the discharge header pushes down the disc tight against the valve seat. Thus, the check valve is closed. When the mating surfaces of the disc and valve seat is roughened or with minor cuts in the surfaces, high pressure high temperature ammonia vapor from the discharge header has the possibility to travel through the cuts and condense in the oil separator and the compressor. This is refrigerant flood back. Oil drain valve is a manual service valve for draining oil with sediment rather than checking pressure nor purging ammonia vapor out of the system.
Failure scenario(s)	• The apprentice who was assigned to replace the leaky check valve was not qualified to perform regulated work on regulated equipment. • The apprentice failed to report to the plant maintenance manager for plant orientation as required prior to entering the machinery room. • The apprentice was able to enter the machinery room through the building exterior door which was supposed locked at all times to prohibit any unauthorized personnel from entering. • It was likely that the refrigeration mechanic did not perform valve tag-out / lock out. He tied a piece of red tape to the valve handle of the pipe discharge valve to indicate that the valve was closed. • The apprentice might have taken the initiative to work by himself in the machinery room without arranging for mechanic's supervisions. • The apprentice failed to check that the compressor's suction valve was open. This meant the compressor, oil separator and the associated pipes were still in the process of pump down. • The apprentice's opening the oil drain valve resulted in ammonia release to the atmosphere in the machinery room.

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Facts and evidence	**Safety Procedures / Standard Operating Procedures:** **Licensed Refrigeration Contractor** • There were no SOPs identified specific to the procedures of Pump-Down, Ammonia Purge, Electrical Lock Out, Valve Lock Out and Tag-Out. • It was likely that the contractor did not recognize PEBPVR Safety Regulation Reg-104 Part1-Division1(5)(2) and Safety Standards General Regulation B.C. Reg.105 Part1-Division1(5)(b) Conclusion 1: The apprentice was likely assigned by the refrigeration contractor to replace the leaky check valve by himself. He was unqualified to perform maintenance and repair on a refrigeration plant unless he was working under the supervision of a refrigeration mechanic on site. Conclusion 2: Evidence indicated that the refrigeration contractor did not have SOPs for their employees to follow in order to work safely and effectively. It was likely that the apprentice was not provided adequate training. **Chicken Processing Plant** • The exterior access door to the machinery was unlocked. • The plant's maintenance manager did not request if he was an apprentice or a refrigeration mechanic. Conclusion 3: There was no practice in place to restrict access to the machinery room from the exterior door. It was likely accessible by the public. There was a reliance by the facility owner upon the contractor qualification for the maintenance and repair.
Causes and contributing factors	The ammonia leak incident was caused by an inappropriate maintenance procedure followed by the apprentice refrigeration mechanic who was unqualified to perform maintenance and repair on a refrigeration plant unless a licensed refrigeration mechanic supervises the individual on site. Lack of a valve lockout and tag-out procedure for compressor maintenance was another contributing factor. The apprentice likely lacked adequate training on safety procedures and 'Pump Down and Ammonia Purge' procedures.

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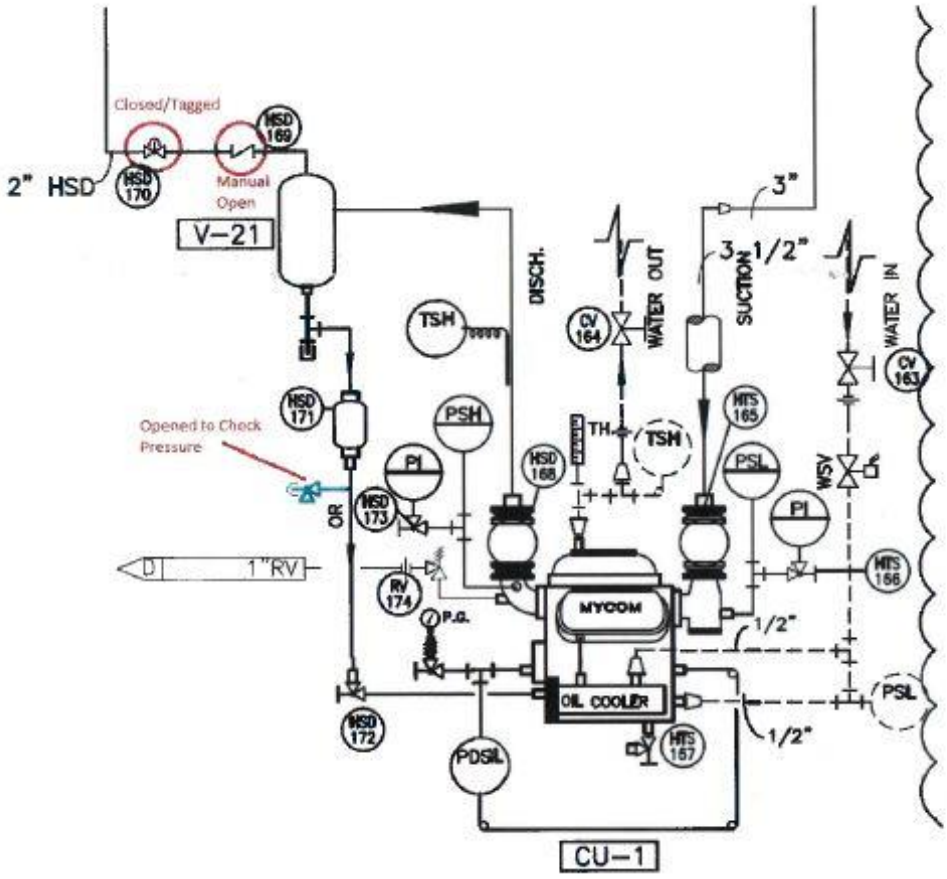
It is possible that ammonia leak could have been prevented provided a licensed refrigeration mechanic had supervised the apprentice while working together to conduct the check valve repair.

Photos or diagrams (if necessary)

Image 1 - Oil drain valve opened



Note: Valve opened to access was not shown on P&ID. It is an oil drain valve on the bottom of the float valve. Approximately where the blue valve is shown above. Float is an old, phillips style float valve with 3 connections, not the 11-LD with 2 connections as shown above.

Image 2 - Compressor CU1 piping diagram

Image 3 - Discharge valve (Closed) and check valve (to be replaced)