PBHE's Response to Technical Safety BC's Report on

The 3 Fatalities due to Ammonia Release at Fernie Memorial Arena - Oct. 17, 2017

Co-Authors: Brian Holtham, President of PBHE
Paulette Medal, Senior Skating Advisor and Director of Strategy and Development of PBHE, EIT
Date: August 28, 2018

Precision Blade Honing Enterprises Inc. (PBHE) is highly invested in Canada's rinks and with over 30 years of experience in working with high pressure boilers and heat exchangers, we feel compelled to respond to the devastating ammonia accident. The explosive release of ammonia at the Fernie Memorial Arena on October 17, 2017 tragically took the lives of two Fernie arena staff and a Cimco Employee. The effects from the ammonia release were widespread and forced 95 residents to evacuate from 55 homes in the area.

Pictured above are the three men who died while trying to fix the Fernie Memorial Arena's ice-making equipment in October 2017. From left, Hornquist, Smith and Podloski. (City of Fernie 2017)

On July 25th, 2018 the following documents were released by Technical Safety BC outlining the results of many months of investigation into the cause of the accident. Technical Safety BC's documents include an Investigation Summary and an Appendices Report which should be mandatory reading for all arena staff which are using ammonia chillers.

Technical Safety BC's Incident Investigation Summary Report
Technical Safety BC's Incident Investigation Appendix

We have thoroughly reviewed these documents along with many others. In PBHE's response we have highlighted key findings, discrepancies, and recommendations to support the need for change. We were appalled by some of the findings, the lack of regulations, and the current condition of many Canadian ammonia rinks.

Contents

Introduction

As a brief introduction, Brian Holtham, has over 30 years of experience in the Thermal and Nuclear power generating industry as a journeyman, supervisor, training officer, superintendent and manager. His direct experience deals with high pressure vessels including industrial chillers for some of Canada's largest power stations. Paulette Medal is PBHE's Senior Skating Advisor and Director of Strategy and Development. She has travelled internationally skating professionally and has worked closely with PBHE for the last 15 years. Paulette, with her skating background and her Masters of Engineering education, provides a unique perspective. PBHE is currently writing a report identifying proper ice requirements for National and International Figure skating events under the control of the International Skating Union (ISU).

We have spent a number of days reviewing Technical Safety BC's report and am very pleased with its content but would like to offer some constructive comments. It is our belief that a revised summary of Technical Safety BC's report should be mandatory reading by all arena staff. We will be widely distributing both Technical Safety BC's report along with our comments on a global scale with the hope of making a difference. This is not just a local issue. Most of Canada's rinks are ammonia based since there is a higher cost and an environmental concern (greenhouse gases) with the use of freon. There are over 1300 ammonia rinks in Canada not including rinks in Quebec, Nova Scotia, or Canada's Territories. (The Canadian Press "A list of ammonia rink regulations across Canada" 2018) We must do a much better job of educating everyone on the risks associated with ammonia. In Canada, we have hundreds of aging (to the point of replacement) ammonia refrigerant arenas, similar to the Fernie Memorial Arena.

We believe a revised summary of Technical Safety BC's report must be easily accessible and readable by anyone who may occupy the arena including but not limited to:

- the arena staff
- hockey, figure skating and curling coaches
- hockey, figure skating and curling organizers
- the general public and athletes.

It is in everyone's best interest to be responsible and share this report as it will improve the safety of thousands of participants and spectators. It was discouraging that Technical Safety BC's Appendices A, B, D, E, F, G, K, L, M, N, P, S, T, W, X, and Y were all in low resolution, making it very difficult to read and limiting proper review. PBHE's response to Technical Safety BC's report is not meant to take away from the detailed information required to set future recommendations/standards for our industry but to add some general details on current requirements/standards.

We must make lasting improvements in training, communications, operating procedures, equipment inspection and arena safety drills for the benefit of all ice sports and to ensure an accident like the one in Fernie never happens again.

We encourage the distribution of this document to all interested parties in your organization, since awareness is part of the solution that will drive change.

Understanding the Fernie Accident: Key Facts

A basic understanding of ammonia is important to grasp the full dangers of ammonia chillers and the necessity for enforced safety procedures, training, and maintenance. Below is a list of some of the key facts about the accident and ammonia.

1. The three fatalities in the Fernie arena ammonia leak were all top ranked professionals in their field; the Director of Leisure Services (Facility Manager), the Refrigerant Operator (Class 4 Operating Engineer), the Refrigerant Mechanic (Cimco – International installers and maintenance contractors for refrigerants)
2. Arena anhydrous ammonia is 99.95% pure and is colorless, transparent, and lighter than air
3. Current safety standards for arena ammonia:
    - Permissible exposure of 50 parts per million (ppm) over an 8 hour period (odour can be detected between 5 – 50 ppm) As a general rule, if you can smell the strong, pungent smell of ammonia, leave the area immediately.
    - 5 to 25 ppm results in severely irritated eyes, nose and throat. Exposure of 25 to 50 ppm causes headaches, coughing and burns. Prolonged exposure of greater than 50 ppm, causes pulmonary edema which is a condition caused by fluid in the lungs that can be fatal.
    - Emergency alarms are set at 100 ppm
    - Above 300 ppm immediate danger and life threatening. Use a self-contained breathing apparatus (OSHA). Note: There are multiple sources that state that 300 ppm is a life threatening level of ammonia (ie. the report put out by the United States Department of Labor ("Ammonia Refrigeration - Emergency Response"), the fact sheet by New Jersey Department of Health ("Hazardous Substance Fact Sheet" 2016), and the data sheet published by the Ontario Ministry of Labour (Ministry of Labour "Engineering Data Sheet 4-04: Anhydrous Ammonia" 2010)). However, in the Technical Safety BC's Appendix there is conflicting information. Table C0-1 states 2500 ppm as fatal, but then in Table C0-2, 300 ppm is stated as the level that causes immediate danger to life and health. (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena - Appendices."* 2018, Page 43) This is misleading and confusing to many readers.
    - First Aid is total flushing with water
4. The scenario in Fernie, where a four inch pipe burst, releasing anhydrous ammonia, resulting in over 20,000 ppm in the machine room, is catastrophic and fatal. All three individuals (director, operator, and mechanic) in the Fernie facility died due to over 20,000 ppm exposure in the machine room. The ammonia rate throughout the building reached a minimum level of 400 ppm. The reading after the release, directly outside the machine room, was recorded at 5395 ppm. Thankfully, there were only three people in the building. There could have been many more fatalities if it had occurred during the next day's hockey game, when there would have been a lot more people in the facility.
5. The general public have the right to ask the arena when was the last safety audit done by an outside contractor and were there any deficiencies that needed to be addressed. It is our opinion that inspections should be done annually. Fernie's last inspection was done in 2014 by Technical Safety BC. In 2010, the maintenance contractor recommended that the chiller should be replaced due to its age, but it was not part of a standing work order.

Potential for another Disaster

Every year in Canada we have ammonia leaks that have the potential of being another Fernie disaster. It is imperative that safety standards and regulations change to minimize this risk. On July 5, 2018, six children were

sent to the hospital in Keswick, Ontario due to an ammonia leak. It is difficult to get statistics since records are kept provincially but it runs into the hundreds per year from leaky valves to major fractures. In some retrofits, arenas are going back to Freon, since it is a much safer refrigerant (although bad for the environment).

In 2011, Canada's Karen Magnussen, a figure skating World Champion (1973) and Olympic Silver Medalist (1972), was able to evacuate young skaters, but she was left permanently disabled after inhaling ammonia from the Northshore Winter Club's refrigeration unit in British Columbia. (Crawford & Eagland "Numerous safeguards in Vancouver ice rinks to avoid ammonia dangers" 2017) Technical Safety BC was the lead investigating team for this accident and is also responsible for the current Fernie Investigation.

Technical Review and Comments

The intent of PBHE's review is purely to identify reasons for change on how ammonia based arenas are operated and maintained. Some issues are already addressed in the Technical Safety BC's Investigation report's recommendations.

It is important to note the degree of dysfunctional equipment, limited training/knowledge, inadequate inspecting/reporting, and the negligence of management to replace the chiller, increased the severity of this emergency. It strongly supports the demand for change.

Equipment

There were many issues with the Fernie equipment that lead to this horrific accident. Unfortunately, these issues are not uncommon in other aging ammonia chillers in Canada. It is important to learn from the Fernie mistakes and repair, replace, or modify the insufficient equipment. The primary equipment issues have been listed below with recommendations on how to improve them.

1. The brine system should have had a pressure release valve with the appropriate drain lines and associated dump tank vented outdoors. This is standard for all pressure systems and should be part of the recommendations. A 25 psi pressure release valve limit should be set since research found that "the four inch pipe-coupling joint was pressurized and at 30 pounds per square inch (psi) the coupling began to slip toward separation." (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena."* 2018, Page 14)

C5 Separated Coupling

Photo C5-1 and **Photo C5-2:** Separated brine system coupling.

Photos C5-1 and C5-2 show the coupling dislodged from the piping. The report discusses the configuration of the piping components observed after the incident.

The above two pictures are of the four inch pipe that separated when the internal pressure reached somewhere between 40 to 150 psi which instantly saturated the machine room with up to 22,000 ppm anhydrous ammonia. According to Technical Safety BC's graph the machine room was still above 10,000 ppm ten minutes after the pipe burst. (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena - Appendices"* 2018, Page 30)

2. Given the schematic shown in Figure 3, there are multiple ways that the brine system could be pressurized by the ammonia system. (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena."* 2018, Page 9) It is not uncommon to have a major rupture in a heat exchanger and this condition should have been anticipated.

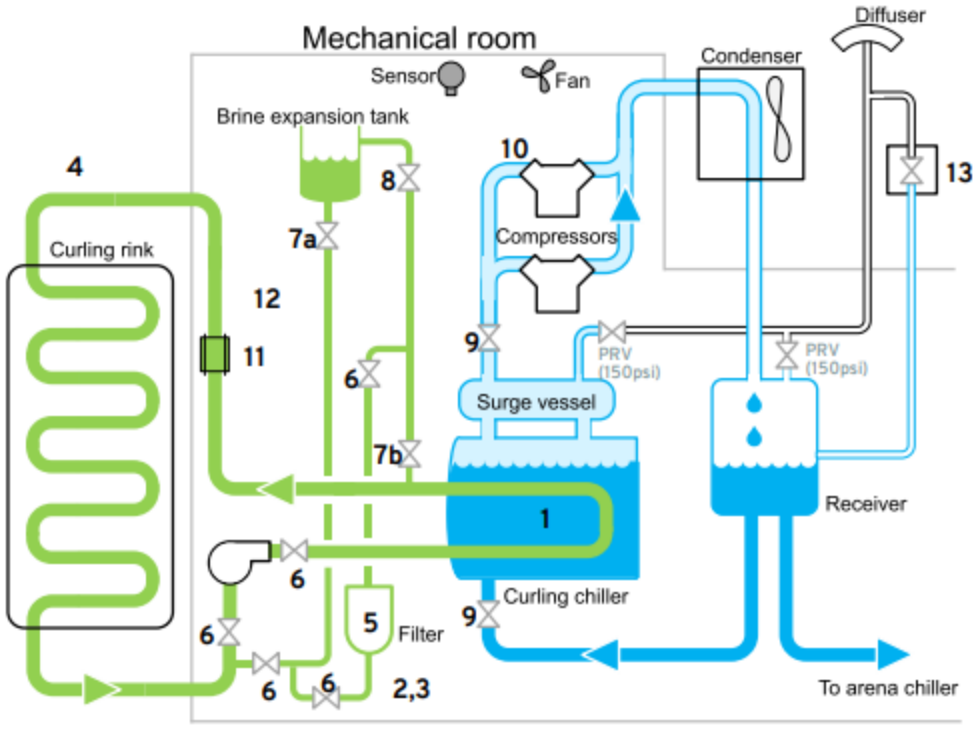

Figure 3: Schematic of the Fernie Memorial Arena curling refrigeration system. Numbers identified correspond to the items and descriptions in the Table 1 below.

3. The age of the chiller is not visually obvious when they are covered in aluminum cladding (as shown in Photo C3-12). (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena - Appendices."* 2018, Page 56)

Photo C3-12: Curling chiller (with insulation) showing the ammonia liquid inlet configuration. Valve positions are noted in Appendix B.

However, when the cladding is removed (as shown in Photo C3-1) the age and state of the chiller is quite apparent and concerning. (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena - Appendices."* 2018, Page 51)

C3 Curling Brine System Chiller

Photo C3-1: Curling chiller with the brine inlet and outlet piping removed. The photo below shows the curling chiller with its head removed, exposing the tube sheet.

4. Calcium chloride brine, tube welds and time (31 yrs.) was the cause of the tube leak. Technical Safety BC's recommendations should identify the corrosive power of calcium chloride brine and therefore be considered when setting chiller life span. A glycol solution is less corrosive to chiller tubes but is less efficient than a calcium chloride brine solution.With the end covers removed, it is apparent that all of the tubes were in severe condition (shown in photo C3-4 and C3-5 below).

Photo C3-4: Curling chiller, tube sheet upon opening in January 2018 showing residue.

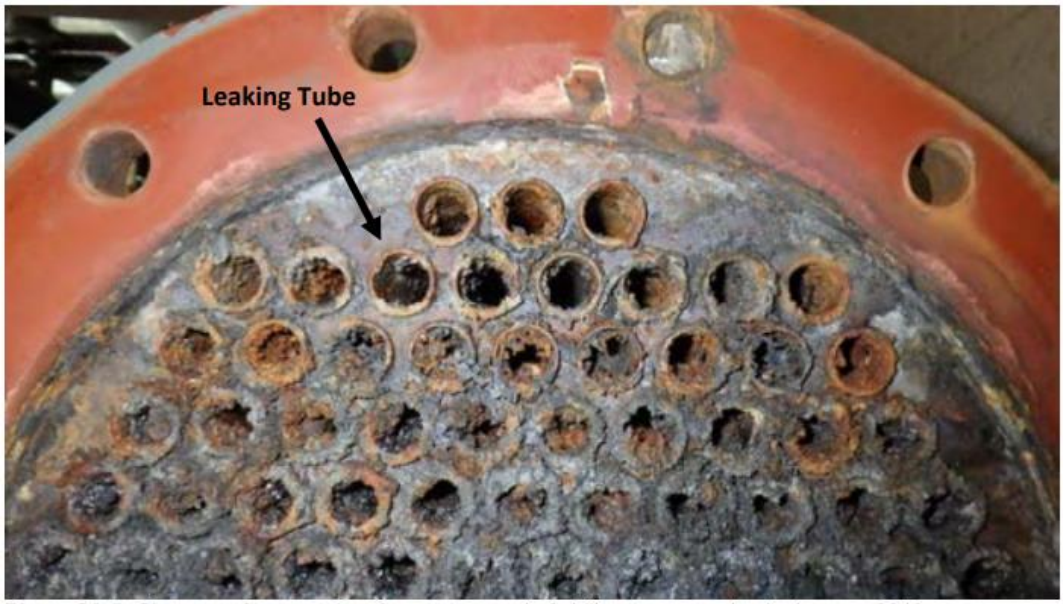

Photo C3-5: Close up of upper tubes from return end of chiller upon opening in January 2018.

5. In industrial heat exchangers there is generally a documented inspection and maintenance procedure which includes tube cleaning. This is often done on a regular basis to increase efficiency. The conditions of the tubes indicate there was no such procedures in place. The Photo below (Figure 107) shows the external view of the leaking pipe. (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena - Appendices."* 2018, Page 166)

Figure 107 Main leaking defect on row 2 – tube 3 removed from bundle. Several smaller defects were found along the ERW weld.

The below photos show the inside of the leaking pipe before and after it was cleaned. (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena - Appendices."* 2018, Page 171) The cleaned pipe shows excessive corrosion, reducing the metal thickness ultimately leading to the accident. This type of corrosion was found on all the pipes examined.

Figure 117 Closer view of leaking defect showing a line of "stitch-like" defects adjacent to the leaking defect. Nozzling effect has removed material above the leak.

Figure 118 Typical corrosion damage found along row 2 – tube 3 approximately 12" from the leaking defect.

6. The issues of defective lines, couplings, and valves, along with one of the valves being Zap strapped (cable tied) open (which restricted operation) with no formal documentation is of major concern.

7. The capacity and poor condition of the ventilation system could have been easily evaluated by a proper safety inspection and standard smoke test; another reason for mandatory annual inspections.
8. In a simulated case, the concentration in the (machine) room rapidly reached concentrations exceeding 20,000 ppm ammonia and required several minutes to reduce the levels to below 5,000 ppm. 300 ppm is immediately life-threatening. There was no possibility that the three individuals could have survived this accident even with proper emergency response. Additionally, ammonia continued to leak into the machine room at extremely high levels for days following the accident. (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena."* 2018, Page 31) Again, it would have been an unthinkable catastrophe if the arena was full of workers, athletes, volunteers, and spectators during a hockey, figure skating or curling event. The possibility of this or similar accidents happening in the future is not acceptable and needs to be eradicated through improved equipment, training, procedures, and safety alarms.
9. The ammonia concentration in the room reached over 20,000 ppm and likely remained above 15,000 ppm for at least 5 minutes. If the ventilation system was functioning with the designed air flow and perfect mixing, the ammonia concentration should have dissipated to below 4,000ppm after 5 minutes. This is shown in the graph below (the resolution quality of the original document is unreadable). (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena - Appendices."* 2018, Page 30)

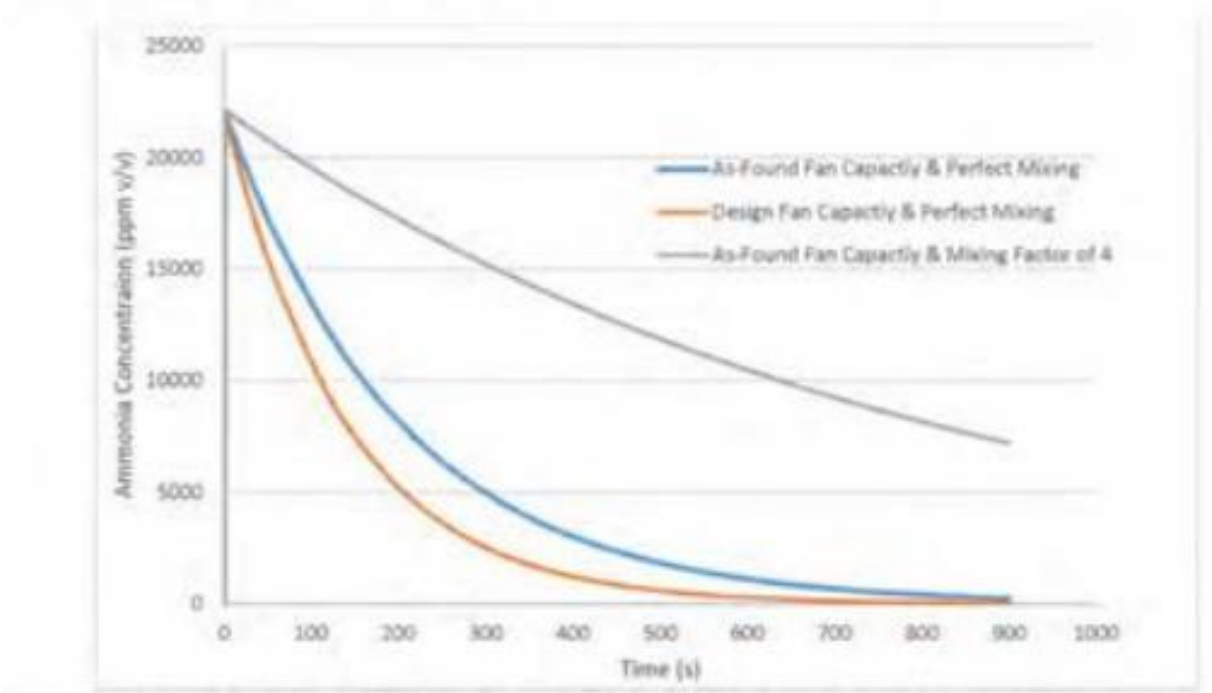

Figure 14: The dilution rate of the ammonia in the machine room for a 4 kg instantaneous release of ammonia, assuming a volume averaged concentration.

This is still significantly above the life threatening ammonia levels. The ventilation system was yet another piece of equipment that was not functioning properly.

10. The refrigeration operator advised the alarm monitoring company at 7:33 am to not dispatch first responders for ammonia alarms until after 4:00 pm as they were working on the system. Consequently, when the coupling ruptured around 9:30 am, no emergency crews were deployed. An electrician found the victims at 12:50 pm, three hours after the rupture and called 911. Staff disregarding alarms, due to

the fact that it was a regular occurrence, is not acceptable behavior and leads to major catastrophes. Unfortunately, this is common in industry and a solution to this is to have more than one alarm set to different rates. As an example, one could be set at 100 ppm which activates the ventilation system, a second at 120 ppm which requires the use of self-contained breathing equipment and a non-over-ride-able set at 130 ppm which automatically alerts 911 and evacuates the facilities.

Training

Training is often overlooked but it is one of the most important investments a company can make. Ongoing training and testing is essential to maintain the high level of skill that is required to operate and maintain such dangerous equipment. Unfortunately, it was clear that none of the three men had sufficient training for such a situation. Below is a list of knowledge that should have been included in basic training.

1. Given the chiller was 31 years old and had been leaking into the brine solution for at least 6 months and brine was also detected in the compressor oil, to start and pressurize the system is folly at best. This information was recorded before the accident in the log book. All three victims should have understood the severity of the decision and not worried about the up and coming hockey game which required the two compressors. Contamination within either system should be grounds to not start the system and it should be mandatory to drain/remove the liquid ammonia in the chiller. This should be a part of basic training and emphasized in the recommendation.
2. The ammonia in the system should have been pumped out (as mentioned in 2), not discharged into the atmosphere. This caused a state of emergency and the evacuation of 95 residents and 55 homes for the next four days. This reaction was like throwing oil on a contained fire. Technical Safety BC's recommendations should undertake a safety response solution to avoid this action.
3. In reviewing this report and a schematic of the refrigeration system, it is hard to believe that evidence of the eventual outcome was not apparent at the time the decisions were made to only isolate the curling chiller. This may be a result of limited knowledge of pressure vessels and the specific toxicity of ammonia. The three who died in the accident were the most knowledgeable in the field of operating/maintaining facilities and we have hundreds of similar facilities like Fernie across Canada. This is a huge problem and does not speak highly of the training and examination process required to operate and maintain these systems. With such a lethal chemical, ongoing training and testing should be mandatory and implemented immediately.
4. It is important to enforce the dangers of working with ammonia chillers during training. The training must include lessons on the chemical properties of anhydrous ammonia and all the necessary associated safety working standards. There is an arena culture that strongly supports toughness, competitive skills, a tendency to push limits, and downplaying problems. It should be mandatory that when issues arise due to pressure vessels, ammonia, ventilation, and equipment exhaust that it be addressed and corrected immediately.

Document/ Investigation Inconsistency

There were document inconsistencies leading up to the Fernie accident, which was the result of poor management and financial planning. Unfortunately, there continues to be quite the discrepancy in the accident's reports as well. Below is a list of the primary inconsistencies.

1. It is apparent that administration failed to properly plan for the replacement of the chiller. This would not have happened if:
    a. external, annual inspections were mandatory under Provincial government regulation

b. chiller replacement was mandatory under government regulation after a 25 year life cycle (even with an additional two year extension to arrange financing).

2. The following statements in Technical Safety BC's report are unbelievable and irresponsible:
    a. "There was no evidence to suggest awareness that the leaking (AMMONIA) chiller presented a hazard and there was industry practices of operating leaking (AMMONIA) chillers while repairing or replacements are arranged" (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena."* 2018, Page 24) There is always a chance the tube could have split open along the corroded, welded seam resulting in a two inch gap instantly pressurizing the brine system beyond limits. This supports the need for pressure relief valves.
    b. "No emergency procedures or training relevant to the situation… Guidelines of this nature have reportedly been omitted due to a wide variety of potential emergency circumstances and the possible consequences of providing the wrong direction. The result is that no guidance or training is provided to assist with situational awareness during such emergencies." (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena."* 2018, Page 27) Given the number of past chiller leaks reported and the knowledge that many of Canada's arena chillers are reaching the critical age requiring replacement, the recommendations in the Technical Safety BC Investigation Report should include a wide variety of emergency procedures and training for different scenarios including chiller tube leaks in ammonia systems.
3. After reviewing numerous pictures in the Acuren Report that showed corrosion on a full sample of heat exchanger tubes and the report stating that all samples showed significant pitting and corrosion, Acuren's overall evaluation is concerning. The Acuren Report's opinion of chiller corrosion states, "The overall condition of the chiller was relatively good with no evidence of tube – tube sheet leaks and no evidence of any significant corrosion on the ammonia pressure vessel." (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena - Appendices."* 2018, Page 104) This statement contradicts many of their specific findings in their report listed below:
    a. "The leaking tube was sectioned along its length adjacent to the leak. Severe pitting is evident all along the tube internal surface" (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena - Appendices."* 2018, Page 98)
    b. "Pitting was found with every tube examined" (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena - Appendices."* 2018, Page 102)
    c. "All of the tubes examined contained ERW (electric resistance welds) fusion defects on the weld line. The leaking through-wall corrosion pit was found on the weld fusion line of row 2- tube 3 initiating at a lack of fusion defect." (Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena - Appendices."* 2018, Page 104)

Industry Survey in B.C.

To understand the need for emergency action, every ammonia arena owner should read "Appendix V: Survey of Arenas with Ammonia Detected in Brine" on page 268 to 271 of the Technical Safety BC Investigation Report Appendices.

The survey reviewed 15 arenas that tested positive for ammonia in the brine. Some arenas had concentrations over 2000 ppm. The report does not mention how many arenas were tested in total, including arenas that tested negative for ammonia in the brine. This would provide a percentage of arenas that have ammonia in the brine.

Through this survey, Technical Safety BC discovered that the arena's actions varied. One arena decided to immediately shutdown, some arenas decided to ignore the problem, while others continued to monitor and run the system till the end of the season.

New regulated standards must be implemented given the severity of non-action. The following additional information/recommendations would be beneficial in this report and when developing an emergency evacuation policy:

1. An accurate estimate of the rate of ammonia dispersion from the original concentration of +20,000ppm down to 0ppm (on a timeline) for the following areas:
    a. Machine room
    b. Just outside the machine room in the corridors where staff and organizers have access while setting up and running events
    c. Change rooms
    d. Closest stand area open to the public
    e. Ice surface
    f. Area of public gathering such as the concession stand, main entrance area, etc.

    This information is vital to properly document and recommend a specific emergency evacuation policy that includes first responders' action.
2. Fernie's chiller tube wall thickness when it was new and what was the maximum depth of corrosion on each of the tubes tested. The percentage of corrosion through the tube could be calculated with this information.
3. It should be standard practice that when hosting a public indoor event, there is an announcement encouraging the public to identify where the closest fire exits are located and to immediately evacuate the building following an alarm. Over the last twenty years, I can confidently say this is not a common practice.

Conclusion

The severity of the Fernie accident was extreme; however, it could have been much worse. The goal of this response was to highlight some key issues and provide recommendations on how to improve upon them so that a similar accident does not happen again. It is clear that there are multiple areas of concern that all have the potential to endanger individuals and the general public at large. Non-action, given the history of ammonia leaks in the industry, is the greatest concern. Management, rink staff, technical specialists, and government inspectors all need to work as a team to ensure public safety.

Below is a list of concerns that are directly associated with the Fernie Memorial Arena ammonia accident. They must be addressed, given there are hundreds of arenas with similar conditions.

1. Original design of the system, which did not include a pressure release valve in the brine system
2. Improper installation of the piping system allowing the coupling to separate
3. Service specialists must take more responsibility on how the equipment is being operated and maintained
4. The questionable operating procedure of using cable ties to ensure a valve is always open
5. The limited routine maintenance and inspection procedures (ex. The damaged emergency ventilation fan belt which limited air flow)

6. No consistent documentation on how to respond to a chiller tube leak
7. Industry survey of other arenas operating with a chiller leak and their actions to accommodate scheduled public events
8. Questionable operator training and certification
9. No required inspections by a registered third party
10. Government regulations that vary from province to province add inconsistency and confusion
11. Owners limited knowledge and yet they are responsible to make major decisions
12. Poor management and budgeting for ammonia system service and replacement

It is clear that arena chiller equipment needs to be regulated and maintained better, that training needs to be more consistent and thorough, and that reporting needs to be more complete and reliable. From the industry survey in BC, it does not seem like much has changed. The government needs to step in and set regulations to protect its people if arenas are not willing to put the lives of their employees and customers as a priority.

Bibliography

"Ammonia Refrigeration - Emergency Response." Edited by OSHA Directorate of Technical Support and Emergency Management, *Occupational Safety and Health Administration*, United States Department of Labor, www.osha.gov/SLTC/etools/ammonia_refrigeration/emergency/index.html#plan

City of Fernie. 2 Nov. 2017, www.facebook.com/pg/CityOfFernie/posts/?ref=page_internal

Crawford, Tiffany, and Nick Eagland. "Numerous Safeguards in Vancouver Ice Rinks to Avoid Ammonia Dangers." Vancouver Sun, 19 Oct. 2017, www.vancouversun.com/news/local-news/34-ammonia-injuries-over-8-years-in-bc-most-at-arenas-report

"Hazardous Substance Fact Sheet." NJ Health, New Jersey Department of Health, Feb. 2016, www.nj.gov/health/eoh/rtkweb/documents/fs/0084.pdf

Ontario Ministry of Labour. *"Engineering Data Sheet 4-04: Anhydrous Ammonia."* Ontario Ministry of Labour, Government of Ontario, Ministry of Labour, Occupational Health and Safety Branch, Sept. 2010, www.labour.gov.on.ca/english/hs/pubs/eds4-04_ammonia.php

Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena."* July 25, 2018, www.technicalsafetybc.ca/sites/default/files/2018-07/FaultTrees/TSBC_257671_InvestigationReport_v14_online.pdf

Technical Safety BC. *"Investigation Report Ammonia Release – Fernie Memorial Arena - Appendices."* July 25, 2018, www.technicalsafetybc.ca/sites/default/files/Appendices_withAppendixE_LowRes.pdf

The Canadian Press. *"A List of Ammonia Rink Regulations across Canada."* The Chronicle Herald, 18 Mar. 2018, www.thechronicleherald.ca/canada/1554084-a-list-of-ammonia-rink-regulations-across-canada