TRIAGE

MUNICIPALITY OF CLARINGTON

TRIAGE REPORT FOR
INSPECTION – RINK REFRIGERATION & PAD
ORONO ARENA & COMMUNITY CENTRE

2 PRINCESS STREET, ORONO, ON

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VERSION 1.0

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Official Rink Engineering Consultant of the NHL®

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REVISION LOG

REVISION DOCUMENTATION

Revision	Date	Description
VER: 1.0	*23-Sep-2020*	*Issued to Client*

APPROVAL

INTRODUCTION

I.B. Storey Inc. has performed a triage inspection for the Orono Arena & Community Centre. A triage report assesses the current state of the facility and provides recommendations for immediate action on safety issues, short-term corrective actions on safety mitigation and performance enhancements, and long-term capital expenditure planning to ensure the longevity of the building. The intent of this inspection is to stabilize immediate issues and secure the ongoing operations for the rink into the future.

This report is divided into two parts in order to provide a complete assessment of the equipment in the building and the current adherence to health and safety codes. Part 1 addresses the age and current integrity of the installed equipment, and part 2 addresses the current adherence to the CSA B52 safety standards. Both sections provide recommended next steps.

Part 1 of this report has been prepared to provide an assessment of the equipment and infrastructure at the Orono Arena & Community Centre in Orono, Ontario. I.B. Storey visited the site on August 24, 2020 and reviewed the status of the following equipment and systems:

- Refrigeration plant
- Rink floor, boards and glass
- Rink dehumidification

In addition to an assessment of the age and useful life of the equipment, this report will provide an overview of recommended corrective actions in the form of immediate actions, short term corrective actions and long-term capital expense planning to address any noted issues. These recommendations are provided as an action plan to provide guidance for the safe operation of the rink.

Part 2 of the report is a plant safety compliance review and risk mitigation strategy. During the inspection on August 24, 2020 I.B. Storey Inc. reviewed the current plant safety features and compared them to the current safety standard used by the Technical Standards and Safety Authority (TSSA) for refrigeration plants in Ontario, CSA B52-18 Mechanical Refrigeration Code. This section presents a summary of the noted safety issues and recommended corrective actions to bring the refrigeration plant up to the code standards as well as further risk mitigation strategies.

BACKGROUND

The Orono Arena & Community Centre is a single sheet ice rink constructed in 1978. The building operates as an ice rink from September through April, and as a floor venue from May through to September.

Category	Building Details
Year of Construction	1978
Building Use	Seasonal single sheet ice rink; Out of season community floor space
Refrigerant Type	Ammonia
Major Refrigeration Plant Equipment	Compressor x 2 Cold Brine Pump Condenser Pump Evaporative Condenser Shell and Tube Chiller
Dehumidification	Mechanical dehumidifier in rink zone x 2

Part 1 – Integrity Triage

EQUIPMENT ASSESSMENT

I.B. Storey conducted an on-site inspection of the refrigeration plant, dehumidification system and rink floor, boards and glass on August 24, 2020. The following highlights the status of all of the major equipment in these systems with an overview of their current status as of the inspection date.

REFRIGERATION PLANT

Chiller

Figure 1: Chiller barrel and vessel.

Category	Information
Model	Cimco Refrigeration Shell and Tube Chiller
Year of Construction	2001
Purpose	Uses ammonia gas in conjunction with compressors and condensers to cool ice rink and maintain ice.
Median Equipment Life	24 years
Current Age	19 years

Observations and Analysis

Figure 2: Signs of rusting on the chiller.

- The chiller is very near the median end of life, and may be subject to failures in the near future. The chiller and attached surge drum are the primary ammonia storage vessels and given the hazardous nature of ammonia the chiller should not be allowed to operate near the median end of life.
- **Chiller failures are a serious risk to public health and safety because toxic refrigerant may leak. Replacement of the chiller should be considered as soon as possible**[1].
- Inspection of the chiller is due in January 2021 for insurance purposes.
- Chiller relief valves need to be replaced by June, 2023. This is a critical safety component.
- While the chiller and surge drum are covered in an insulating layer that limits direct inspection, exposed elements where piping connects shows significant signs of rusting. This suggests the potential for corrosion throughout the vessel.

Recommended Actions

Category	Recommended Action
Immediate Actions	• Have a brine analysis performed to check for ammonia contamination in brine as an early sign of chiller failure to mitigate danger to operators and users.

Short-Term Actions	• Have chiller and surge drum re-inspected by January 2021 for insurance purposes.
	• Replace chiller relief valves by June 2023 as required.
	• Perform ongoing monitoring of brine to test for potential chiller failure. Additional ongoing monitoring is recommended, including[2]:
	  ○ Check for any increase in volume in the secondary refrigerant (brine) system.
	  ○ Check for any unusual increase in pressure in the secondary refrigerant (brine) system.
	  ○ Test the system heat exchange for leaks during the off season.

Capital Expenditure Planning	• Pursue opportunities to replace the chiller as soon as possible. ○ **This is a significant health and safety risk. Replacing the chiller on its own or as part of a total refrigeration plant upgrade should be prioritized. Given the age of all of the equipment, a full plant replacement is recommended at this time.**

[1] Based on the current condition of the refrigeration plant equipment, a full plant replacement is recommended.
[2] Refer to Technical Safety BC SO-BP-2017-01 "Safety Order: Ammonia refrigeration systems in public occupancies" for detailed recommendations prepared by Technical Safety BC following the tragic and fatal ammonia release accident in Fernie, British Columbia in 2017.

Compressors

Figure 3: Compressor #1

Figure 4: Compressor #2

Category	Compressor 1 Information	Compressor 2 Information
Model	Cimco C5-W06A[3] (Mycom N6WA[4])	Cimco C5-W04A (Mycom N4WA)
Year of Construction	2001[5]	2001[5]
Purpose	The prime mover[6] of the refrigeration system, the two compressors work together to provide cooling to the shell and tube chiller to maintain ice conditions.	
Median Equipment Life	20 years	
Current Age	19 years	19 years

Observations and Analysis

- Both compressors are aged with signs of rust all over the unit.
- Both compressors are due to have reliefs replaced by April 2024.
- The compressors are nearing the end of the typical operating life for this type of equipment, beyond which it will become increasingly more expensive to maintain them.
- These compressors represent a significant safety risk, as they are compressing gaseous ammonia, a toxic, flammable refrigerant. Aging compressors pose a serious hazard to life and health.

[3] There's no nameplate attached to this compressor, but the equipment configuration matches with a Cimco C5-W06A.
[4] Though these compressors have been rebranded as Cimco compressors, they are Mycom compressors manufactured by Mayekawa and rebranded by Cimco Refrigeration.
[5] No data on the current age of this unit was available, however the unit matches with the chiller equipment installed in 2001. It is reasonable to assume that this compressor is as old as the chiller.
[6] Prime mover refers to the hardware powering the refrigeration system, performing the compression on the gaseous ammonia.

- Though having multiple compressors allows for the system to continue operating at a limited capacity with only one compressor, these units are near the end of life and should be replaced. Plan for compressor replacements as soon as possible.

Category	Recommended Action
Immediate Actions	• Maintain routine maintenance procedures.
Short-Term Actions	• Replace compressor relief valves as needed. ○ Due for replacement April 2024..
Capital Expenditure Planning	• Pursue opportunities to replace the compressors as soon as possible. ○ **Compressors are essential equipment for the refrigeration plant and ice cannot be maintained without them. Additionally, as the prime mover responsible for compressing ammonia mechanical issues with this equipment is a safety hazard. This equipment should be planned for replacement in conjunction with the chiller.**

Pumps

Figure 5: Cold Brine Pump

Category	Information
Model	Peerless Pump F2 1040 AM
Year of Construction	2001[7]
Purpose	Circulates cold brine (secondary refrigerant) through the ice rink floor in order to maintain ice.
Median Equipment Life	20 years
Current Age	19 years

Observations and Analysis

- The cold brine (secondary refrigerant) pump is showing serious signs of corrosion, with obvious rust all over the pump casing. The use of brine as a secondary refrigerant in the system may introduce greater stress on the equipment and reduce the overall service life.
- Brine as a secondary refrigerant requires regular maintenance and monitoring of corrosion inhibitors, and if this maintenance has not been carried out significant corrosion and damage to the pump interior is likely.
- Regular maintenance on the equipment should be maintained.
- The failure of this pump would disable the ice rink until a replacement could be installed.
- Plan for equipment replacement in 1 - 3 years. It is recommended that if the compressors and chillers are replaced, the brine pump be replaced as well for overall system longevity.

[7] No data on the current age of this pump was available due to the conditions of the pump. Based on the advanced deterioration of the pump it is reasonable to assume that this pump is as at least as old as the chiller.

Figure 6: Condenser Pump

Category	Information
Model	Cimco (Armstrong[8]) 4280 3x2x8
Year of Construction	2010[9]
Purpose	Delivers cooling water to the evaporative condenser to help heat rejection from the refrigeration plant.
Median Equipment Life	20 years
Current Age	10 years

Observations and Analysis

- The condenser pump shows some signs of wear on the outer casing particularly near pipe couplings, though any issues with the impeller or interior casing could not be assessed.
- Based on the age and visual inspection of the equipment, it should be planned to replace this pump within 10 years or when the refrigeration plant is upgraded.
- Failure of this pump may limit the ability of the refrigeration plant to operate in high outdoor temperatures during the shoulder seasons, and will increase overall energy consumption and operating costs.

Category	Recommended Action
Immediate Actions	• Maintain routine maintenance procedures.
Short-Term Actions	
Capital Expenditure Planning	• Plan to replace cold brine pump in 1 to 3 years. ○ Brine pump should be replaced at the same time as large refrigeration plant overhaul if pursued. • Plan to replace condenser pump in 10 years.

[8] Though this pump is badged as a Cimco pump, it is manufactured by Armstrong Pumps and rebranded by Cimco post construction.

[9] The age of this pump was not available, however based on the condition of the pump compared to other equipment in the room it is likely that it has been replaced. Based on the condition of the pump it is estimated that it has roughly ten years of service life remaining.

Controls

Figure 7: Primary Control Panel

Figure 8: Backup Controls

Category	Primary Controls Information	Backup Controls Information
Model	Cimco Seasonal Plus	Honeywell T775
Year of Construction	2001[10]	2001[10]
Purpose	The primary control system operates the refrigeration plant as needed based on control sensors, with logic for equipment staging and seasonal adjustments. The backup controls are used when there are issues with the primary controls.	
Median Equipment Life	N/A years	
Current Age	19 years	19 years

Observations and Analysis

- The primary control system is a proprietary Cimco system that includes limited controls for seasonal adjustments and basic staging options.
- This control system is used to provide floating head control by adjusting the discharge pressure of the compressors only, and is not a full refrigeration plant automation system.
- The control system is proprietary and locked, restricting edits and the ability to change sequences.
- The backup control unit is an industry standard Honeywell T775.
- Control systems have no definitive service life and can be used for long periods of time, however improvements to controls technology provide energy savings so periodic upgrades are recommended.
- Control sensors should be recalibrated to ensure accuracy for controls.

[10] No data on the current age of this equipment was available, however it can be reasonably assumed that this equipment was installed with the chiller in 2001.

Category	Recommended Action
Immediate Actions	• Maintain routine maintenance procedures.
Short-Term Actions	• Recalibrate all sensors to ensure accuracy in controls.
Capital Expenditure Planning	• Plan to replace the control system when the refrigeration plant is overhauled. ○ **I.B. Storey Inc. recommends open source control systems when upgrading to ensure that the hardware and software can be updated indefinitely to match improvements in control technology and add new features to the plant. This control system should control the entire refrigeration system.**

ICE RINK FLOOR, BOARDS AND GLASS

Ice Rink Floor

Figure 9: Scuff marks and scrapes throughout the ice rink floor

Figure 10: Large scrapes found on the rink floor

Category	Information
Construction	Poured concrete over rink piping
Year of Construction	1978
Purpose	The concrete floor and piping used to create the ice surface for the ice rink. Also used for indoor sports and community activities in the off season.
Median Equipment Life	25+ years
Current Age	42 years

Observations and Analysis

- Scuffs and surface abrasions were observed on the concrete, along with general wear and tear.
    - A large scuff mark was noted as well, and may be a result of hosting events on the floor in the off season.
- The rink cold floor piping was not accessible, so an assessment of its condition could not be made.
    - The cold brine supply system should be monitored for dropping fluid levels which indicate a leak in the cold floor.
- As the floor is original to the building, the probability of internal piping failure is high. It is recommended that the floor system be replaced as soon as possible.

Category	Recommended Action
Immediate Actions	• Maintain routine maintenance procedures and check ice rink cold brine feeder system regularly to catch any potential leaks.
Short-Term Actions	• Consider a rugged cover to place over the concrete surface during off-season activities to prevent ongoing damage to concrete.
Capital Expenditure Planning	• Plan to replace the ice rink concrete and piping as soon as possible. ○ **I.B. Storey Inc. recommends new ice rink floors be installed with fusion welded HDPE piping to remove the need for ongoing clamp maintenance and provide corrosion resistant piping.**

Boards and Glass

Figure 11: Ice rink boards and glass

Category	Information
Construction	Wooden boards on metal frame, no back cover
Year of Construction	1978[11]
Purpose	The boards and glass are used to keep play on the ice surface and keep spectators and players safe.
Median Equipment Life	25+ years
Current Age	42 years[11]

Observations and Analysis

Figure 12: Scuffing and wood damage near foot level.

- Boards and glass are aging, with some plexiglass scuffing, as well as distorted wood tops and cracking around the players bench.
- Some corrosion of the metal frame is noted on the metal around the doorways into the rink zone.
- Portions of the wooden boards show signs of being replaced recently, but serious wear can be seen near foot level in places.
- Board facings show significant waviness, likely as a result of moisture issues with the wooden components underneath.

Figure 13: Signs of metal rusting at door interfaces.

[11] While the boards and glass were originally installed in 1978 with the construction of the building, parts of them have subsequently been replaced over the years.

- The boards and glass system does not currently have modern safety features like:
    - Soft protective cover over the caprail to prevent player injuries
    - Curved terminations at player entry areas to prevent player collisions with sharp edged glass.
    - While these safety features are not mandatory, they are highly recommended by I.B. Storey Inc. for improved user comfort and safety.

Figure 14: Example photos of curved terminations (left) and soft caprail protections (right).

Category	Recommended Action
Immediate Actions	
Short-Term Actions	• Consider replacing portions of wooden boards that show significant wear near foot level.
Capital Expenditure Planning	• Plan to replace the ice rink boards and glass at the same time as the floor replacement. ○ **I.B. Storey Inc. recommends a modern board system with an aluminum frame to resist metal corrosion and provide flexibility for safety, along with a soft protective plastic piece along the caprail before the glass to prevent player injury and curved terminations for enhanced safety.**

DEHUMIDIFICATION

Figure 15: Mechanical dehumidifier in rink zone

Category	Information
Model	Dectron
Quantity	2
Year of Construction	N/A
Purpose	Removes moisture from the air using a compressor to cool the air below dewpoint, before returning the air to the zone.
Median Equipment Life	20 years
Current Age	N/A

Observations and Analysis

- No information on the age of the two dehumidifier units is available and the units were not accessible. Based on a visual inspection they seem to be in reasonable condition.
- The location of these units makes for an operational and maintenance hazard, and makes maintenance difficult.
- It is recommended that these units be integrated into a central automation system to provide proper control and monitoring.

Category	Recommended Action
Immediate Actions	• Inspect the dehumidifiers to ensure that both units are working properly. • Continue regular maintenance on the units.
Short-Term Actions	
Capital Expenditure Planning	• Plan to integrate the existing units into a central automation system in order to provide better monitoring and control of zone humidity.

PRIORITIZED ACTION PLAN

The following summarizes the recommended actions in order of priority.

Immediate Actions				
Number	Equipment	Action	Timing	Budget Cost[12]
1	Chiller	Have a brine analysis performed to check for ammonia contamination in brine as an early sign of chiller failure.	Immediately	$500
Short Term actions				
Number	Equipment	Action	Timing	Budget Cost[12]
1	Rink Floor	Consider a rugged cover to place over the concrete surface during off-season activities to prevent ongoing damage to concrete.	Before spring 2021	$140,000[13]
2	Controls	Recalibrate all sensors to ensure accuracy in controls.	Before start up 2021	$4,000
3	Chiller	Perform ongoing monitoring of brine to test for potential chiller failure. Recommended twice per year.	Before start up 2021	$1000 / year
4	Boards and Glass	Consider replacing portions of wooden boards that show significant wear near foot level.	Summer 2021	$20,000
5	Chiller	Have chiller and vessel re-inspected by January 2021 for insurance purposes and to test for leaks.	January 2021	$800
6	Chiller	Replace chiller relief valves by June 2023	June 2023	$2,400
7	Compressor	Replace compressor relief valves by April 2024	April 2024	$800

[12] AACE Class 5 Concept Screening budget.
[13] This budget cost includes an insulated floor that could be used over the ice surface. More budget friendly options may be available if insulation is not required.

Capital Expense Planning				
Number	Equipment	Action	Timing	Budget Cost[12]
1	Refrigeration Plant	Replace the refrigeration plant to address issues with aging equipment approaching end of life. • The chiller and compressors are nearing end of typical useful life. • Given the cost of replacing a chiller and compressors relative to the cost of the refrigeration plant, it is recommended that a full plant replacement be considered. • This should include new compressors, chiller, condenser and associated pumps. • This should include a controls upgrade as part of the overall plant refresh. • The upgrade should include integrated heat recovery, using waste heat from the refrigeration plant to save on heating costs.	As soon as possible	$750,000
2	Rink Floor, Boards and Glass	Replace the rink floor, boards and glass with new fusion welded piping and an aluminum dasherboard system with advanced safety features. • The existing floor concrete surface is showing signs of wear. • The cold brine piping was not accessible for inspection but the aging cold floor runs the risk of leaking, and brine levels should be closely monitored to determine the risk. • It is recommended that the floor piping be replaced with a fusion welded system to prevent maintenance issues with the current clamped headers, while simultaneously pouring a new concrete floor and replacing the boards and glass. Replacing the boards at the same time as the floor will allow anchors to be placed without having to drill into a new or existing floor, potentially causing leaks.	As soon as possible	$1,050,000

Part 2 – Plant Safety Compliance Review and Risk Mitigation Strategy

CSA B52-18 COMPLIANCE REVIEW

The CSA B52 Mechanical Refrigeration Code is the standard adopted by the TSSA for refrigeration regulation in Ontario and is intended to minimize the risk of personal injury by providing minimum requirements for the design, construction, installation, inspection, and maintenance of mechanical refrigeration systems. As these standards are updated regularly, even facilities which were once in compliance may find that their systems have either been grandfathered into "compliance" or age has rendered some, or all, components non-compliant. The following are two lists of non-compliant TSSA issues found during the review of the refrigeration room at the Orono Arena. The first list contains critical items which need to be addressed at the next available opportunity to ensure safety of the community centre users in the case of an emergency and the second list contains other items which need to be taken care of to ensure complete compliance with code. To aid in understanding these deficiencies, clauses associated with deficiencies have been laid out with associated photos and a complete check list of the B52-standard attached as appendices.

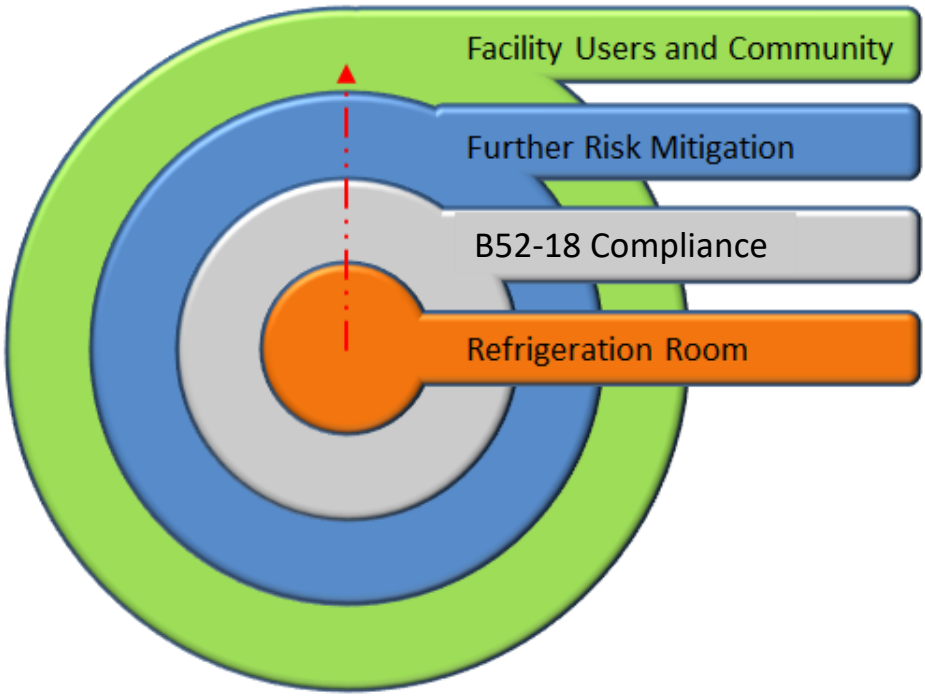
CRITICAL B52-18 NON-COMPLIANT ITEMS		
Section	Description	Notes
6.1.1 a)	Appropriate equipment clearance	• Insufficient clearance for maintenance was noted between the refrigeration skid and the sump.
6.1.3 b)	Equipment that is not accessible from floor level shall be installed so that it can be safely reached by a permanently installed staircase(s) or ladder(s) with a platform(s) and railings meeting the workplace safety requirements; or by a mobile device(s) for lifting personnel to the equipment.	• Evaporative condenser installed on the roof has no permanently installed staircase or ladder for access.
6.1.3 c)	(c) Roof- and mezzanine-mounted equipment shall be set back 3 m (10 ft) from any edge where a fall hazard exists, except under the conditions specified in Item (d). If the workplace safety requirements of the jurisdiction of installation impose a greater setback, those requirements shall apply.	• Evaporative condenser is installed near the edge of the roof

CRITICAL B52-18 NON-COMPLIANT ITEMS		
Section	Description	Notes
6.1.3 d)	(d) Where roof- and mezzanine-mounted equipment cannot be set back as specified in Item (c), railings and fall-arrest system attachment points shall be provided in accordance with the workplace safety requirements of the jurisdiction of installation.	• No railings or fall-arrest system installed though the equipment is placed next to the edge.
6.2.5.4	Fan switches are installed inside and outside of the machinery room. Switches outside the room shall start but not stop fans.	• Switch outside of the room can turn the exhaust fan on and off.
6.3 f)	All pipes piercing the interior walls, ceiling, or floor shall be tightly sealed to the walls, ceiling, or floor through which they pass.	• Sprinklers and conduit that pass through the wall are not properly sealed.

OTHER B52-18 NON-COMPLIANT ITEMS		
Section	Description	Notes
5.11.1	Each refrigeration system shall be provided with a permanent sign that is securely attached, readily accessible, and legible, and that indicates the following: (a) name and address of the installer; (b) refrigerant type; (c) lubricant type and amount (d) total weight of refrigerant required for normal operation (e) field test pressures applied; (f) refrigeration capacity at design or nominal conditions; and (g) for prime movers, the rating or full-load current and voltage	• A sign displaying all this information was not located in the mechanical room
5.11.2	Equipment signs that indicate the following: (a) manufacturer's name; (b) manufacturer's nationally registered trademark; (c) identification number; (d) test pressures; (e) refrigerant type.	• Compressor #1 does not have a nameplate.

RISK MITIGATION ITEMS

While the review of the ammonia plant has revealed several items that are non-compliant with the TSSA refrigeration standards, it is paramount to note that the TSSA standards are only a bare minimum. Ensuring that the mechanical room meets TSSA safety standards is the first step that should fit into an overall plan to mitigate risks associated with providing efficient refrigeration for the facility.

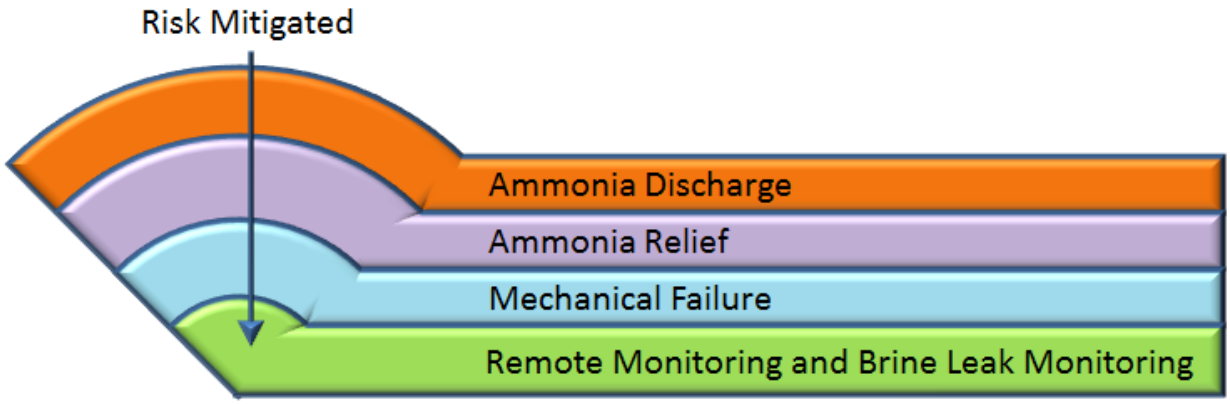


At a minimum, the following should be considered when determining the safety requirements that should be adopted for a refrigeration system:

- Safety to operators of the refrigeration system.
- Safety to users of the facility.
- Safety to public infrastructure (malls, schools, roads, etc.) around the facility.
- Safety to private infrastructure (homes, condos etc.) around the facility.
- Safety to the natural environment around the facility.

Since the initial installation of the refrigeration system in the 1970s and the refurbishment in 2001, advancements in technology have continued to provide risk mitigating options for ammonia plant installations that would not have been available or feasible in the past.

The review at the Orono Arena has revealed that risk mitigation strategies can be implemented for several aspects of the system as follows, with each measure identified as focusing on health or finance concerns. Risk items are presented in a stacked order, with each risk being prevented by the successful mitigation of all risk items that follow.



Risk Mitigation		
Risk Type	Item	Notes/Actions
	Ammonia Discharge Due to Component failure	• The refrigeration system at the Orono Arena does not have its refrigerant charge posted in the mechanical room as per B52 requirements (see Section 1), but based on the equipment in the plant the approximate refrigerant charge is 600 pounds. • In some cases, ammonia forms denser than air mixtures that roll along the ground, posing a danger to life, environment, and property. • Accidental full discharge is unlikely; however, reduction in charge greatly reduces risk range in a worst-case scenario. • Less charge reduces dispersal speed, providing emergency services with more time to respond. • A low charge plant will require approximately 60% less charge than existing system. • An ultra-low charge plant will require approximately 80% less than existing system. • Switching to an alternate, low-toxicity, environmentally sustainable refrigerant will prevent any hazards to nearby buildings and people.

Risk Mitigation		
Risk Type	Item	Notes/Actions
	Ammonia Relief Due to Component Over-Pressure	• The relief system at the Orono Arena ensures that dangerous pressures do not develop in the refrigeration system, causing component failure. • This relief system releases ammonia gas into the atmosphere when pressure is too high in a refrigeration component. • Adding an indoor relief system as a first relief stage renders discharged ammonia harmless and keeps it from the atmosphere.
 	Mechanical Failure Due to Mechanical Age	• Both component failure and over pressure can result from the use of aging equipment. • Preventing component failure mitigates accidental ammonia discharge. • Aged equipment at the Orono Arena includes the chiller, pumps and compressors. At around 20 years old this equipment is nearing the end of its useful life and is recommended for replacement in the coming years. • Only one brine pump is available at the arena. In the event of failure, there is no emergency backup for continued ice operation. • Efficient mechanical design increases equipment life and reduces available failure points.
	Remote Information Monitoring	• Information monitoring provides an operator with a first line of risk mitigation in any system. • Remotely provides information which alerts to operation of the system outside of a preset tolerance. • Knowledge of such operation helps diagnose failing components or dangerous conditions long before they would become obvious.
	Brine Leak Monitoring	• The disposal of brine, which is used as a secondary refrigerant at the facility, is regulated and needs to be carried out properly. • To prevent, or at least, mitigate brine leaks, a brine leak monitoring system should be installed on site. • Additional monitoring should be considered to detect ammonia leaks in the brine, to provide additional safety.

Full Ammonia Discharge
Immediately Dangerous to Life and Health (IDLH) Range

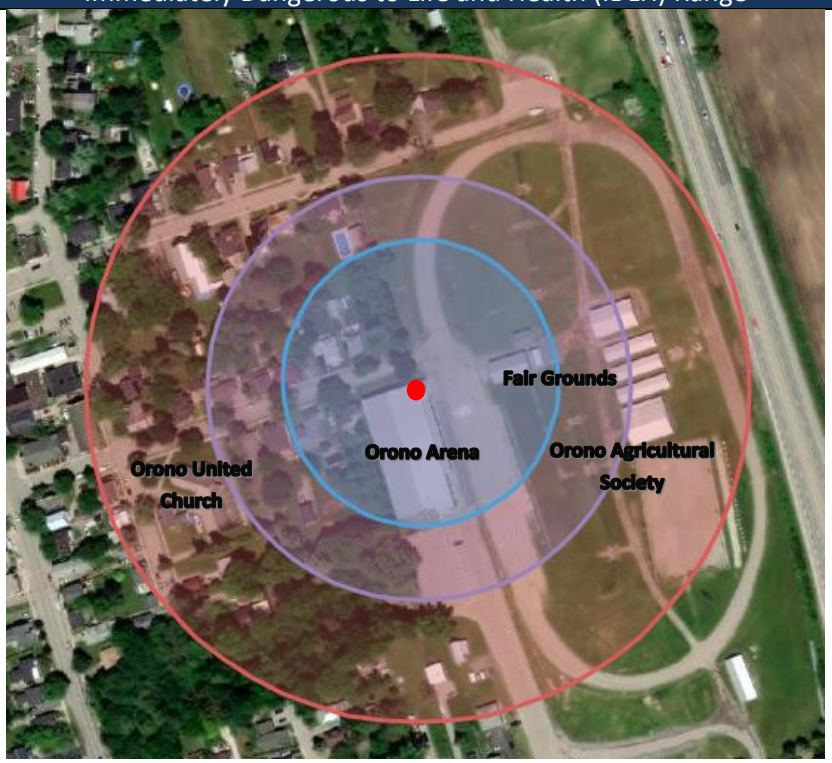


Figure 16: Health and safety danger ranges for visualization and decision-making.

- IDLH range does not factor in wind distribution and refrigerant charges have been estimated as no detailed signage is available. These ranges are presented for visualization and decision-making purposes only.
- The existing refrigeration plant range, shown in red, covers nearly 50 residential properties, Orono United Church, Orono Agricultural Society, fair grounds, and an antique market.
- Low charge plant (60% reduction), shown above in purple, would result in roughly 30 properties being removed from the immediately dangerous to life and health range but would still impact the fair grounds and private residences.
- Ultra-low charge plant (80% reduction), shown in blue, would limit dispersal to the arena, its parking lot, part of the fair grounds and a handful of nearby residential properties.
- Switching to an alternate, lower toxicity, environmentally sustainable A1 category refrigerant could remove the impact to surrounding buildings entirely and eliminate issues with toxicity and flammability.
- Reduction in the IDLH range provides more time for people to evacuate and emergency teams to arrive, as the charge disperses slower. These ranges must be considered even if on-site ammonia evacuation equipment is used, as the refrigerant is still on site.

CORRECTIVE ACTIONS

The following recommendations have been categorised into compulsory actions required to meet the CSA B52 standards and risk mitigation considerations for implementation as budget allows.

1. **Safety Compliance**
   - Tight fitting of pipe and conduit through machine room walls.
   - Installation of proper system labelling including key details about refrigerant charge and emergency contacts.
   - Installation of railing or fall protection measures for the evaporative condenser.
   - Install on-only switch for the ventilation fan outside the mechanical room.
   - Install a new exhaust ventilation system that only serves the refrigeration room.

   Budget Cost: $12,000
2. **Risk Mitigation**
   - As the age of the refrigeration plant is closing on 20 years, it is advised that new refrigeration plant equipment be investigated in the near future.
     - Based on the close proximity to nearby residential and community properties, it is recommended that a low-toxicity refrigerant be pursued.
     - Converting to a low-toxicity environmentally sustainable refrigerant will not result in operating cost increase.
   - Install indoor ammonia containment for the relief system if ammonia is kept on site.
   - Install, or have on standby, an extra brine pump in case of unexpected failure of the main pump.
   - Install, or have on standby, an extra water pump in case of unexpected failure of the main pump.
   - Install a remote monitoring system for the refrigeration plant.
   - Install brine leak detection system.

   Budget Cost: $750,000[14]

[14] This budget cost is suitable for either the low charge (60% refrigerant reduction) or low-toxicity refrigerant options. Additional costs required for the ultra-low charge (80% refrigerant reduction) option.

CONCLUSIONS AND NEXT STEPS

In order to ensure efficient and safe operation of the plant, it is recommended that the renewal of the refrigeration plant be pursued at the earliest convenience as the most recent TSSA assessment in the room was from May 2012, 8 years ago. Corrective actions not directly related to the installation of a new refrigeration plant should be corrected at the same time. Next steps are outlined as follows:

- Review report to select measures to be implemented.
- Engineering design of selected measures.
- Obtain actionable budget.
- Project facilitation to ensure compliant installation.

Based on the aging life of the refrigeration equipment, it is recommended that a complete renewal of the rink refrigeration system be planned for within 1 to 5 years. The ongoing status of the chiller should be closely monitored to ensure public health and safety with regular brine tests to detect ammonia leaks and potential chiller failure.

I.B. STOREY
Rink Engineering Experts

APPENDIX A
B52-18 COMPLIANCE PHOTOS

CONFIDENTIAL & PROPRIETARY

6.1.3 Evaporative condenser installed on the roof has no permanently accessible ladder, is near the edge, and has no railing

6.3 f) Pipes passing through walls and ceiling not properly sealed

6.2.5.4 Switch outside the mechanical room is capable of turning exhaust fans OFF, should be ON only

5.11.2 Compressor is missing a nameplate to show relevant data

APPENDIX B
B52-18 COMPLIANCE CHECKLIST

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CSA B52-18 MECHANICAL REFRIGERATION CODE - CHECKLIST			
SECTION	**DESCRIPTION**	**Status**	**Comments**
4	**SYSTEM CASSIFICATION AND APPLICATION REQUIREMENTS**		
4.6.1	No portion of a refrigeration system shall be installed in or on a public stairway, stair landing, or exit.	✓	
4.6.2	No portion of a refrigeration system shall interfere with free passage through a public hallway or lobby.	✓	
	Refrigeration systems installed in a public hallway or lobby shall be limited to unit systems containing not more than the quantity of a Group A1 refrigerant as specified in Table 1.	N/A	
5	**EQUIPMENT DESIGN AND CONSTRUCTION**		
5.4.3	Copper and its alloys shall not be used in contact with ammonia, except as a component of bronze alloys for bearings or other uses not involving refrigerants.	✓	
5.6.3.1	Low side ammonia separation vessels > 12 in. diameter must have a high liquid level sensing device installed to automatically trip compressors.	✓	
5.9.2.1	All systems containing more than 3 kg (6.6 lb) of refrigerant shall have stop valves installed		
	(a) on each suction inlet of each compressor, compressor unit, or condensing unit;	✓	
	(b) on each discharge outlet of each compressor, compressor unit, or condensing unit, and on each liquid receiver; and	✓	
	(c) on each inlet and outlet connection of a volatile direct system separator/receiver.	N/A	
	Systems containing more than 50 kg (110 lb) of refrigerant shall have stop valves installed at the following locations:		

CSA B52-18 MECHANICAL REFRIGERATION CODE - CHECKLIST			
SECTION	**DESCRIPTION**	**Status**	**Comments**
5.9.3.1	(a) on each suction inlet of each compressor, compressor unit, liquid refrigerant pump, or condensing unit;	✓	
	(b) on each discharge outlet of each compressor, compressor unit, liquid refrigerant pump, or condensing unit;	✓	
	(c) on each inlet of each liquid receiver, except for self-contained systems or when the receiver is an integral part of the condenser or condensing unit;	✓	
	(d) on each outlet of each liquid receiver; and	✓	
	(e) on each inlet and outlet of condensers when more than one condenser is used in parallel in the system.	✓	
5.11.1	Each refrigeration system shall be provided with a permanent sign that is securely attached, readily accessible, and legible, and that indicates the following:		No signage provided.
	(a) name and address of installer;	X	
	(b) refrigerant type;	X	
	(c) lubricant type and amount;	X	
	(d) total weight of refrigerant required for normal operation;	X	
	(e) field test pressures applied;	X	
	(f) refrigeration capacity at design or nominal conditions; and	X	
	(g) for prime movers, the rating or full-load current and voltage.	X	
5.11.2	Equipment signs that indicate the following: (a) manufacturer's name; (b) manufacturer's nationally registered trademark; (c) identification number; (d) test pressures; (e) refrigerant type.	X	Compressor missing relevant signage.

CSA B52-18 MECHANICAL REFRIGERATION CODE - CHECKLIST			
SECTION	**DESCRIPTION**	**Status**	**Comments**
5.11.3	For systems containing more than 45 kg (100 lb) of refrigerant, signs that designate the following: (a) the main electrical disconnect switches; (b) any remote control switches; (c) any pressure-limiting devices; (d) each pressure vessel; (e) the main shut-off to each vessel; and (f) the refrigerant piping.	✓	
5.11.5	Systems with movers having capacity exceeding 175 hp, the following information is provided: (a) emergency first responders number; (b) emergency shutdown instructions; (c) Contact info forr for emergency service; (d) Contact info for local authority, and instructions to contact in emergency.	N/A	
6	**INSTALLATION**		
6.1.1	Compressor and Condenser foundations to be structurally sound.		
	(a) Appropriate equipment clearance	X	Insufficient clearance between skid and sump
	(b) Equipment that is not accessible from floor level shall be installed so that it can be safely reached by a permanently installed staircase(s) or ladder(s) with a platform(s) and railings meeting the workplace safety requirements; or by a mobile device(s) for lifting personnel to the equipment.	X	Condenser has no permanent ladder.

CSA B52-18 MECHANICAL REFRIGERATION CODE - CHECKLIST			
SECTION	**DESCRIPTION**	**Status**	**Comments**
6.1.3	(c) Roof- and mezzanine-mounted equipment shall be set back 3 m (10 ft) from any edge where a fall hazard exists, except under the conditions specified in Item (d). If the workplace safety requirements of the jurisdiction of installation impose a greater setback, those requirements shall apply.	X	Condenser is not set back on the roof.
	(d) Where roof- and mezzanine-mounted equipment cannot be set back as specified in Item (c), railings and fall-arrest system attachment points shall be provided in accordance with the workplace safety requirements of the jurisdiction of installation.	X	No railing is provided on the roof.
6.2.1	Adequately sized machinery room restricted to authorized personnel.	✓	
6.2.2	Machinery room doors open outward and are self-closing and tight fitting. The doors do not open to a public corridor or any room used for assembly.	✓	
6.2.4.3	Combustion equipment can be used, as long as combustion air is ducted from outside OR vapour detector automatically shuts down combustion process	N/A	
6.2.5.1	Machinery rooms to be ventilated to outdoors	✓	
6.2.5.2	Ventilation is provided by one or more power driven fans	✓	

CSA B52-18 MECHANICAL REFRIGERATION CODE - CHECKLIST			
SECTION	**DESCRIPTION**	**Status**	**Comments**
6.2.5.3	Exhaust air from machine room to be located close to area where refrigerant should collect. Make up air shall replace exhaust air. Make up air shall be positioned so that discharged air does not short cycle into make up air. Supply and exhaust serve ONLY machine room.	✓	
6.2.5.4	Fan switches are installed inside and outside of the machinery room. Switches outside the room shall start but not stop fans.	X	The switch outside of the room can stop the fans.
6.2.5.5.1	Mechanical ventilation sized to exhaust potential accumulation of refrigerant due to leaks or a rupture of the system as specified in the clause.		
6.2.5.5.2	Minimum ventilation required when the refrigeration system is operating or the room is occupied.	✓	
6.3	No flame-producing devices installed.	✓	
	The machinery room has an exit door that opens directly to the outer air. Exits communicating with the building are through a vestibule.	✓	
	The machinery room envelope, including any vestibule, shall be of tight construction.	✓	
	Walls, floors, and ceiling of constructed of 1-hour fire-resistive construction.	✓	
	Exterior openings are not to be under any fire escape or any open stairway.	N/A	
	All pipes piercing the interior walls, ceiling, or floor shall be tightly sealed to the walls, ceiling, or floor through which they pass.	X	Sprinklers and conduit are not properly sealed.
	Air ducts passing through shall be of tight construction and have no openings in the refrigeration room.	N/A	

CSA B52-18 MECHANICAL REFRIGERATION CODE - CHECKLIST			
SECTION	**DESCRIPTION**	**Status**	**Comments**
	Remote pilot control of the mechanical equipment immediately outside the machinery room solely for shutting down the equipment in an emergency.	✓	
	Ventilation fans shall have a control switch on a separate circuit and be located immediately outside of the machinery room.	✓	
	Detectors working, and in a location where refrigerant would collect. Detector shall start the ventilation fans and actuate alarms.	✓	
	Alarm system installed	✓	
6.8.1	Minimize danger of ammonia piping being struck (by falling objects, material handling, e.t.c) from any direction.	✓	
6.8.2	Refrigerant piping crossing an open space that provides a passageway is at least 7-1/2 ft above the floor.	N/A	
6.8.3	Refrigerant piping shall not obstruct passages, or be installed in a shaft containing moving objects (elevators etc), or in a stairway	✓	
6.10	Emergency discharge system per Annex B		
7	**OVERPRESSURE PROTECTION**		
7.1.2	Pressure vessels (with diameter above 6in) and volume less than 3ft3, that contain liquid refrigeratant and can be isolated need pressure relief valves	✓	
7.2.3.2.1	Pressure relief valves on refrigerant pumps.	N/A	
7.3.1.1	Every refrigeration system shall be protected by a pressure-relief device	✓	
7.3.6.1.2	Emergency discharge > 15 feet above ground, > 25 ft from any door, vent, or window	✓	
7.3.6.1.3	Ammonia relief stack, or dilution tank.	✓	
8	**MAINTENANCE OF SYSTEMS**		
8.4.2	Look for maintenance tags.	✓	

CSA B52-18 MECHANICAL REFRIGERATION CODE - CHECKLIST			
SECTION	**DESCRIPTION**	**Status**	**Comments**
8.4.4.a)	Refrigeration equipment must be clean - no water residue or dirt.	✓	
8.4.5.a)	Check for refrigeration logbooks.	✓	
9	**PRECAUTIONS**		
ANNEX B	**GUIDELINES FOR EMERGENCY DISCHARGE OF REFRIGERANT**		
B.2.7	Emergency discharge line must slope down to receiver.	✓	
B.2.8	An emergency switch to stop the refrigeration equipment shall be provided alongside the emergency valve.	✓	
B.2.9	Emergency valve: glass-fronted box; painted bright red; placed outside where it can't be used by general public. At least 7 ft above ground, unless permitted.	✓	