AGENDA
DISTRICT OF PORT HARDY
COMMITTEE OF THE WHOLE MEETING
6:30pm TUESDAY, JULY 10, 2018
COUNCIL CHAMBERS, MUNICIPAL HALL
7360 COLUMBIA STREET

Mayor: Hank Bood
Councillors: Pat Corbett-Labatt, Dennis Dugas, Rick Marcotte, Fred Robertson, John Tidbury and Leightan Wishart

Staff: Allison McCarrick, CAO; Heather Nelson-Smith, Director of Corporate Services; Lynda Sowerby, Director of Financial Services;

Regrets: Abbas Farahbakhsh, Director of Operational Services

Page			
	A. CALL TO ORDER	Time:	
	B. APPROVAL OF AGENDA		
	Motion required	1.	2.
	C. DELEGATION		
1-10	1. Eric C. Bradley, P. Eng., Bradley Refrigeration Consultants Ltd. (via telephone) re: Don Cruickshank Memorial Ice Arena Refrigerant Review.		
	D. ADJOURNMENT		
	Motion required	1.	2.
			Time:

BRADLEY REFRIGERATION CONSULTANTS LIMITED

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June 27, 2018

District of Port Hardy
7360 Columbia Street,
Port Hardy, BC V0N 2PO

Attention: Ms. Allison McCarrick, CAO

Dear Ms. McCarrick

Subject: Don Cruickshank Memorial Ice Arena
Refrigerant Review

Executive Summary

This report is a review of the different refrigerants that are commonly used for arena refrigeration. The refrigerant review is being conducted for the Don Cruickshank Memorial Ice Arena.

The refrigerants considered for this review are the alternate refrigerants (Freon based), packaged Freon systems, carbon dioxide and ammonia.

The evaluation criteria for the refrigerant review are:

- Risk of leak or exposure
- Energy Efficiency
- First Cost
- Operating Cost

Based on the information in this review, ammonia is being recommended as the best refrigerant for the Ice Arena.

The estimated cost of converting your existing ammonia plant to a new low charge ammonia plant is estimated at $600,000.

Eric C. Bradley, P. Eng.

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Discussion

A refrigerant is defined as a substance used in a cooling mechanism, such as a refrigeration system, to transfer the heat. Refrigerants change from gas to liquid and the back to gas in the refrigeration cycle.

All refrigerants are considered high pressure liquids or gases. Their use in arenas is regulated by the CSA B.52 Refrigeration Code as required for public facilities. This refrigeration code is administered in British Columbia by Technical Safety B.C. Engineers and refrigeration contractors are required to demonstrate compliance with the code when installing large refrigeration systems for arenas.

The refrigeration code includes requirements that ensure the safe operation of the refrigeration plant under all operating conditions.

The refrigerants commonly used in arenas are Freon alternates, carbon dioxide or ammonia. These refrigerants are chosen for their risk, first cost, operating cost and system efficiency. Note: Freon refrigerants considered as CFC's are banned or in the process of being banned because of their environmental damage. These refrigerant are being replaced with non-CFC refrigerants known as Freon alternate refrigerants.

For Freon alternate refrigerants and carbon dioxide, the safeguards include a detection system and ventilation that will remove a buildup of refrigerant in the refrigeration room in the event of a refrigerant leak. For the ammonia refrigerant, a similar ventilation system is also used. In addition, the ammonia refrigeration room is sealed from the adjoining public facility by a one hour rated, Class T building construction and vestibule to prevent any escape of ammonia. The additional cost of this Class T room for new construction, is estimated at less than $10,000. Additional features in the Class T room, such as the ventilation and detection systems are common to any refrigerant. For new ammonia systems, the Class T room for ammonia is substantially smaller than the other the other refrigeration rooms, due to the compact size of the low charge ammonia system.

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Characteristics of refrigerants:

1. Freon alternate Refrigerant (R-507a)

- Cost $20.00 per pound ($18,000 total cost)
- Typical charge for one arena: 900 lbs.
- Maximum Working pressure: up to 300 PSI.
- Heavier than air
- Odorless
- Greenhouse gas rating (GWG) 3300 (ozone depletion)

2. Carbon dioxide:

- Cost $1.00 per pound ($2,500 total cost)
- Typical charge for one arena: Up to 2,500 lbs.
- Maximum Working pressure: up to 1,000 PSI.
- Heavier than air
- Odorless
- Greenhouse gas rating (GWG) 1(ozone depletion)

3. Low Charge Ammonia Plant

- Cost $3.00 per pound ($225.00 total cost)
- Typical charge for one arena: Up to 75 lbs.
- Maximum Working pressure: up to 250 PSI.
- Lighter than air.
- Pungent smell
- Greenhouse gas rating (GWG): 0 (ozone depletion)

The risk of leaks and the safety requirements for each refrigerant are evaluated by the size of the charge, the working pressure, the greenhouse gas rating, and the size and type of facility. The final cost of applying each refrigerant is also used when determining the type of the refrigerant.

For a single sheet arena, all three refrigerants satisfy the criteria from a risk perspective for a leak and safety. In the event of a major leak, ammonia, Freon alternate and carbon dioxide refrigerants must be detected and alarmed to alert the operator to the risk.

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The size of the charge and the working pressures for the Freon Alternate and carbon dioxide refrigerants are higher than ammonia

The use of Freon alternates is also limited by the environmental damage a leak will cause to the ozone with a GWG (Greenhouse Gas) refrigerant rating of 3300 (Refrigerant R-507a). In addition, most of the Freon alternate refrigerants being used to today will be phased out eventually at a significant cost. The goal is to replace the existing Freon alternate refrigerants with refrigerants that have a smaller impact on the environment. For commercial air conditioning equipment, R-134a is a Freon commonly used. It is not suitable for industrial refrigeration due the limited compression ratio for this refrigerant. R-513a is the replacement refrigerant for R-134a. This new refrigerant is a blend which contains 60 percent R-134a and will be banned in the next round of the Montreal protocol.

The study considered the use of industrial refrigeration equipment for reasons of costing and comparing equal equipment between the various manufacturers. The use of packaged air condition system has been tried before and is not considered an “equal” due to the first cost of and lack of experience by the vendors in the arena industry.

Carbon dioxide has recently been considered as a refrigerant in Western Canada. There are no working plants in British Columbia and one plant being commissioned in Alberta, near Edmonton. The advantages of carbon dioxide are the low GWG rating of 1, and the ability to provide heat at a higher temperature for waste heat recovery. The waste heat recovery must have a large use such as a swimming pool to make this cost effective. The disadvantages of carbon dioxide are the large refrigerant charge and the high working pressure.

Ammonia is a naturally occurring substance with no impact on the ozone. The risks involved in using ammonia are offset by the low charge system and by its 0 GWG rating for the environment. The low charge ammonia system will be vented upwards in a matter of seconds by the ventilation system in the event of a major leak. Older arenas typically had an ammonia charge of 900 lbs for single sheet arena. New arenas with one sheet of ice will have a charge of 75 lbs. of ammonia using the new technologies that have been available to the industry for the last few years.

Our firm has also installed three ice facilities using the Freon alternate refrigerant in the last two years. The Freon alternate was used in these facilities because the smaller size of the facility and the lower first cost for this size of facility.

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Most of the new arenas in British Columbia have been installed using ammonia as the refrigerant due to the lower operating cost, longer life of the equipment, and the high efficiency of the refrigeration system. The City of Vancouver removed the Freon refrigeration plant at the Agrodome in 2009 and replaced it with the spare capacity from the central ammonia plant at the Pacific Coliseum. The City of Calgary installed Freon plants in the 1970's and then replaced these plants in the 1990's with ammonia refrigeration plants at each of their new facilities. The City of Richmond has had a study of refrigerants conducted by a mechanical engineering firm in Calgary last year. The study compares the various types of refrigerant currently being offered. This independent study by a Calgary consultant concludes that ammonia is the best refrigerant for arena operations.

The new technology for ammonia plants uses plate and frame chillers to reduce the ammonia charge. The plate and frame chiller uses titanium and stainless steel materials with an all welded construction to eliminate corrosion and joint failures. The first plate and frame chiller for arenas was engineered in 1998 by our firm for the Chilliwack Twin Rinks. This technology has now been phased into all new ammonia refrigeration plants in the last five years. One of the first major facilities to use a complete low charge system was Rogers Arena in 2015. Our firm provided the engineering to convert the old plant installed in 1995 at GM Place to a low charge system where 100 percent of the ammonia charge is contained in the plant room. The new single sheet Aldergrove Arena will use a low charge ammonia system with a total of 75 lbs. of ammonia. The low charge ammonia systems differ from the old systems where the charge is reduced from 800 lbs. to 75 lbs. for a single ice surface. With the much reduced charge and improved ventilation systems, this has made the ammonia ice plants safer than in the past.

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The following table summarizes the characteristics and costs of each refrigerant:

Refrigerant	**Freon Alternate**	**Carbon Dioxide**	**Ammonia**	**Packaged Freon**
Installed Cost for one new arena	$600,000	$1,000,000	$600,000	$1,100,000
Operating Cost*	$40,000 per sheet of ice	$40,000 per sheet of ice	$25,000 per sheet of ice	$40,000 per sheet of ice
Energy Efficiency	Low	Intermediate (Heat Recovery)	High	Low
GWG	3300	1	0	573
Life Cycle**	27 years	30 years	50 years	20 years

*Operating costs include energy, equipment maintenance, repairs and replacement. Wages are not included**.**

****** Life cycle refers to the expected life of the major component and is based on our experience. The Freon alternate life cycle is based on the NRCAN number of 20 years for air conditioning equipment. For this report, the life cycle is reduced to 27 years to reflect the usage for industrial applications such as arenas.

In addition to the above refrigerants used, there are packaged Freon systems being promoted that offer different types refrigeration systems for ice areas. These packaged refrigeration systems are sold at a premium cost and have not been commercially installed in new rinks in Western Canada due to their high cost and their lack of support in the industry. Packaged equipment suppliers do not include the arena floor refrigeration system with their installation. This presents a procurement problem and a contract administration issue.

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Actual vs. Perceived Risks

The public perception of refrigerants has been dominated by the recent reports in the newspapers. These reports have not been accurate in their description of ammonia as a refrigerant, and have not compared ammonia to other refrigerants. The reports have not reported on the recent improvements in technology used in newer ammonia refrigeration systems. All refrigerants have similar risks.

When comparing ammonia to other refrigerants it is important to note that all refrigerants have characteristics which pose a significant risk.

The environmental impact of the Freon alternate refrigerants are significant. Freon alternate refrigerants are required to be replaced under the Montreal Protocol signed in 1986 because of their impact on ozone depletion. The current Freon alternate refrigerants are scheduled for replacement starting in 2026. The cost of typical Freon charge can be up to $18,000 depending on the refrigerant and the size of the charge.

Ammonia has similar risks as listed above as well as the pungent odour when the charge leaks. Ammonia refrigerant is mildly toxic and covered by the Worksafe Regulations under the Toxic Gas Act. The CSA Refrigeration Code also includes more stringent regulations for ammonia. These requirements include a qualified operator to be in attendance when the building is occupied. The new ammonia plant technology uses plate and frame chillers with a minimal ammonia charge when compared to the older technology. The low charge ammonia chillers plant reduces the risk of an ammonia leak. The replacement cost of an ammonia charge is $225. The weight of the low charge ammonia plant is 10 percent of the Freon alternate charge.

All new arena facilities in British Columbia have used ammonia as a refrigerant. For ice surfaces smaller than one arena, the Freon alternate is considered as viable alternative due to the smaller size of the plant.

Regulations for ammonia plants require a trained operator. The same regulations for the Freon alternate have a loophole that does not require an operator for the same size of plant, even though the equipment complexity and operation has the same complications as ammonia. With the use of ammonia refrigerant, the managed risk through regulatory controls, equipment monitoring, machine room containment, exhaust ventilation systems, operational procedures, and equipment testing and inspections, make the use of ammonia both time tested and low risk. With the new reduced charge systems, it makes the management of the ammonia refrigerant even safer than the past.

If the Freon alternate refrigerant or packaged Freon systems are selected, the rink operating staff with the District of Port Hardy would have to be retrained.

Carbon dioxide refrigerant has similar risks to the other refrigerants when used in large volumes. The heavy duty equipment for the high pressures (1,000 PSI) require an industrial style plant for this type of installation.

A dispersion model or plume study can be conducted for the selected refrigerant. This model will demonstrate the effects of a significant refrigerant leak to the outside under different weather and wind conditions. All points of refrigerant release to the outside will be modeled in this kind of study.

Conversion of Your Existing Arena to a Low Charge Ammonia System

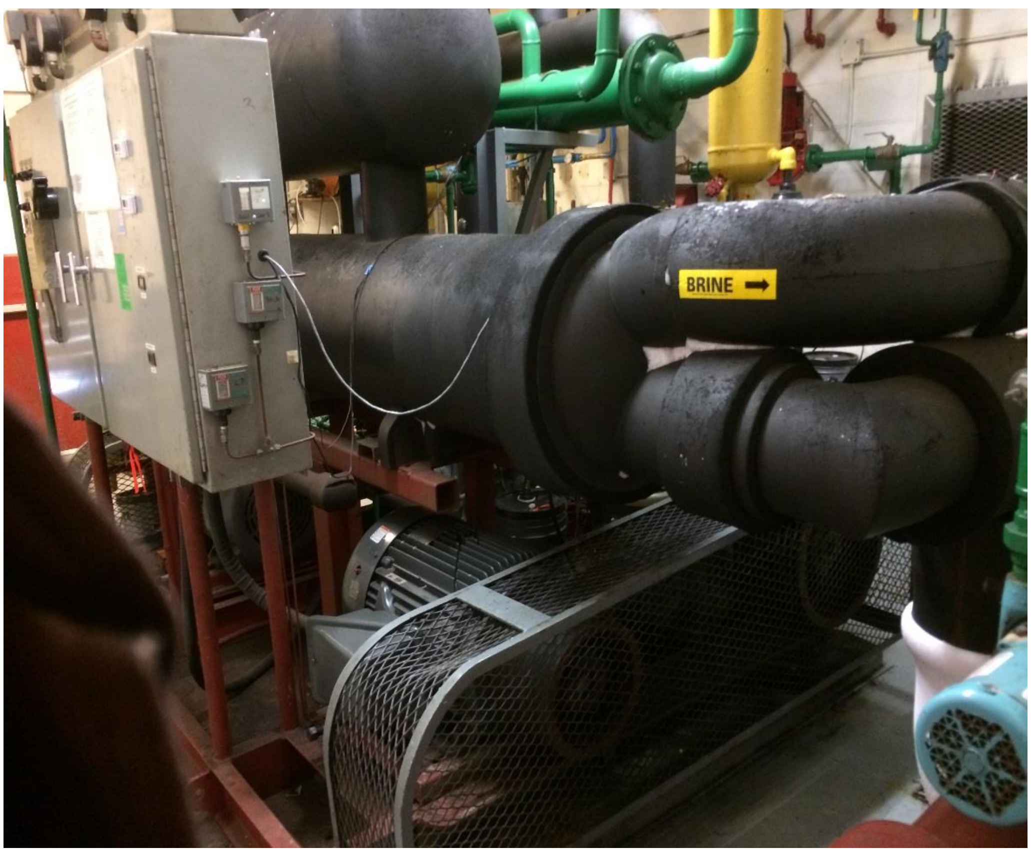
Your existing arena is equipped with an older style ammonia shell and tube chiller and evaporative condenser. This plant can be converted to a low charge system by replacing the shell and tube chiller and condenser.

The new low charge plant would be equipped with a plate and frame chiller, plate and frame condenser and a fluid cooler located outside. The existing compressors would be reused if they are in good operating condition.

All of the ammonia in the low charge plant would be contained in the refrigeration room.

The estimated cost of this conversion would be approximately $600,000. The lead time for design, tendering, and installing this equipment would be 6 to 8 months.

New Plate and Frame Chiller



Existing Shell and Tube Chiller

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Summary

This report reviews the typical refrigerants considered for a single sheet arena facility.

Freon alternate refrigerants, packaged Freon systems, carbon dioxide refrigerant and ammonia were reviewed.

Based on the information available, we are recommending that ammonia refrigerant be considered for the following reasons:

- Lower risk of a low charge system
- Lowest first cost
- Long life of the equipment
- Highest energy efficiency
- Zero impact on ozone depletion

The estimated cost of converting your existing ammonia plant to a new low charge ammonia plant is estimated at $600,000.

Eric C. Bradley, P. Eng.