ALBERTA RFP
RECREATION FACILITY PERSONNEL

PASSING the TORCH

42nd annual

Conference & Trade Show

April 7 - 10, 2019

RED DEER, ALBERTA

Who is Cimco?

- Canadian Ice Machine Company
- Around Since 1913
- Installed Over 50% Of The World's Ice Rinks
- Engineer, Design Build, Manufacture, Install & Service Ammonia, CO_2 And Any Other Refrigerant Systems

Who am I?

- Gerald Curran
- District Manager – N. Alberta, Yukon, NWT, Nunavut
- Joined The Organization in 1981
- Senior Refrigeration Instructor – AARFP

Ever Evolving

- Witness To Changing Trends Within The Components Of The Refrigeration Industry
- Changing Trends On The Use Of Refrigerants In Our Systems
- Components and Control Technology Is Now Front And Center

Are We Concerned About!

- ✓Aging Ice Facilities
- ✓Aging Plant Rooms Not Up To New Codes
- ✓Aging Mechanical Systems Operating Beyond Recommended Life Span
- ✓Increased Energy Costs
- ✓New Rules & Regulations

So, We Would Like!

- ✓Education On Options For Current And Future Considerations
- ✓Want To Make Sure We Maintain Quality Ice
- ✓Want To Be More Aware Of The Right Choices

AGING ARTIFICIAL ICE SYSTEMS

What Do We Do?

- Replace
- Retrofit
- Maintain

WHAT IS YOUR PRIORITY?

6 Considerations for Ice Plants

- ❑Safety
- ❑Efficiency
- ❑Environment
- ❑Cost
- ❑Longevity
- ❑Reliability

SAFETY

Safety

Protecting The Public, Employees And Visitors To The Facility

Factors That Influence Safety

- ❑System Age / Design
  - ❖ Life Span, 50’s Technology
- ❑Refrigerant Selection
  - ❖ Natural or Synthetic Refrigerant
- ❑Refrigerant Charge
  - ❖ Excessive Charge, Receiver

Safety

Protecting The Public, Employees And Visitors To The Facility

SAFETY

Factors That Influence Safety

- ❑ Machine Room Design
  - ❖ Does it Meet CSA B52 Code, Building Code etc.
- ❑ Ventilation and Detection Design
  - ❖ Fan on the Wall?
- ❑ Maintenance
  - ❖ Scheduled Maintenance According to the Manufacture
- ❑ Training

ICE RUNS IN OUR VEINS.

Safety

Protecting The Public, Employees And Visitors To The Facility

Factors That Influence Safety

When We Look At Our Own Facility
The Question Becomes

Is our Ice Plant Safe?

Is our Ice Plant Room Safe?

Safety

Protecting The Public, Employees And Visitors To The Facility

Dangers of Refrigerants

All Refrigerants Are Dangerous:

Synthetics (Freon, Opteon, R507, etc.) - *Displaces oxygen, flammable*

➢Leaks in confined spaces can cause suffocation

➢Damages environment

Ammonia - *Toxic, flammable*

➢Suffocation and damage to air-way

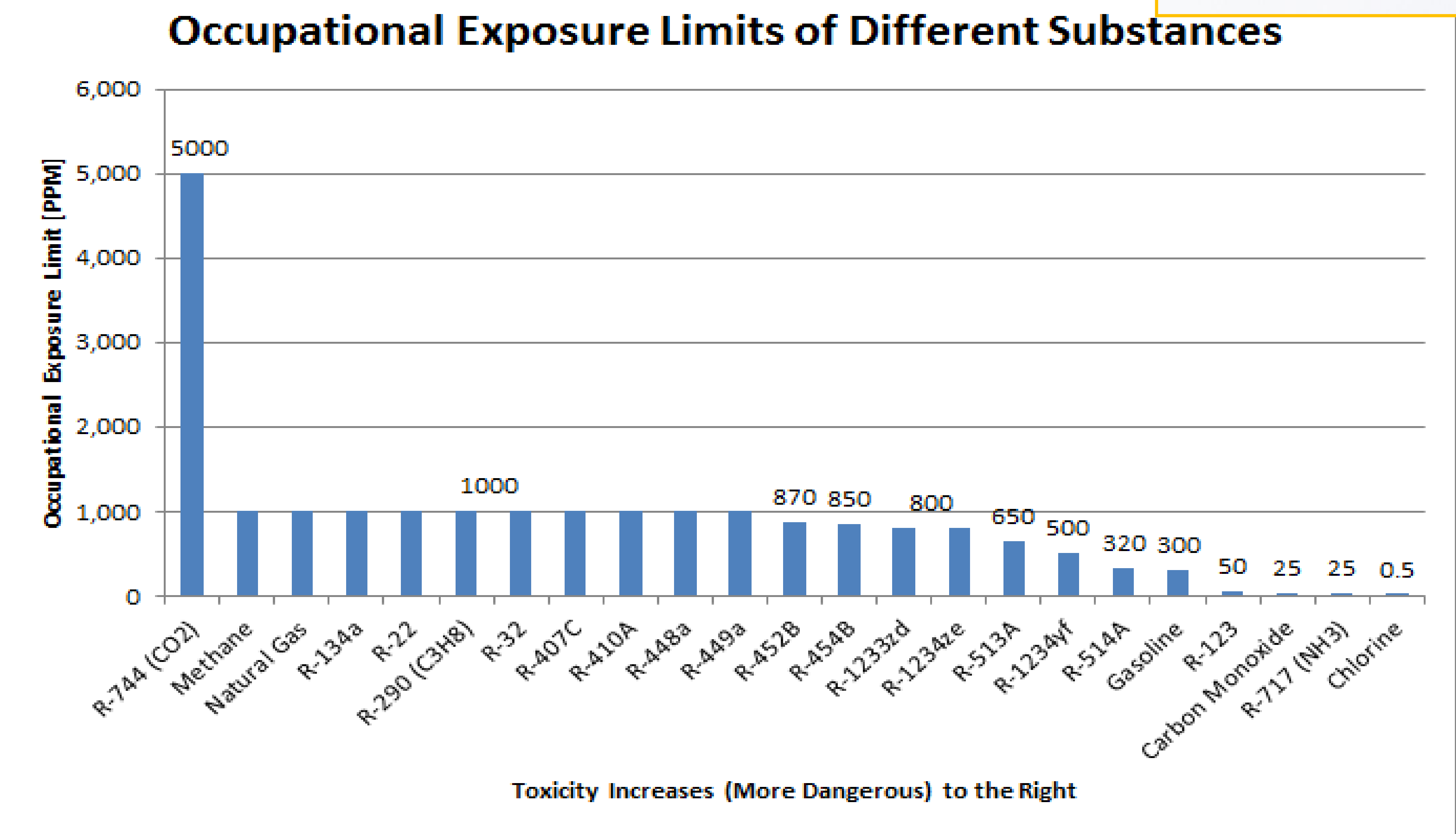
➢Chemical burns

CO2 – *Displaces oxygen*

➢At high concentrations in unventilated areas leaks can cause suffocation

Safety

Refrigerants



Safety

SAFETY

Past History

- ✓ 1991: Alaska, R22, Maintenance Manager Was Killed By Asphyxiation
- ✓ 2010: Alabama, R22, Janitorial Worker Was Found Dead, Believed To Be Due To A Refrigerant Leak
- ✓ 2017: BC, R717 (Ammonia), Three Maintenance Workers Killed During Service Work.

Reality

- ✓There Are in Excess of 5000 Ice Surfaces In North America
- ✓**Incidents Are Rare!**
- ✓With Proper Design And Maintenance, Refrigeration Facilities Are Safe

Safety

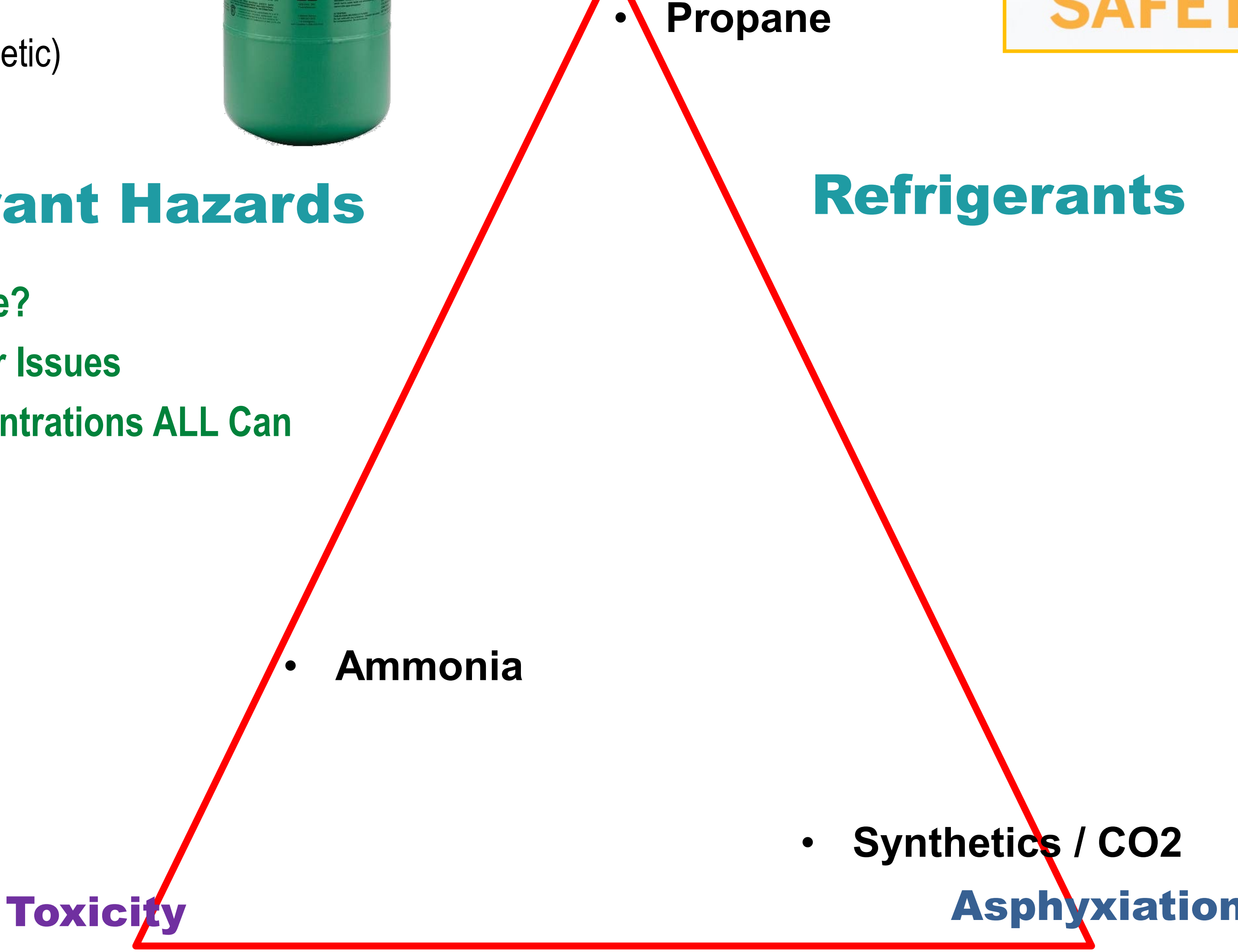
- NH_3 (Ammonia)
- CO_2
- “Freon” (Synthetic)
- Hydrocarbons

Refrigerant Hazards

- Which is safe?
- All have their Issues
- Large Concentrations ALL Can Be Fatal

Refrigerants

Flammability



Safety

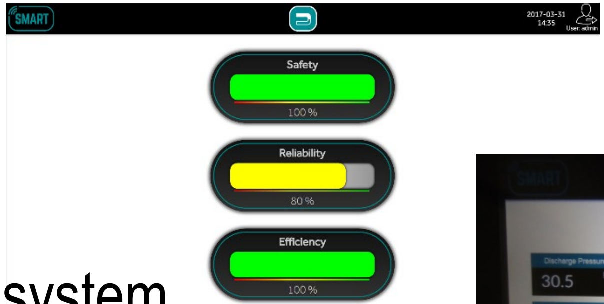
Our Machine Rooms - Are They Safe?

- ✓ Does it Meet the CSA B52-13 Code?
- ✓ Look for New Technology
- ✓ Reduced Charge
- ✓ You Should Know When Hazards Exist
- ✓ Control Hazards

Safety

Monitoring

- ✓ Know when the hazard exists
- ✓ Upgrade to a better monitoring system



Control the Hazards

- ✓ Proper Machinery Room Design
  - ➢ (Ventilation)
  - ➢ (Detection)
  - ➢ Vestibule – Making Sure All Key Safeties Are In Place
- ✓ Proper Isolation Points To Mitigate Leaks
- ✓ Preventative Maintenance Programs

ICE RUNS IN OUR VEINS.

Safety

Proper Maintenance

- ✓ Ensure You Have A Contractor You Can Trust
- ✓ Follow Manufacturer's Guidelines For Equipment
- ✓ Have A Capital Replacement Plan (Nothing Lasts Forever)

Training

- ✓ Plant Operators Have Better Training
  - ✓ Know What Not To Do
- ✓ Better Understanding Of Life Cycle Management
- ✓ Better Understanding Of Preventative Maintenance Programs
- ✓ Better Understanding Of Ice Plant Manuals
- ✓ Better Understanding Of The Supplier System Drawings

ICE RUNS IN OUR VEINS.

Safety

REDUCED REFRIGERANT CHARGE

Plate and Frame Heat Exchangers

Advantages

- Low Charge
- High Heat Transfer
- Small Footprint
- Expandable
- Maintainable
- No Cross Contamination

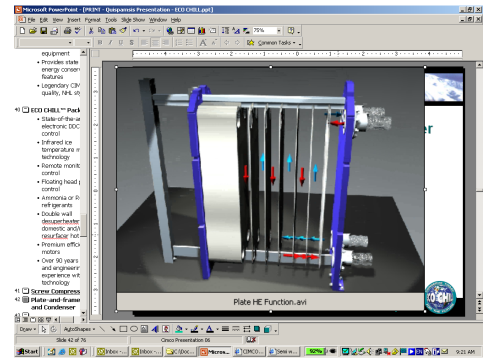
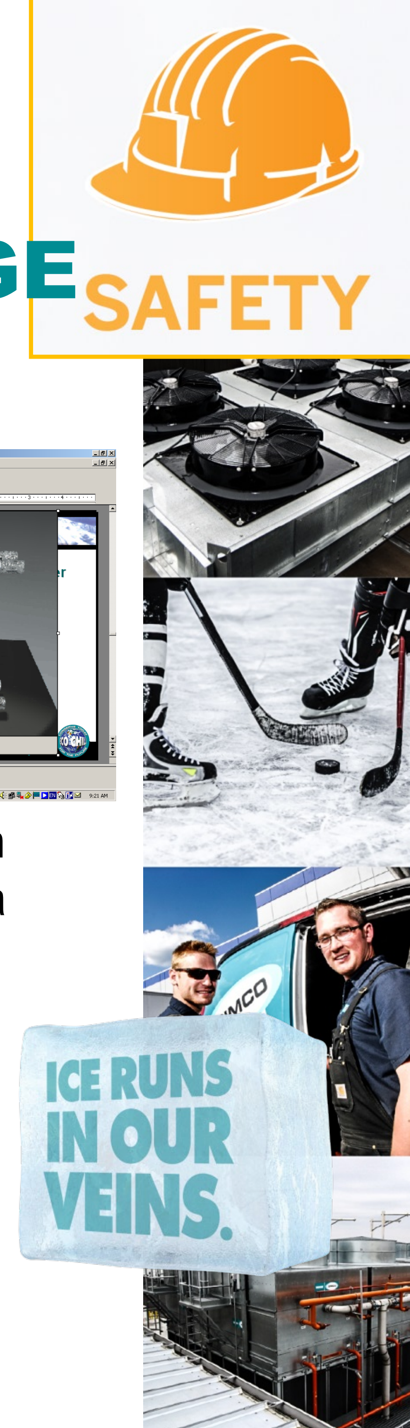


Plate And Frame Technology Was Invented In 1931, But Not Implemented In Arena Refrigeration Until The Mid 1990s.

60 Years Later!

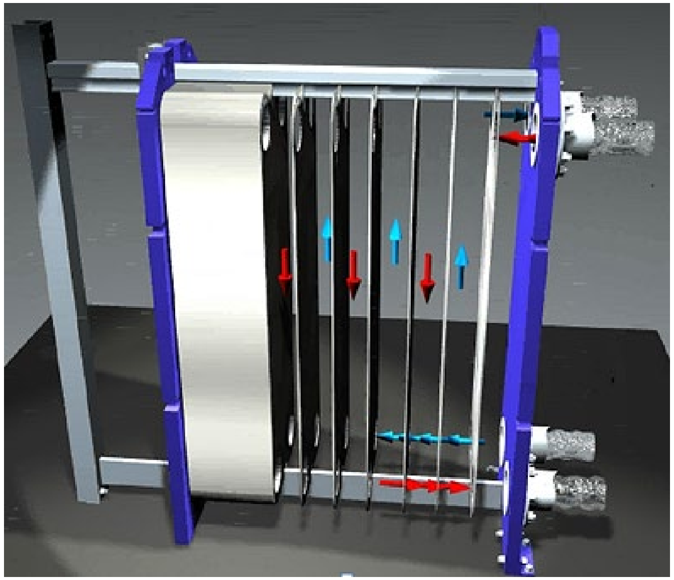
80 - 90% reduction in charge

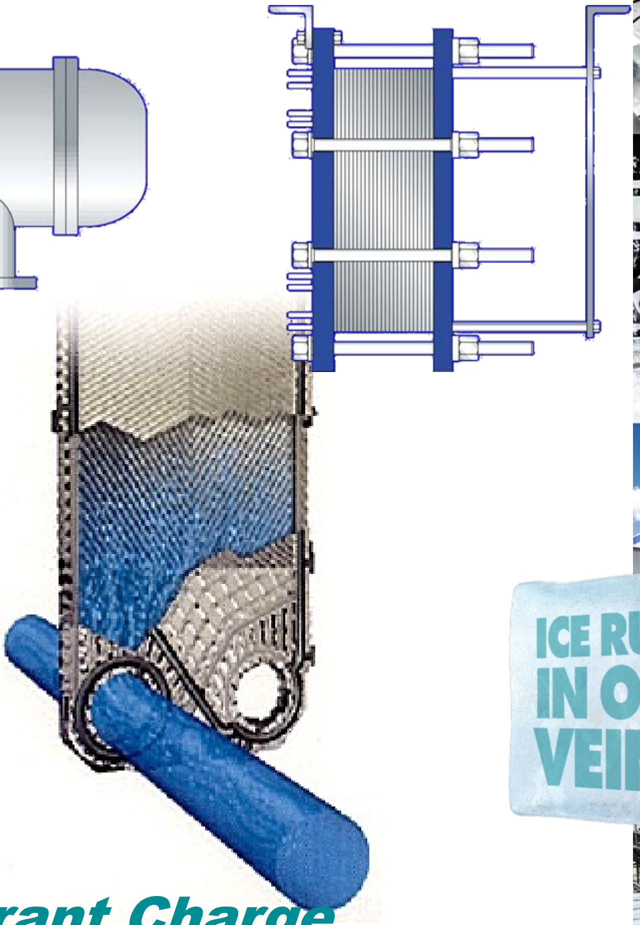
700 LBS → **65 LBS**



Safety

Movement from Shell & Tube Evaporators (Chillers) to Plate Frame Exchangers is now Normal



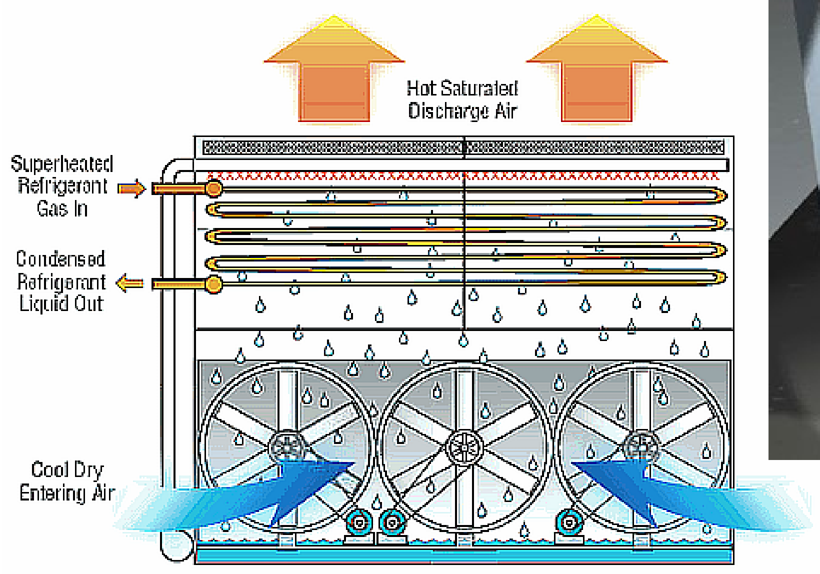


Greater Efficiency - Less Refrigerant Charge

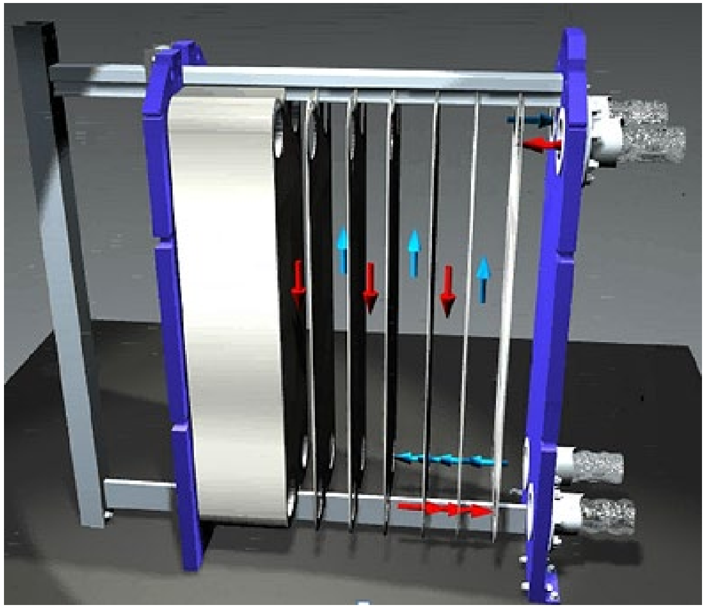
Safety

Plate and Frame Heat Exchangers

Evaporative Condensers Being Replaced by Plate & Frame Exchangers To Reduce the Refrigerant Charge



Principle of Operation

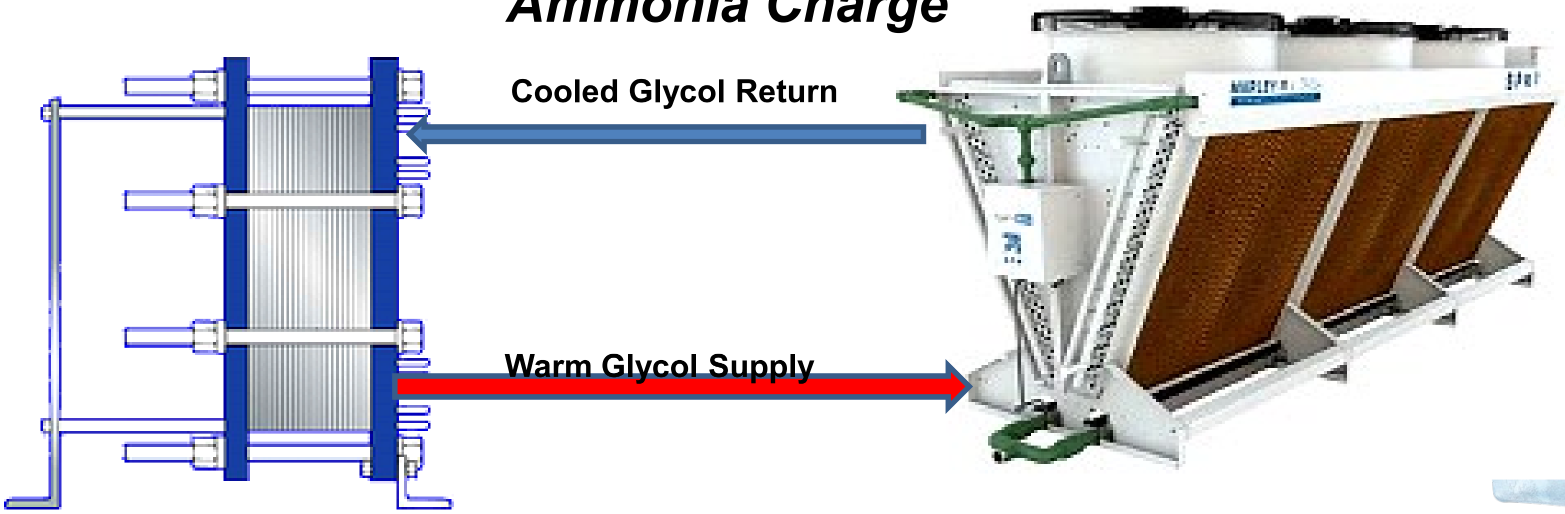


Safety

Plate and Frame Heat Exchangers

Plate & Frame Exchangers Now Work 00in Conjunction with Adiabatic Fluid Coolers

Further Reducing the Operating Ammonia Charge



Estimates of Service Lives

Published by (ASHRAE)
American Society of Heating, Refrigeration & Air Conditioning Engineers

SAFETY

Table 3 Estimates of Service Lives of Various System Components[a]

Equipment Item	Median Years	Equipment Item	Median Years	Equipment Item	Median Years
Air conditioners		Air terminals		Air-cooled condensers	20
Window unit	10	Diffusers, grilles, and registers	27	Evaporative condensers	20
Residential single or split package	15	Induction and fan-coil units	20	Insulation	
Commercial through-the-wall	15	VAV and double-duct boxes	20	Molded	20
Water-cooled package	15	Air washers	17	Blanket	24
Heat pumps		Ductwork	30	Pumps	
Residential air-to-air	15[b]	Dampers	20	Base-mounted	20
Commercial air-to-air	15	Fans		Pipe-mounted	10
Commercial water-to-air	19	Centrifugal	25	Sump and well	10
Roof-top air conditioners		Axial	20	Condensate	15
Single-zone	15	Propeller	15	Reciprocating engines	20
Multizone	15	Ventilating roof-mounted	20	Steam turbines	30
Boilers, hot water (steam)		Coils		Electric motors	18
Steel water-tube	24 (30)	DX, water, or steam	20	Motor starters	17
Steel fire-tube	25 (25)	Electric	15	Electric transformers	30
Cast iron	35 (30)	Heat exchangers		Controls	
Electric	15	Shell-and-tube	24	Pneumatic	20
Burners	21	Reciprocating compressors	20	Electric	16
Furnaces		Package chillers		Electronic	15
Gas- or oil-fired	18	Reciprocating	20	Valve actuators	
Unit heaters		Centrifugal	23	Hydraulic	15
Gas or electric	13	Absorption	23	Pneumatic	20
Hot water or steam	20	Cooling towers		Self-contained	10
Radiant heaters		Galvanized metal	20		
Electric	10	Wood	20		
Hot water or steam	25	Ceramic	34		

Notes: 1. ASHRAE makes no claims as to the *statistical* validity of any of the data presented in this table.
2. Table lists base values that should be adjusted for local conditions (see the section on Service Life).

Source: Data obtained from a survey of the United States by ASHRAE Technical Committee TC 1.8 (Akalin 1978).
[a] See Lovvorn and Hiller (1985) and Easton Consultants (1986) for further information.
[b] Data updated by TC 1.8 in 1986.

Safety *Protecting The Public, Employees And Visitors To The Facility*

Have You Created A Life Cycle Plan

Priority Rank	Equipment	Safety Risk	Business Risk	ASHRAE Life Cycle	Estimated Age	Year to Replace
	Compressor #1	Critical	Critical	20		
	Compressor #2	Critical	High	20		
	Compressor #3	Critical	Medium	20		
	Compressor #4	Critical	Medium	20		
	Chiller	Critical	Critical	24		
	Condenser	High	High	15		
	Electrical Panel	High	Medium	20		
	Controls	High	Medium	15		
	Dehumidifiers	Medium	Medium	15		
	Headers	Medium	High	25		
	Floor	Medium	High	50		

Safety *Protecting The Public, Employees And Visitors To The Facility*

SAFETY

Refrigeration Asset Report

SITE NAME: Home Town Arena
SITE ADDRESS: 123 Anywhere Street Manitoba
PLANT BUILT IN: 1974 Report Date: 20-Feb-19

The purpose of this asset report is to provide insight into the state of condition of the refrigeration equipment in your facility. Even with proper care and maintenance each component has an expected life cycle.

Capital Replacement

COMPRESSOR #1 Arena (Reciprocating)		ASHRAE Life Cycle	Existing Age	Estimated Condition	Replace	Comments	Budget Cost (2018)
Manufacture:	Mycom	20 Years	4	Excellent	2035	New Compressor In 2012 46678 Hours- Due for Overhaul 2018	$45,000.00
Model #	N4M						
Serial #	4110182						
Motor HP	75 HP Leesen						
Motor Serial#:	G 150201.00 F 365T						
Soft Starter	No						
HEAT EXCHANER Shell & Tube		**ASHRAE Life Cycle**	**Existing Age**	**Estimated Condition**	**Replace**		**Budget Cost (2018)**
Manufacture:	CIMCO	24 Years	19	GOOD	2025	Chiller was replaced In 1999 - Life expectancy Is 20-30 Years	$100,000.00
Model #	20x12-20x9						
Serial #	255490A / B						
CONDENSER Evaporative Condenser		**ASHRAE Life Cycle**	**Existing Age**	**Estimated Condition**	**Replace**	**Comments**	**Budget Cost (2018)**
Manufacture:	Evapco 2x3HP fans	15 Years	18	GOOD	2027	Replaced In 2001	$95,000.00
Model #	ATC 105B						
Serial #	W017007						
DEHUMIDIFIER #1 (Mechanical		**ASHRAE Life Cycle**	**Existing Age**	**Estimated Condition**	**Replace**	**Comments**	**Budget Cost (2018)**
Manufacture:	Blanchard Ness	15 Years	n/a	Poor	2018	Past Life Expectancy	$40,000.00
Model #	BA75G- 230/3/60						
Serial #	93040028						

Have You Created A Life Cycle Plan

Safety *Protecting The Public, Employees And Visitors To The Facility*

SAFETY

ELECTRICAL/STARTER PANELl Arena		ASHRAE Life Cycle	Existing Age	Estimated Condition	Replace	Comments	Budget Cost (2018)
Manufacture:	Celco Controls	20 Years	27	Fair	2021	Installed in 1991	$40,000.00
Model #	N/A						
Serial #	1866						
CONTROL System Arena		**ASHRAE Life Cycle**	**Existing Age**	**Estimated Condition**	**Replace**	**Comments**	**Budget Cost (2018)**
Manufacture:	Mixed	15 Years	19-Apr	Fair	2018	Combination of controls- Chronostat, Honeywell - Celco	$42,500.00
Model #	N/A						
Serial #	N/A						
BRINE PUMP (Base/Pipe Mounted) Arena		**ASHRAE Life Cycle**	**Existing Age**	**Estimated Condition**	**Replace**	**Comments**	**Budget Cost (2018)**
Manufacture:	Taco	20 Years	19	GOOD	2023	Replace in 1999 900 USGPM @52ft	$10,000.00
Motor:	WEG 20 HP						
Frame/Mofdel no.:	256T DP020504P						
Model #	FE5010						
Serial #	991544						

Have You Created A Life Cycle Plan

ICE RUNS IN OUR VEINS.

Safety *Protecting The Public, Employees And Visitors To The Facility*

SAFETY

BUSINESS RISK OF EQUIPMENT FAILURE

Number of Compressors	Business Risk
1 x Compressor No Redundancy	Critical: If failure occurs ice surface non-functional and loss in revenue. Emergency Replacement – 12 Weeks
2 x Compressors No Redundancy	High: If failure occurs will result in poor ice conditions and potential lost revenue.
2 x Compressors Full Redundancy	Medium: If failure occurs will result in increased run hours and no back up capabilities.
3 or More Compressors No Standby	Medium: If failure occurs will result in increased run hours and no back up capabilities.
3 or More Compressors One Standby	Low: If failure occurs will result in normal operating until the repairs/replacement has occurred.

Safety *Protecting The Public, Employees And Visitors To The Facility*

BUSINESS RISK OF EQUIPMENT FAILURE

Number of Chillers	Business Risk
No Redundancy	Critical: If failure occurs ice surface non-functional and loss in revenue. Emergency Replacement – 12 Weeks
Partial Redundancy	High: If failure occurs will result in poor ice conditions and increased operational issues to maintain ice.
Full Redundancy	Medium: If failure occurs will result in normal operating until the repairs/replacement has occurred.

Safety ***Protecting The Public, Employees And Visitors To The Facility***

SAFETY

BUSINESS RISK OF EQUIPMENT FAILURE

Number of Condensers	Business Risk
No Redundancy	High: If failure occurs will result in poor ice conditions and potential lost revenue. Emergency Replacement: 10 Weeks
Partial Redundancy	Medium: If failure occurs will result in operational challenges to maintain ice.
Full Redundancy	Low: If failure occurs will result in normal operating until the repairs/replacement has occurred.

Safety ***Protecting The Public, Employees And Visitors To The Facility***

SAFETY

BUSINESS RISK OF EQUIPMENT FAILURE

Electrical/Control Panels	Business Risk
No Redundancy	High: If failure occurs will result in poor ice conditions and operational issues. Repair components are usually readily available so the repair can be made in a timely manner.

Safety *Protecting The Public, Employees And Visitors To The Facility*

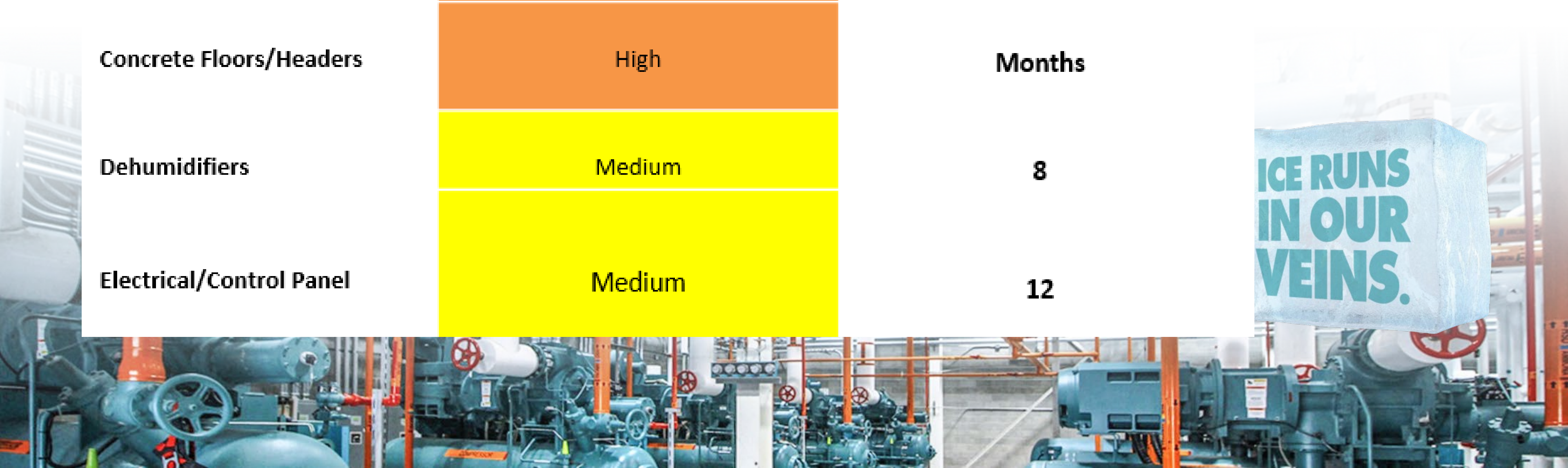
BUSINESS RISK OF EQUIPMENT FAILURE

Refrigeration Equipment	Safety Risk	Ranking
Shell & Tube Chiller	Critical	1
Reciprocating Compressors	Critical	2
Evaporative Condenser	High	3
Electrical/Control Panel	High	4
Dehumidifiers	Medium	5
Concrete Floor/Headers	Medium	6

Safety *Protecting The Public, Employees And Visitors To The Facility*

BUSINESS RISK OF EQUIPMENT FAILURE

Refrigeration Equipment	Safety Risk	Replacement (weeks)
Shell & Tube Chiller	Critical	12
Reciprocating Compressors	Critical	10
Evaporative Condenser	High	8
Concrete Floors/Headers	High	Months
Dehumidifiers	Medium	8
Electrical/Control Panel	Medium	12



Safety Summary

- ❑ Current Design Or Future Design
- ❑ Refrigerant
  - ✓ **All** Refrigerants Have Risks, Make Sure You Account For Them In Your Safety Assessment
- ❑ Design
  - ✓ Designed For Service
  - ✓ Proper Application
  - ✓ Newest Safety Features Available

Safety Summary

SAFETY

- ❑ Maintenance
  - ✓ Inspect And Monitor Equipment
  - ✓ Create A Capital Replacement Plan
  - ✓ Follow Manufactures Recommendations
  - ✓ Have A Trusted Contractor Who Will Do The Required Maintenance
- ❑ Training
  - ✓ Are We Adequately Trained
  - ✓ More Site Specific Training

Safety Summary

- ❑ CSA-B52-13 - Code Compliance Report
  - ✓ Grandfather Clause???
  - ✓ Is Your Machine Room Safe

- ❑ Refrigeration System Audit
  - ✓ Do You Really Know How Good Your Systems Components Are?
  - ✓ What Is Your Equipment's Current Lifespan
  - ✓ What is Your Risk Tolerance

AGING ARTIFICIAL ICE SYSTEMS

What Do We Do?

- Replace
- Retrofit
- Maintain

WHAT IS YOUR PRIORITY?

EFFICIENCY

Efficiency

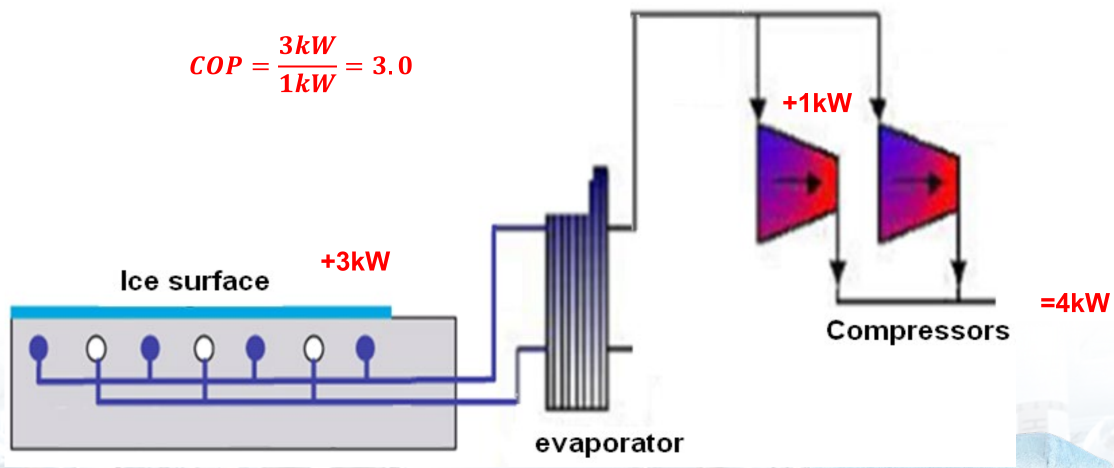
Maintaining Budgets with Rising Energy Costs

Efficiency Factors

- Design Conditions
- Refrigerant Selection
- Component Selection
- Design Type
- Heat Usage

Defining Efficiency

$$COP = \frac{3kW}{1kW} = 3.0$$

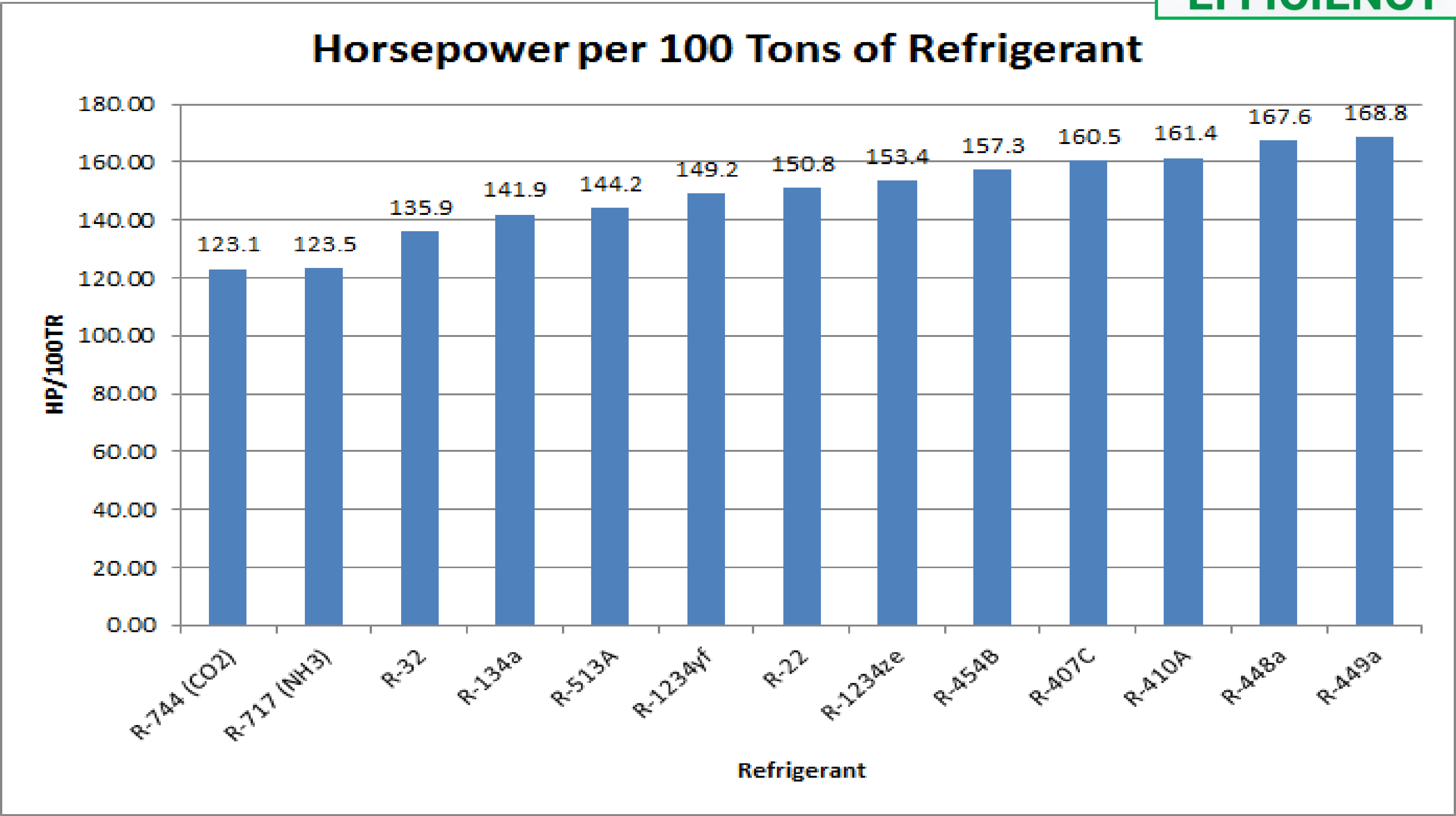


EFFICIENCY

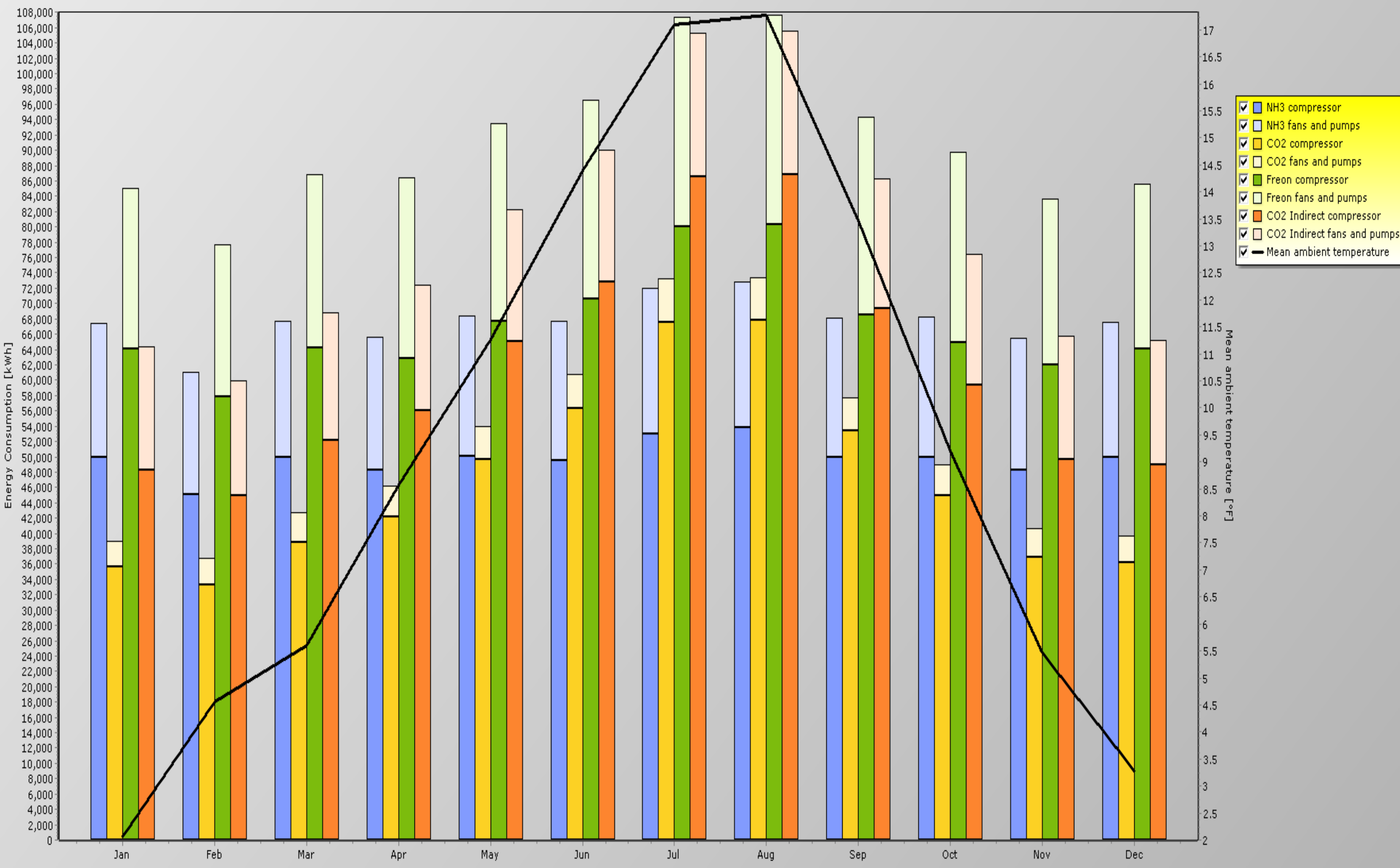
ICE RUNS IN OUR VEINS.

Refrigerant Selection

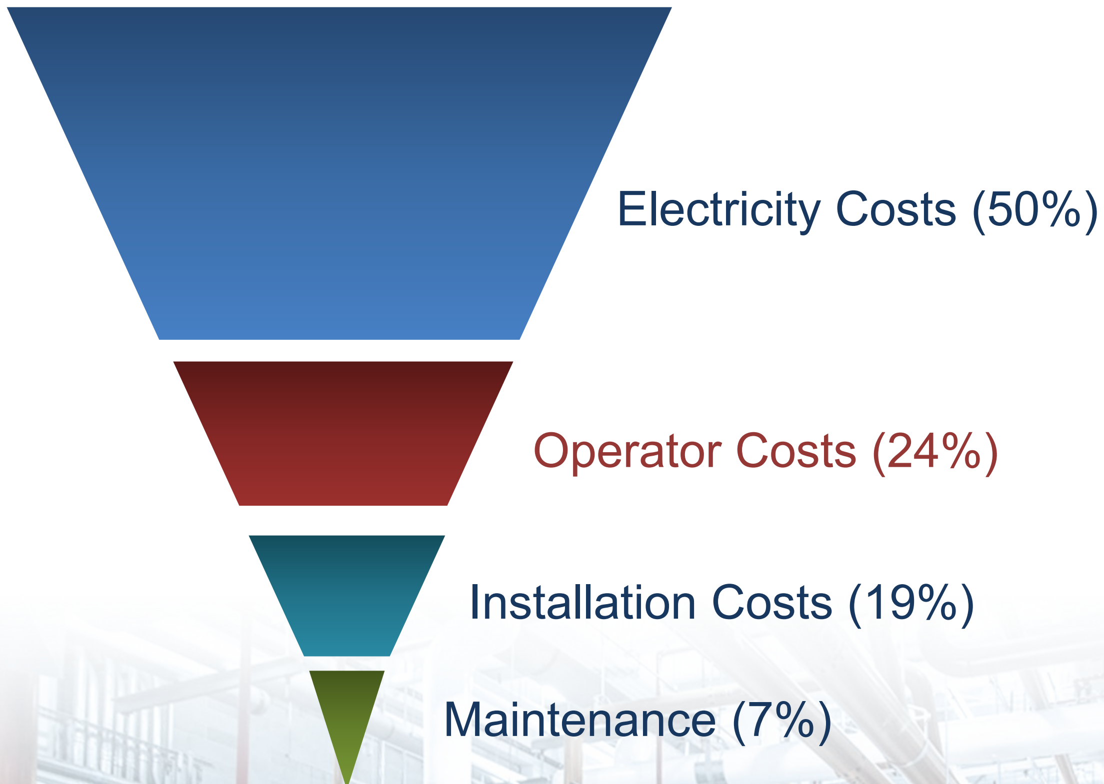
EFFICIENCY



Refrigerant Selection

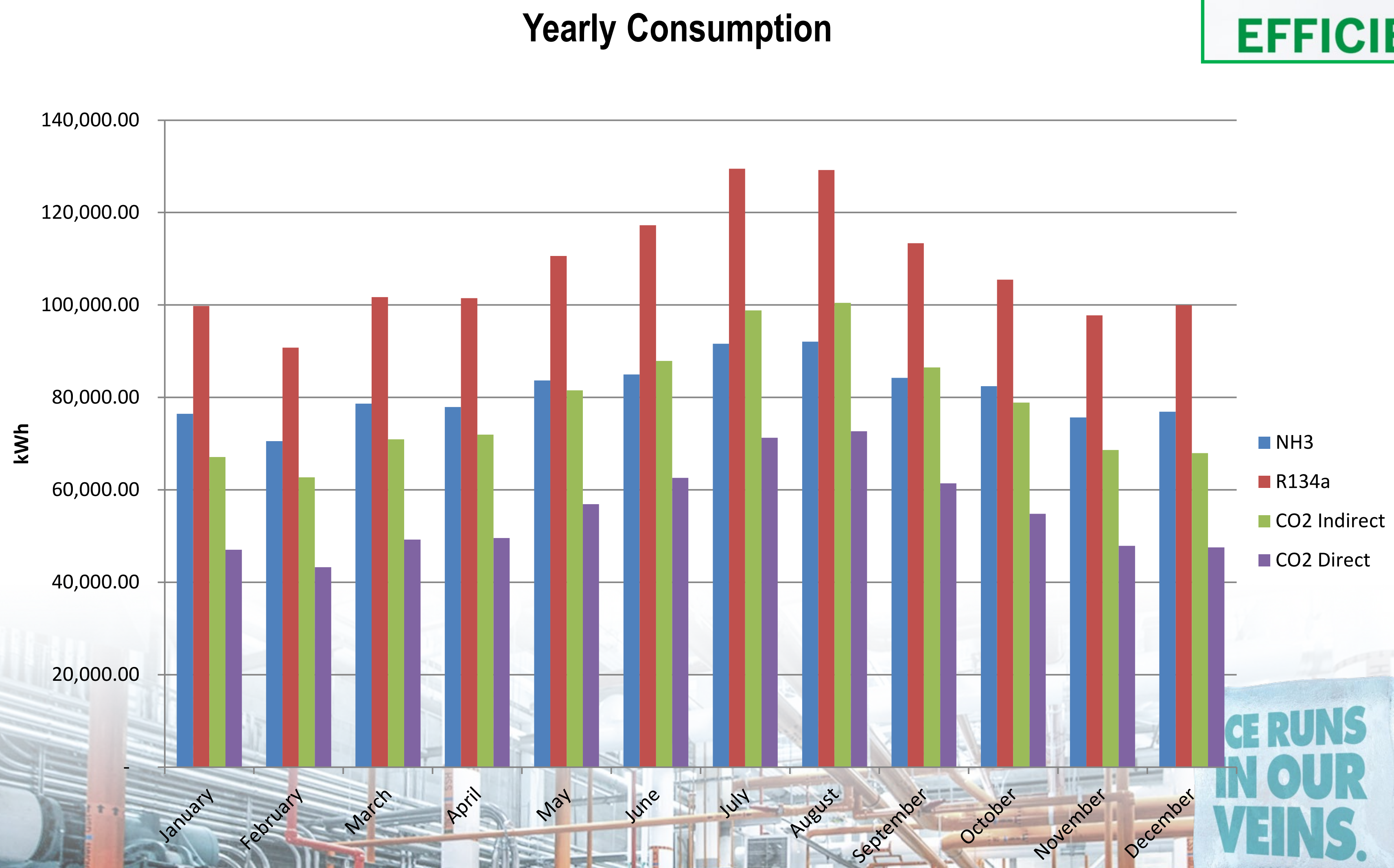


What To Consider?

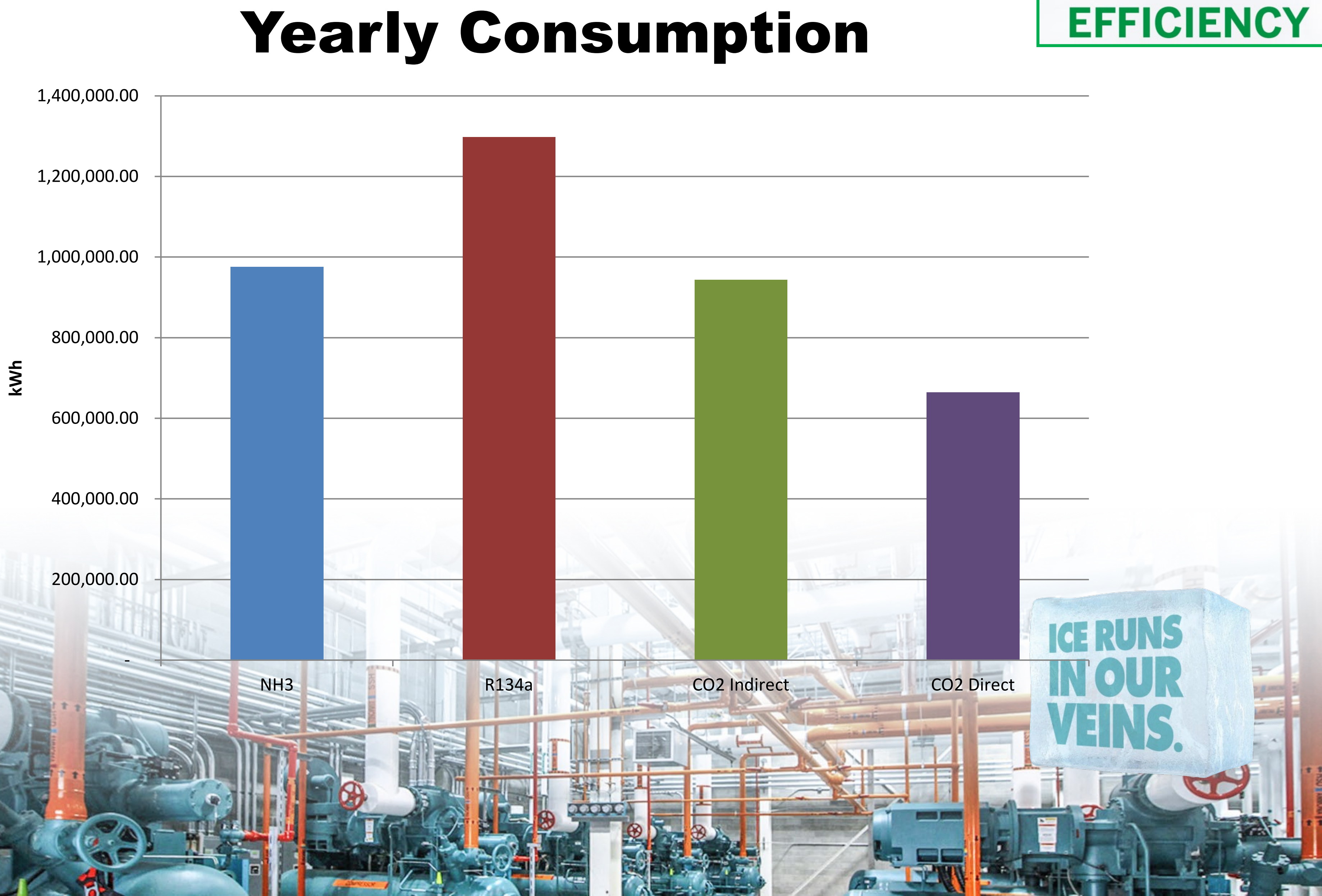


Refrigerant Selection

EFFICIENCY



Refrigerant Selection



Refrigerant Selection

R-22 Retrofit

R-448A - Honeywell **R-449A - Chemours**

- Either have very similar performance characteristics at rink conditions and there is no real difference between them
- Require POE lubricant for the compressors.
- Only suitable for use in DX type evaporator
- Expect about a 10-12% performance decrease with these refrigerants based on selection using DEW and BUBBLE point temperatures in the evaporator and condenser respectively.

Equipment Selection

- Refrigeration (High Differential)
- Air Conditioning(Low Differential)
- Refrigeration(Subcritical/Transcritical)
- Air Cooled / Water Cooled
- Reciprocating Compressors
- Screw Compressors

EFFICIENCY

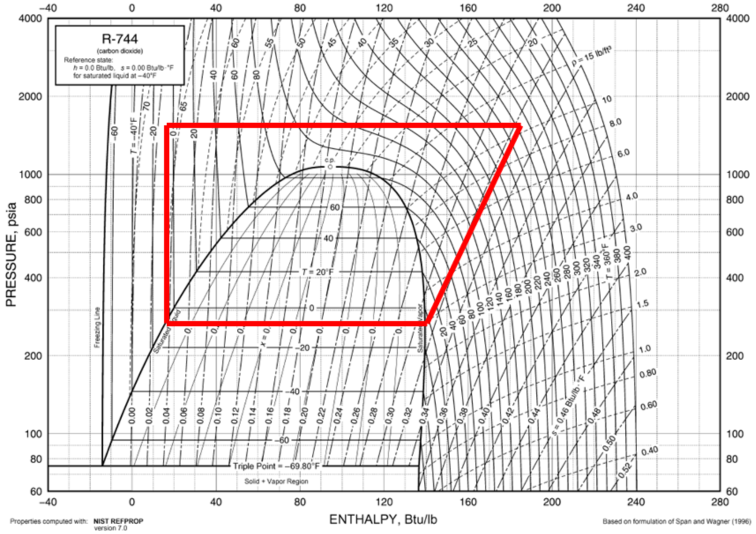
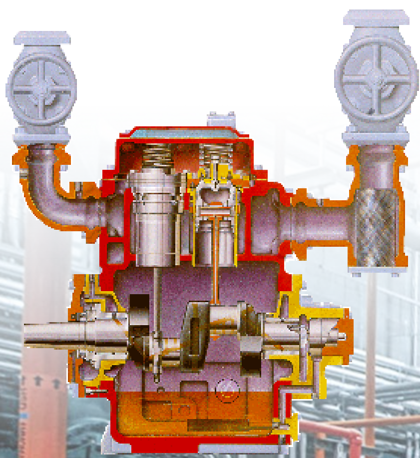
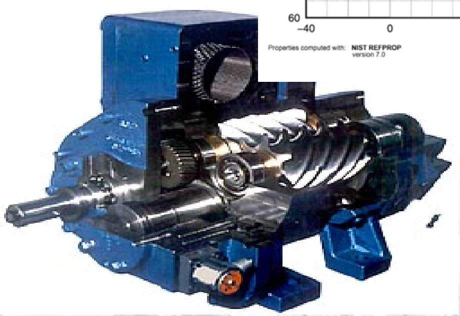


Fig. 18 Pressure-Enthalpy Diagram for Refrigerant 744 (Carbon Dioxide)

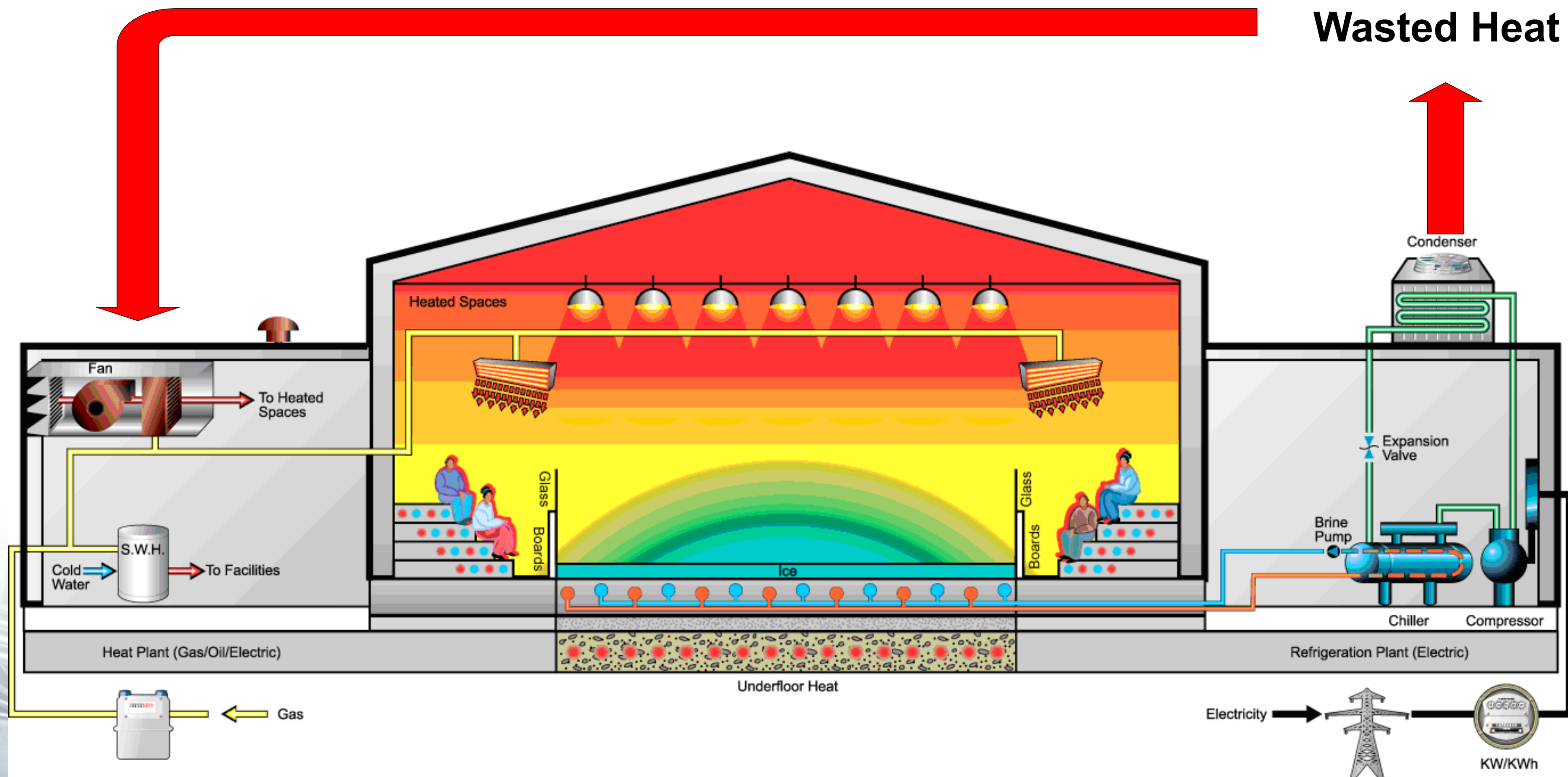




ICE RUNS IN OUR VEINS.

Heat Reclaim

EFFICIENCY



WASTE HEAT PRODUCED BY THE REFRIGERATION SYSTEM

EFFICIENCY

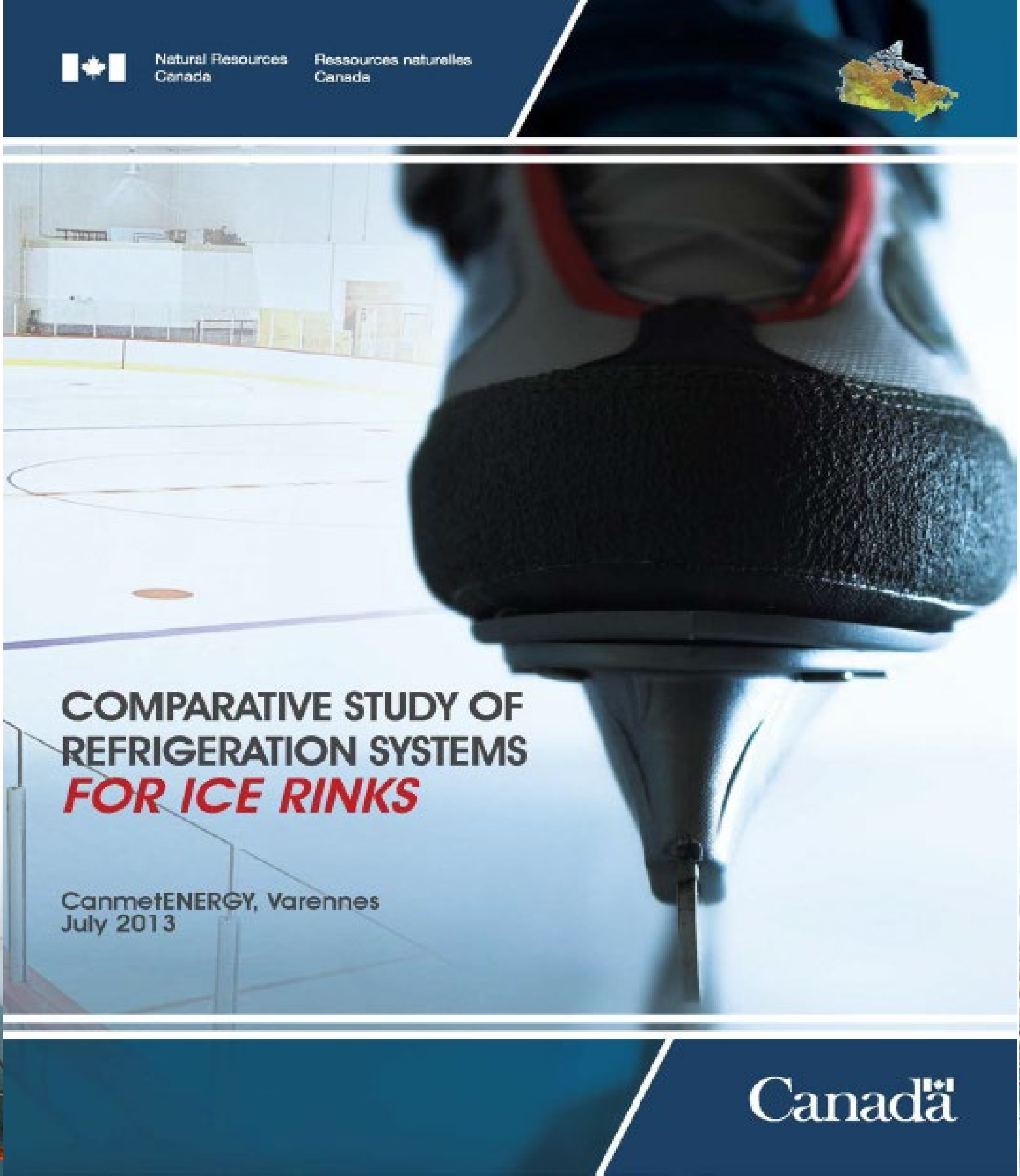
A Typical 100 Ton Artificial Ice System Will Produce The Following Waste Heat; Heat That Is Available For Heat Reclaim

Refrigeration Capacity (100 Tr. = 1,200,000 Btuh)

Electrical Input (150 Hp = 2545 X 150 = 381,750 Btuh)

Total Waste Heat Available = ***1,581,750 Btuh***

- ✓ ***A Typical Home Requires A 80,000 Btu/Hr Furnace***
- ✓ ***The Waste Heat Could Heat 20 Homes All Winter***


Natural Resources Canada
Ressources naturelles Canada
COMPARATIVE STUDY OF REFRIGERATION SYSTEMS
FOR ICE RINKS
CanmetENERGY, Varennes
July 2013
Canada


EFFICIENCY


ICE RUNS
IN OUR
VEINS.

Plant Options (Canmet)

EFFICIENCY

Table 12: Energy Consumption of Refrigeration Systems

Case	Assembly Type	Refrigerant	Compressors	Slab Pump	Heat rejection equipment	Total	Variation
Unit			kWh/year	kWh/ year	kWh/year	kWh/year	%
A1	Packaged	R717	279,200	73,300	54,500	407,000	6
A2	On site	R717	245,000	73,300	65,000	383,400	0
A3	On site	R717	267,800	122,200	63,600	453,600	18
A4	Packaged	R717	264,000	73,300	74,900	412,200	8
A5	Packaged	R717	298,500	73,300	74,600	446,400	16
C1	Split-packaged	R744	263,400	14,700	13,000	291,100	-24
C2	Split-packaged	R744	281,200	73,300	19,900	374,500	-2
H1	**On site**	**HCFC R22**	**411,900**	**122,200**	**16,100**	**550,200**	**44**
H2	Packaged	HFC R507A	368,800	73,300	26,200	468,400	22
H3	Modular	HFC R410A	465,300	36,200	53,100	554,600	45
H4	Modular	HFC R507A	323,900	97,800	63,900	485,500	27
H5	Packaged	HFC R134A	339,300	73,300	106,000	518,600	35

- The C1 refrigeration system using CO_2 consumes less energy, 18% less than Unit A2. This is mostly due to the CO_2 directly recirculating in the rink slab.
- Unit C2 that is CO_2–based uses a secondary fluid in the rink slab and is a more realistic comparison to ammonia systems.

EFFICIENCY

Efficiency Summary

- **Refrigerant Selection**
  - Select the correct refrigerant for your application and conditions
- **Design**
  - Select appropriate equipment
  - Use equipment that was designed for the application
  - Integrate heat reclaim when possible
- **Ongoing Improvement**
  - Monitor energy consumption to ensure equipment is working properly
  - Implement technologies when possible which can save money over the long term

ENVIRONMENT

Environmental

Protecting the Future

ENVIRONMENT

Environmental Agreements

Agreement	Date	Target
Montreal Protocol	1987	Ozone Depletion
Paris Accord	2016	Mitigate Global Warming
Kigali Agreement	2016	HFC Use/Production

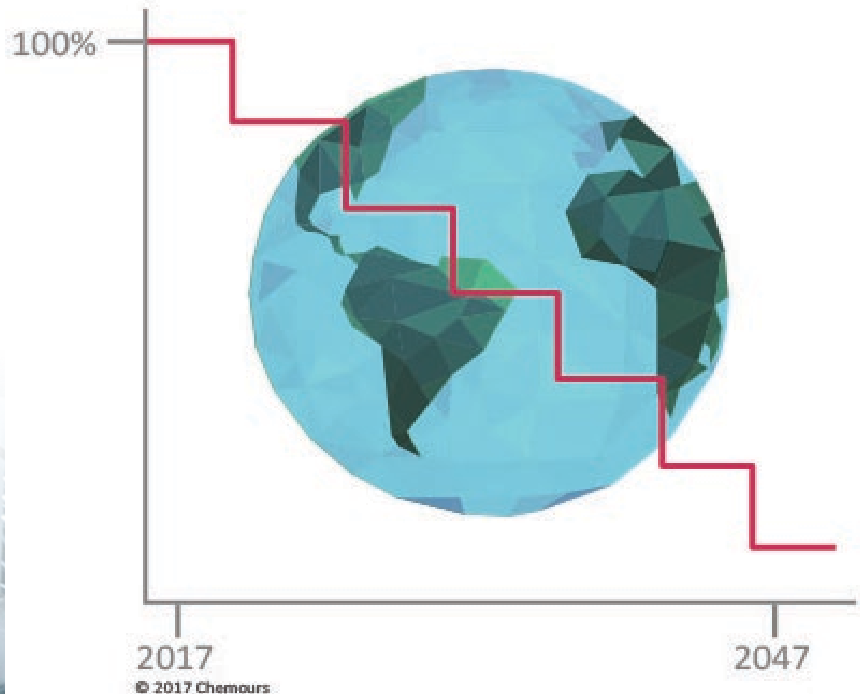
Environmental

Protecting the Future

ENVIRONMENT

Environmental Agreements

Global CO2 Emissions



HFC Phase-down Not a Phase-Out But May be Charged Based On GWP Potential

Takes effect end of 2019 when at least 20 member countries ratify

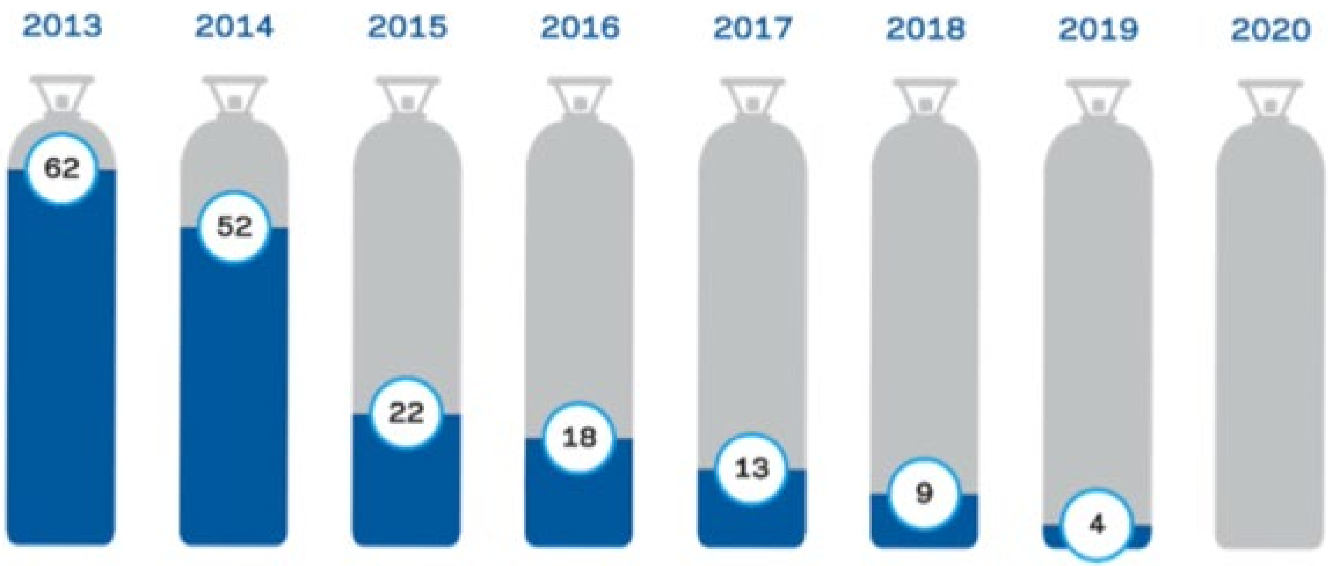
Businesses should start planning now for a low-GWP future.

Kigali has created a framework for regulatory bodies to address global warming

Environmental

ENVIRONMENT

R-22 Phaseout (Montreal Protocol)



R-22 Production (million lbs)

ICE RUNS IN OUR VEINS.

Environmental

ENVIRONMENT

Timeline of Refrigerant Technologies

1800s-1920s	1930s	1950s	1990s	Today
Industrial Chemicals	**CFCs** (R-12)	**HCFCs** (R-22)	**HFCs** (R-134a)	**HFOs and HFO Blends**
Methyl Chloride, Sulfur Dioxide, Ammonia, etc.	Chlorine Single Bond	Less Chlorine Single Bond	No Chlorine Single Bond	No Chlorine; Double Bond
Toxic Flammable	**High ODP Highest GWP**	**Lower ODP High GWP**	**No ODP High GWP**	**No ODP Low GWP**

ENVIRONMENT

New Regulations

Stand-Alone Medium Temperature Systems (Self-contained Systems)
Maintaining product temperatures above 0 Celsius
January 1, 2020 **>650 GWP**

Stand-Alone Low Temperature Systems (Self-contained Systems)
Maintaining product temperatures from 0 Celsius to above -50 Celsius
January 1, 2020 **>1500 GWP**

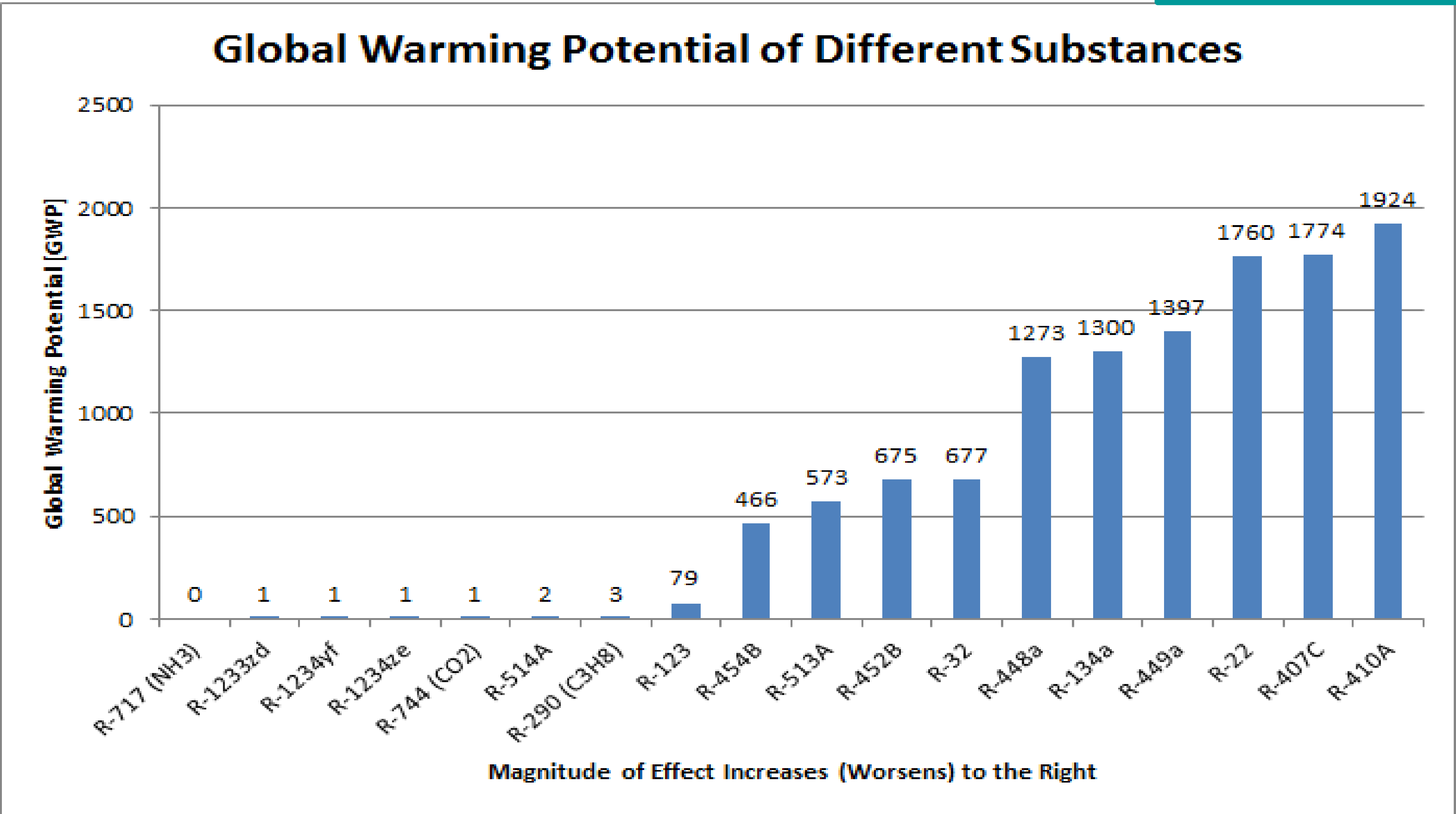
Centralized Refrigeration Systems (Parallel Racks, Condensing Units)
January 1, 2020 **>1500 GWP**

Chillers For Air-Conditioning
January 1, 2025 **>700 GWP**

Domestic Refrigeration
January 1, 2025 **>150 GWP**

Mobile Refrigeration Systems
January 1, 2025 **>2200 GWP**

ENVIRONMENT



ENVIRONMENT

Product information (sorted by Product Type and Name)

Type	Product R- Number	ODP[1]		GWP[2]	
CFC	12	1	High	10900	High
	502	0,33	High	4657	High
HCFC	22	0,055	Medium	1810	Medium
	123	0,060	Medium	77	Low
	401A	0,033	Medium	1182	Medium
	401B	0,036	Medium	1288	Medium
	402A	0,019	Medium	2788	High
	402B	0,030	Medium	2416	Medium
	408A	0,024	Medium	3152	High
	409A	0,046	Medium	1909	Medium
HFC	23	0	Zero	14800	High
	32	0	Zero	675	Medium
	134a	0	Zero	1430	Medium
	404A	0	Zero	3922	High
HFO	1234yf	0	Zero	4	Low
	1234ze	0	Zero	6	Low
Natural/Not in Kind	170	0	Zero	6	Low
	290	0	Zero	3	Low
	600a	0	Zero	3	Low
	717	0	Zero	0	Zero
	744	0	Zero	1	Low
	1150	0	Zero	4	Low
	1270	0	Zero	2	Low

Refrigerant Choice

ENVIRONMENT

Table 4: Main Refrigerants and Their Environmental Impacts

REFRIGERANT	COMPONENTS	GWP(1)	ODP(2)
R-717	**Ammonia**	**0**	**0**
R-744	Carbon dioxide (CO_2)	1	0
~~CFC-R11~~	~~Pure~~	~~3800~~	~~1.0~~
~~CFC-R12~~	~~Pure~~	~~8100~~	~~1.0~~
~~**HCFC-R22**~~	~~**Pure**~~	~~**1810**~~	~~**0.055**~~
~~HCFC-R123~~	~~Pure~~	~~76~~	~~0.012~~
~~HFC-R134A~~	~~Pure~~	~~1430~~	~~0~~
~~HFC-R404A~~	~~R-125 /143A/134A~~	~~3900~~	~~0~~
~~HFC-R407A~~	~~R-32/125/134A~~	~~2100~~	~~0~~
~~HFC-R407C~~	~~R-32/125/134A~~	~~1800~~	~~0~~
~~HFC-R410A~~	~~R-32/125~~	~~1725~~	~~0~~
~~HFC-R417A~~	~~R-125/134A/600~~	~~2300~~	~~0~~
~~HFC-R422A~~	~~R-125/134A/600A~~	~~3100~~	~~0~~
~~HFC-R422d~~	~~R-125/134A/600A~~	~~2700~~	~~0~~
~~HFC-R427A~~	~~R-32/125/143A/134A~~	~~2100~~	~~0~~
~~HFC-R507A~~	~~R-125 /143A~~	~~4000~~	~~0~~

Legend:
Bold font = frequently used in ice rinks
(1) GWP: Global-warming potential
(2) ODP: Ozone depletion potential
Source: ASHRAE Handbook Fundamentals 2009, Refrigerants

Opteon XP10 (R 513A)

ENVIRONMENT

GWP

Flammability

HFCs are going away and in fact are already seeing a shrinking marketplace both in the European Union and in North America.

ENVIRONMENT

CHEMOURS HFO Refrigerants

- Opteon™ YF (HFO-1234yf):
- Opteon™ XP10 (R-513A)
- Opteon™ XP40 (R-449A)
- Opteon™ XP44 (R-452A):
- Opteon™ XL55 (R-452B):
- Opteon™ XP30 (R-514A):

HONEYWELL HFO Refrigerants

- Solstice L40X (R-455A)
- Solstice YF (R-1234yf)
- Solstice zd (R-1233zd)
- Solstice ze (R-1234ze)
- Solstice N13 (R-450A)
- Solstice N40 (R-448A)

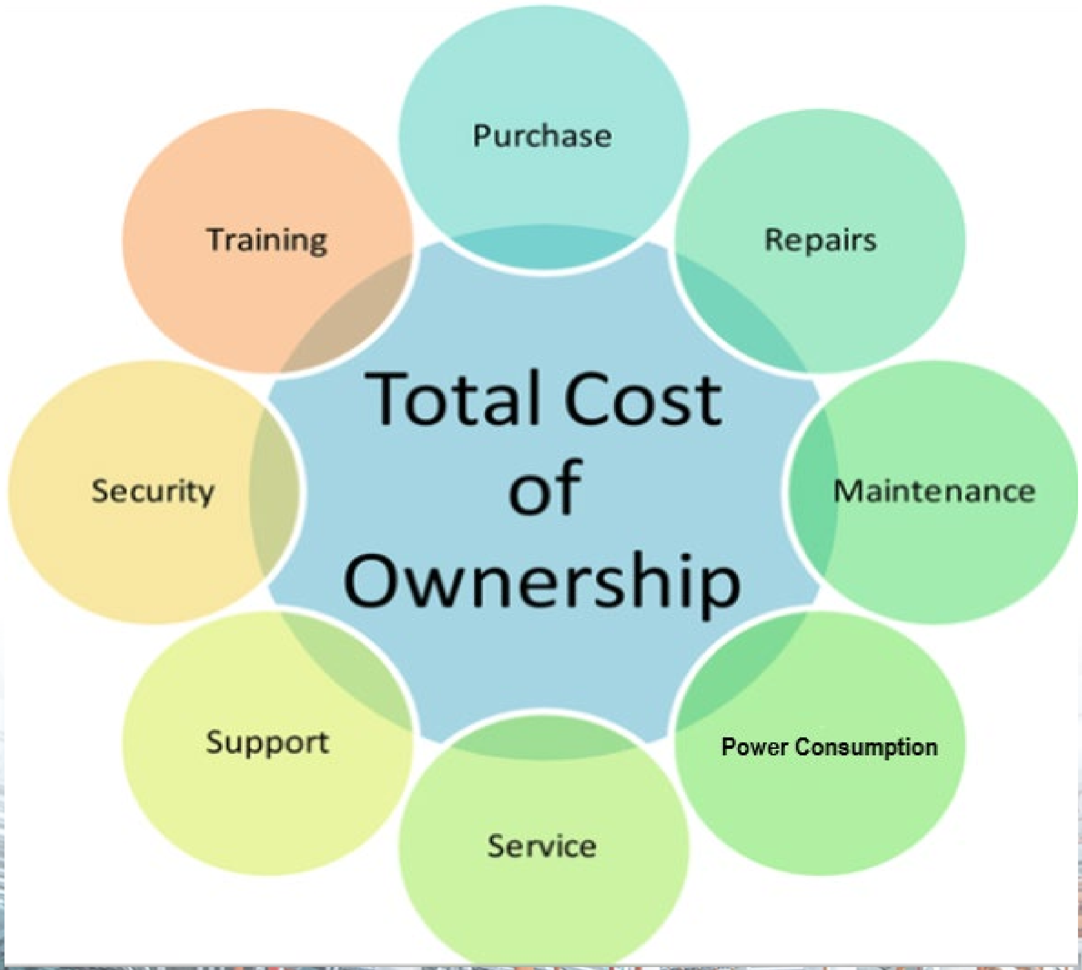
COST

?

COST ?

?

Cost of Ownership

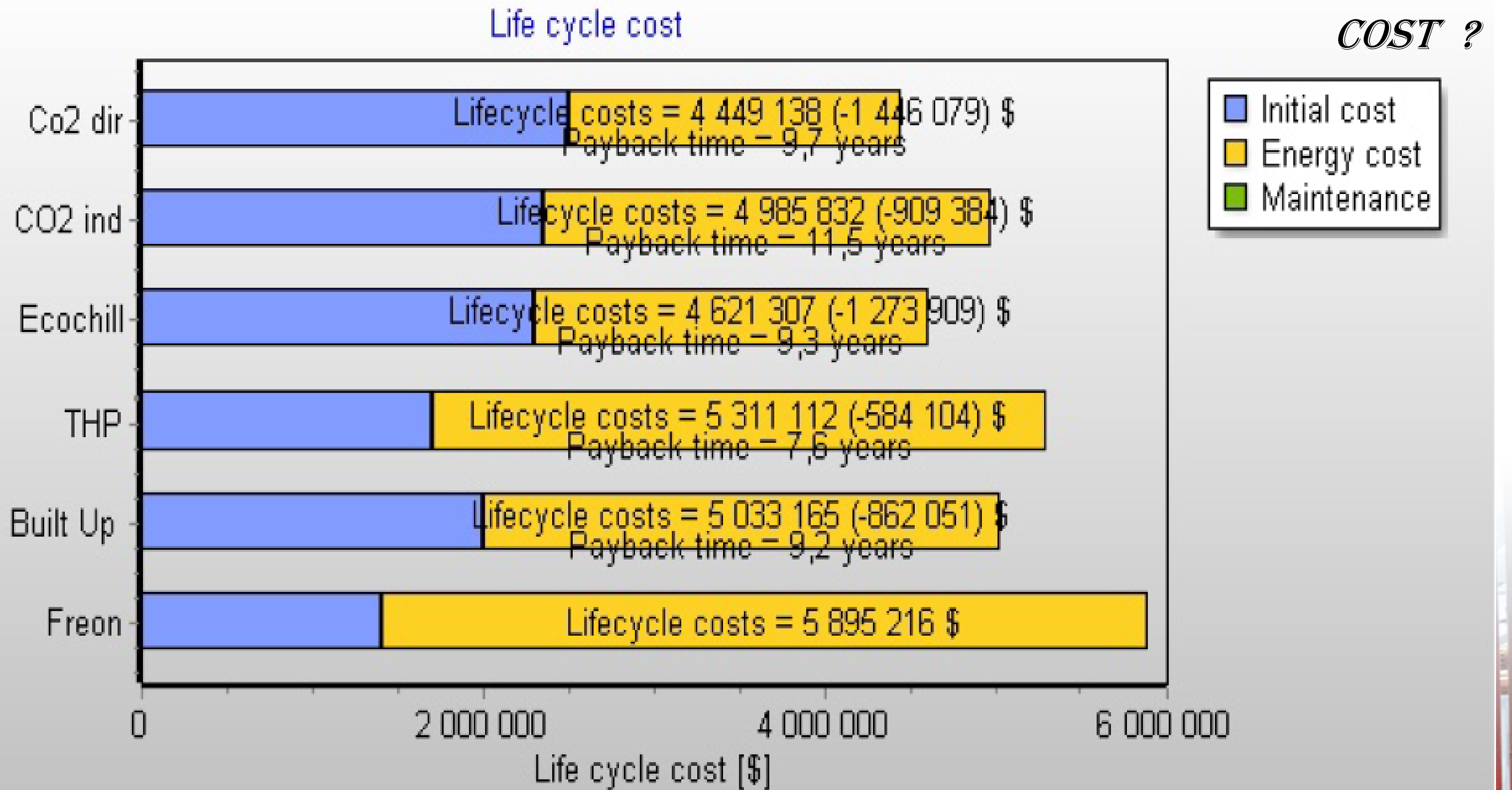


Cost of Ownership

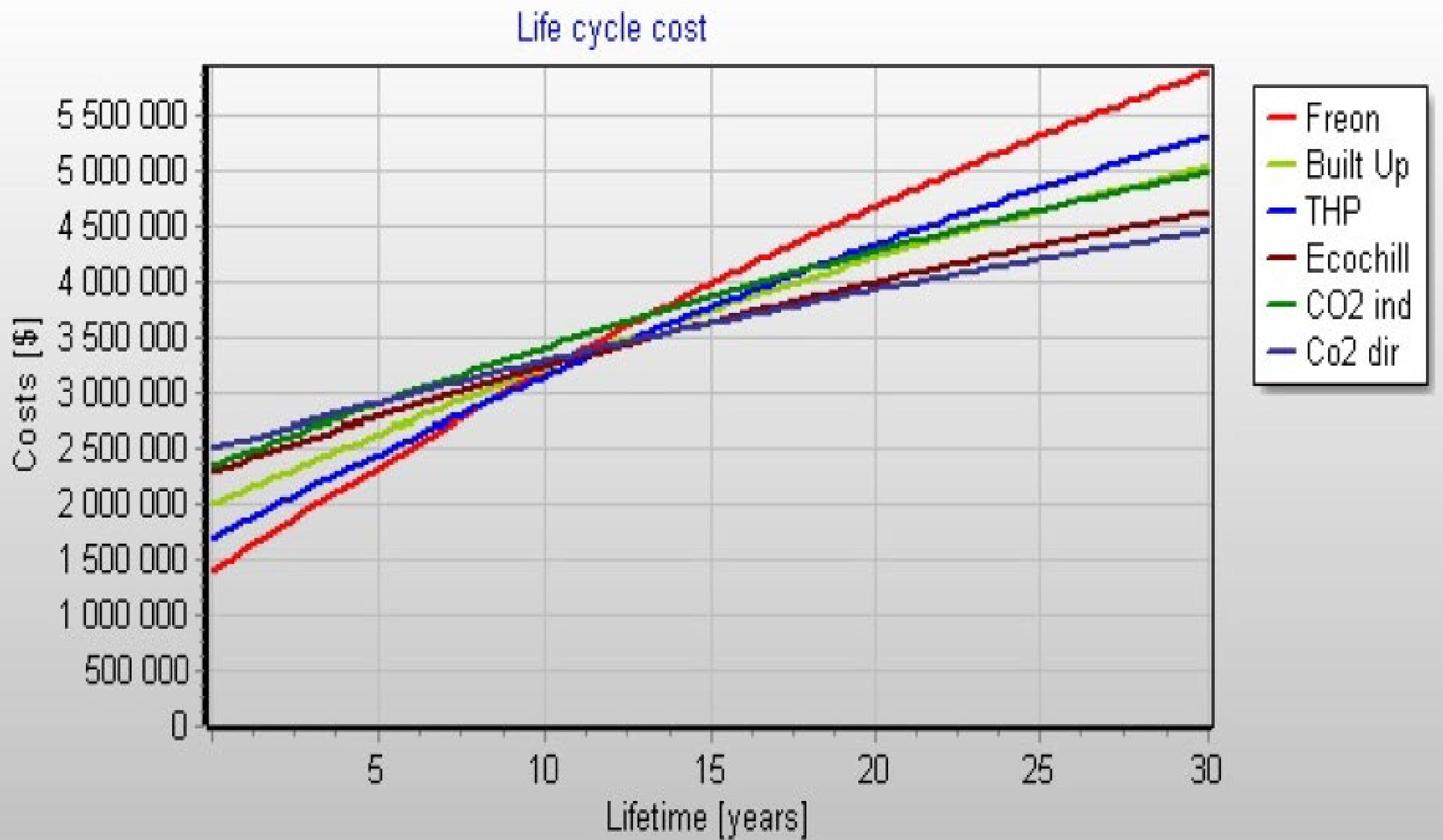
Component Selection Is Important

- Type of Compression
- Type of Condensing Unit
- Type of Evaporation Unit
- Type of Refrigerant
- Horsepower per Ton
- Heat Reclaim
- Based on TIME OF PURCHASE TO GRAVE

Cost of Ownership



Cost of Ownership

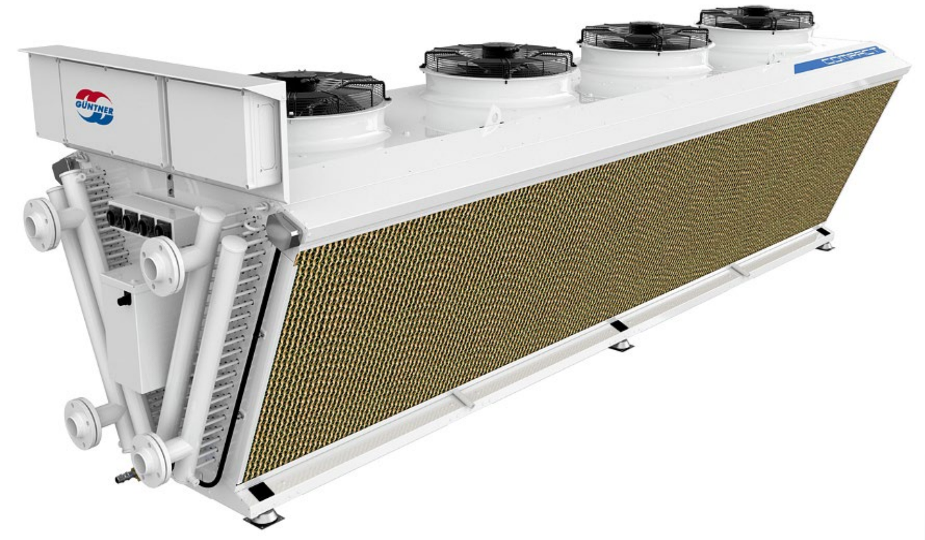


Reliability

Keeping the ice and Maintaining the Ice – NHL Quality

Redundancy

Construction



Reliability – The Right Tool

COMPRESSION

Hermetic

- No Maintenance
- No Rebuild
- Short Life

Open Reciprocating

- Maintenance
- Rebuild
- Lasts almost indefinitely

Open / Packaged Screw

- Maintenance
- Rebuild
- Lasts a lot longer between rebuilds

Reliability – The Right Tool

CONDENSATION

Induced Draft Evap. Condensers

- High Maintenance
- Scale Problems
- Short Life

Forced Air Evap Condenser

- High Maintenance
- Scale Problems
- Leaks

Adiabatic Fluid Cooler Or Condenser

- Low Maintenance
- No Scale / Ice Build Up
- No Remote Sump System

ICE RUNS IN OUR VEINS.

Reliability – The Right Tool

EVAPORIZATION

Shell & Tube Chiller

- High Maintenance
- Carbon Steel Tubes
- Mid Efficient
- Large Refrigerant Charge

Plate & Frame

- Low Maintenance
- Stainless Steel or Titanium
- Lasts almost indefinitely
- Replaceable Gaskets
- Low Refrigerant Charge

Reliability – The Right Tool

Commercial Style

Industrial Style

AGING ARTIFICIAL ICE SYSTEMS

What Do We Do?

- Replace
- Retrofit
- Maintain

WHAT IS OUR PRIORITY?

Replace

Replacement

Advantages:

- ✓ Brand new plant
- ✓ Complete Warranty
- ✓ Take advantage of new technologies

Disadvantages:

- Equipment Costs
- May require building changes
- Building Costs…

Replace

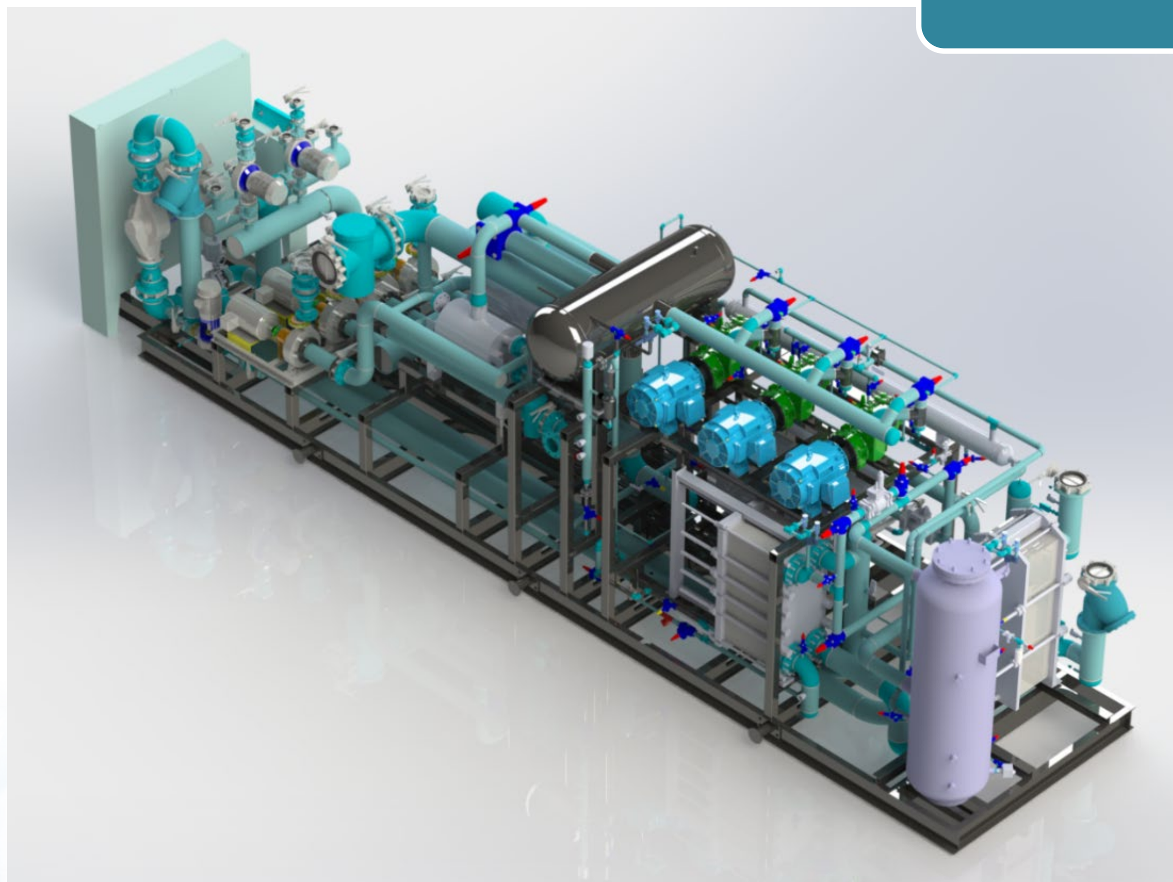
Replacement Outside Stand Alone

- ✓ Lowest Cost
- ✓ Commercial Grade
- ✓ Adapted for Rink Conditions
- ✓ Synthetic Refrigerant
- ✓ High Energy Usage
- ✓ Low Lifespan

Replacement

Replace

- ✓NH_3 Refrigerant
- ✓Industrial Grade
- ✓Engineered For Rink Conditions
- ✓Low Charge
- ✓Smart Connected



Replacement – Heat Reclaim

Replace

- ✓Any Refrigerant
- ✓Industrial Grade
- ✓Engineered For Rink Conditions
- ✓Low Charge
- ✓Inherent Heat Reclaim

Replacement – CO2 System

Replace

- ✓CO_2 Refrigerant
- ✓Industrial Grade
- ✓Engineered For Rink Conditions
- ✓Direct Floor or
- ✓Indirect (Glycol / Brine)
- ✓Available Heat Reclaim

CO_2

ICE RUNS IN OUR VEINS.

Retrofit

✓Make use of existing infrastructure

✓Like for Like

Retrofit

Advantages:

- ✓ Reduced costs
- ✓ Take advantage of existing equipment
- ✓ Can take advantage of a lot of new tech
- ✓ Can do piece by piece

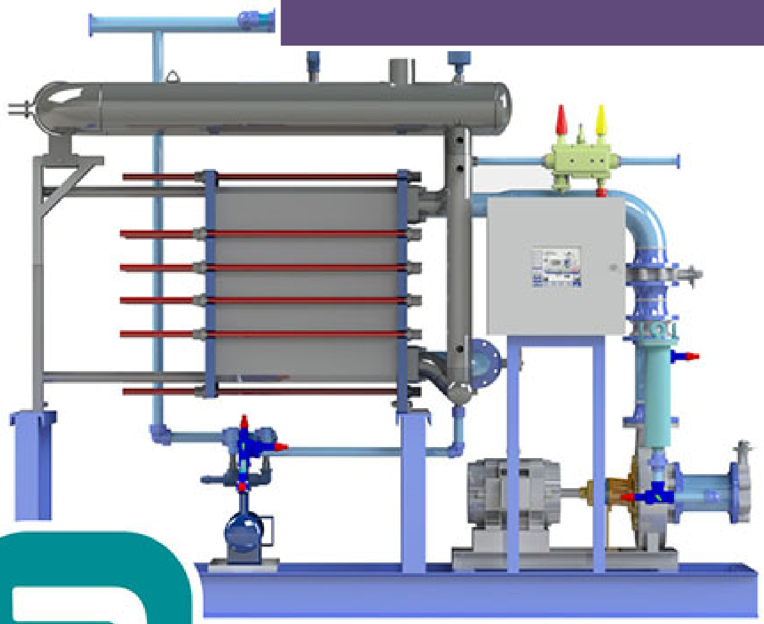
Disadvantages:

- Not everything is new
- Partial Warranty

Retrofit

- ✓Make use of existing infrastructure
- ✓Add additional features
- ✓Take advantage of new technologies
- ✓Reduce charge
- ✓Potential for Heat Reclaim

Retrofit



SMART RINK CONNECT

Do Nothing

Maintain

Advantages:

✓ No Cost

Disadvantages:

- Don’t address any of the concerns
- No improvement to the plant
- No improvement to safety
- Unknowns
- Risk of Shutdown
- Risk of Injury if equipment fails

Maintain
SUMMARY

- Need To Do What's Right For You, Based On Your Primary Criteria
- Typically The Refrigeration Plant Is "Part Of The Building" Make Sure The Plant Itself Can Last As Long As It Needs To
- Consider All The Options, Retrofit And Replacement, And All The Factors.

- **Ask Questions**
    - To Make Sure What You're Getting, Is Right For You!