

High Tech Chiller for High Tech Facility

Magnetic Bearing Chillers Cooling Office Building

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CampusEnergy2020

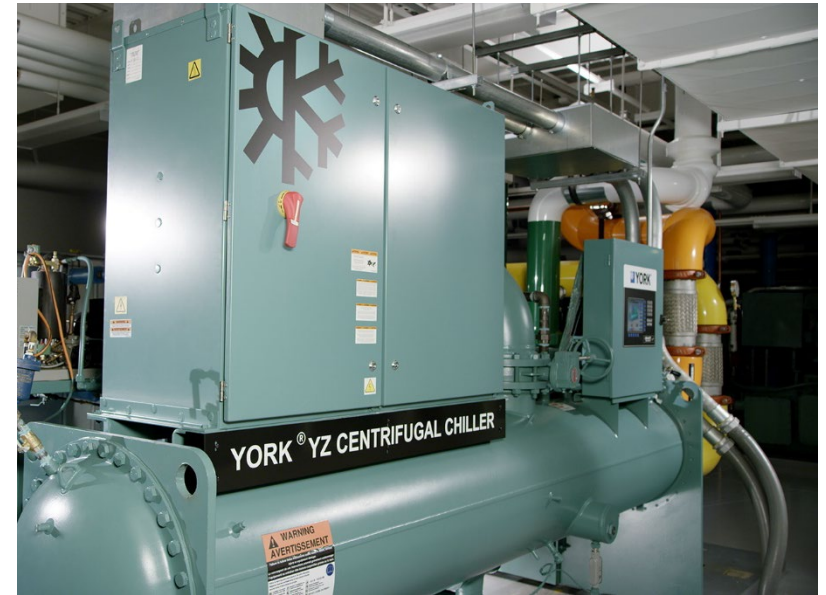
THE POWER TO CHANGE

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Agenda

- Case study
 - Facility insight
 - Installed equipment
 - Outcome
- History and future of magnetic bearing chillers
 - Timeline of magnetic bearing
 - Magnetic bearing centrifugal chillers for the future



High Tech – Sustainable Facility

- 385,000 square foot facility
- Used by 1,500 professionals
- Office and laboratory environments
- **LEED® platinum certification** - highest such recognition possible
- Geothermal heat pumps, photovoltaic energy, under-floor heating and cooling, parking structure with plug-ins for hybrids, etc.



Installed Equipment

- Installed August 2017
- Over 7,000 run hours
- Water-cooled centrifugal chiller
- 350 tons
- Variable Speed Drive
- Magnetic Bearing
- Quick Start Feature
- Using R-1233zd (GWP of 1)



Replaced oil bearing centrifugal chiller

“

“We installed in August, our peak cooling season, and the chiller picked up the pace flawlessly”

- Facility Manager

”

QUICK REVIEW - Refrigerant Legislation Today

Existing Refrigerant Bans

- R-123 - **no longer sold** in new chillers - Per Montreal Protocol 1/1/20
- HFC refrigerant - there is **no global ban** on HFC refrigerants

Kigali Amendment

- Kigali Amendment to the Montreal Protocol is a **global regulation**
- Ramps down demand for HFCs on a timeline for transition over **several decades**
- The United States has **not ratified** the Kigali Amendment

US EPA SNAP Ruling

- SNAP Rule limiting the sale of 134a & 410A chillers in 2024 was **vacated**
- Some states have joined the US Climate Alliance, aiming to reduce GHG emissions by **2025**
- **No current legislation** impacts the sale, use or servicing of HFC chillers

QUICK REVIEW - Refrigerant Landscape Today

Conventional Refrigerants				
Refrigerant	Safety	Products	Pressure	GWP
R-134a	A1	Centrifugal and Screw	Medium	1300
R-410A	A1	Scroll	High	1924
Next Generation Low-GWP Refrigerants				
Refrigerant	Safety	Products	Pressure	GWP
R-513A	A1	Centrifugal and Screw	Medium	573
R-1233zd	A1	Centrifugal	Low	1
R-514A	B1	Centrifugal	Low	2

Other low-GWP refrigerants are flammable, requiring revisions to building codes, safety standards, service and transportation practices

Outcomes To Date

- **Reduced Emissions**
 - Reduced total emissions from efficient chiller and low GWP refrigerant
- **Increased Uptime**
 - Cloud-based analytics to drive increased uptime
- **Reduced Maintenance**
 - Magnetic Bearings means less maintenance



TEWI: Total Equivalent Warming Impact

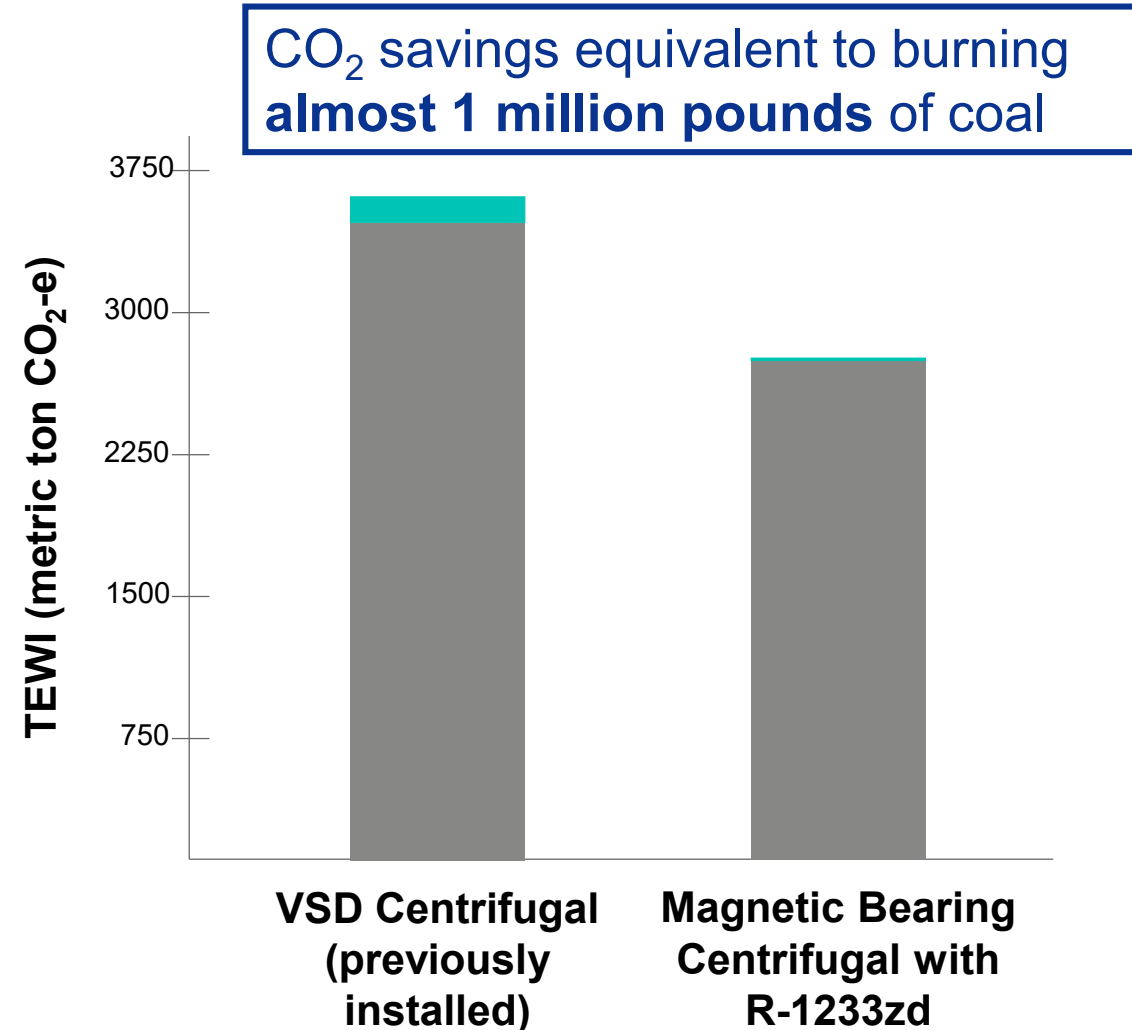
TEWI = the measurement of a chiller's **direct** + **indirect** emissions

■ **Indirect Emissions** - Amount of energy used by the chiller (based on energy source mix of power generation used to operate the chiller)

■ **Direct Emissions** – determined by impact of possible leak from chiller & GWP of the refrigerant in the chiller (R-1233zd GWP = 1)

Improved efficiency + low GWP refrigerant
= **Lower Environmental Impact**

- **Direct emissions** are reduced by 100%
- **Indirect emissions** are reduced by 22%
- **Total TEWI reduction: 25%**



Connecting to the cloud in HVAC

Cloud-based Service Platform for Chillers



Critical alarms sent directly to your local service provider



Chiller operating data is sent for storage and analysis



Analytics used to produce Chiller Health Reports, provided every visit



Operating & trend data accessible anywhere, anytime by our local, regional and global experts

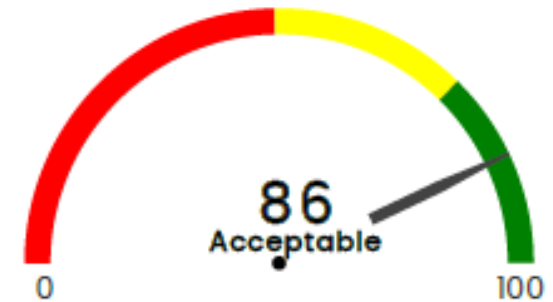
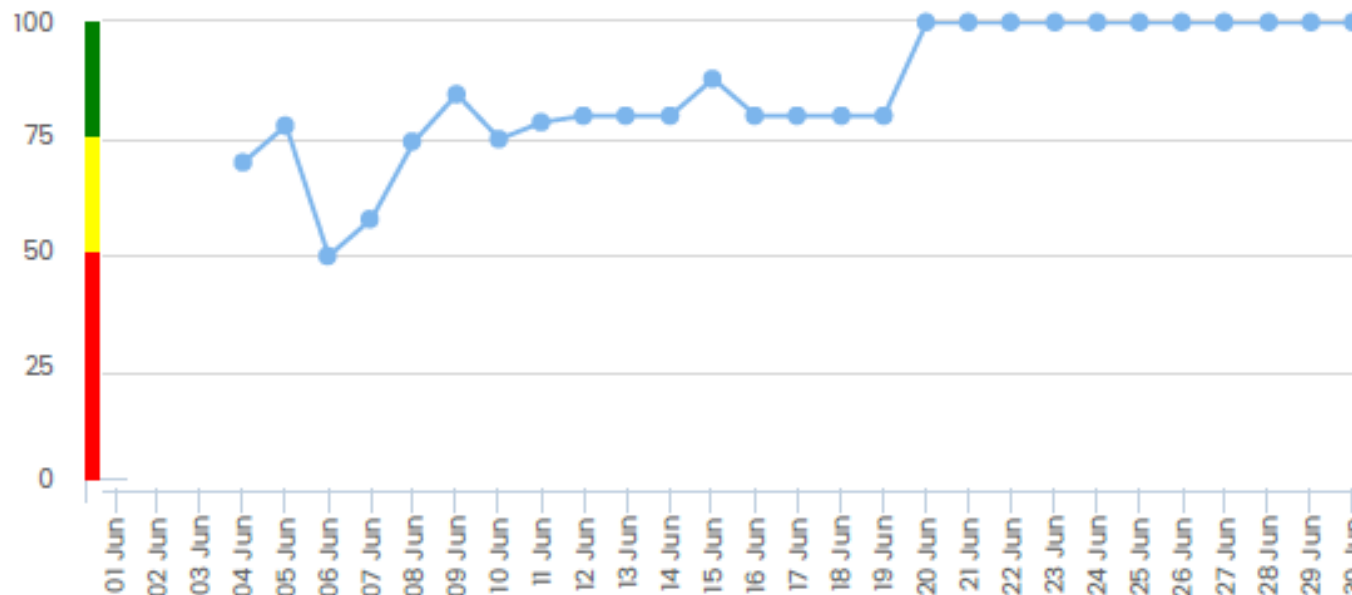
- Constant monitoring of chiller and performance
- Regular reporting
- Preventative maintenance alerts – before failure

Chiller Performance Index Summary

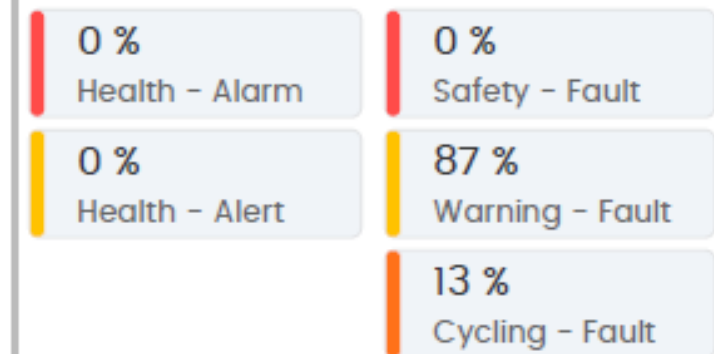
Water-cooled
magnetic bearing
centrifugal chiller



CPI Trend



CPI Penalizing Factors




Broader algorithms can be applied in multi-chiller plant scenarios to identify which chillers require the most attention


Connected to the Cloud in HVAC


Regular checks can alert to:


- Need for chiller tube cleaning
- Cooling tower problems
- Refrigerant leaks


High Internal Ambient Temperature in VSD  Acceptable


High Condenser Refrigerant Level  Acceptable

High Entering Condenser Water Temperature  Acceptable

High Evaporator Approach Temperature  Acceptable

High Condenser Approach Temperature  Acceptable

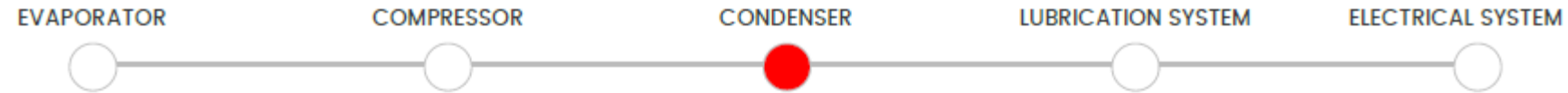
Low Condenser Refrigerant Level  Acceptable

Low Entering Condenser Water Temperature  Acceptable

Monitoring and Reporting capabilities to proactively look for potential issues

Connected to the Cloud in HVAC

- Possible causes and impacts are identified
- Time chart shows when the issue is occurring to help diagnose potential issues



High Entering Condenser Water Temperature

⚠ Alarm

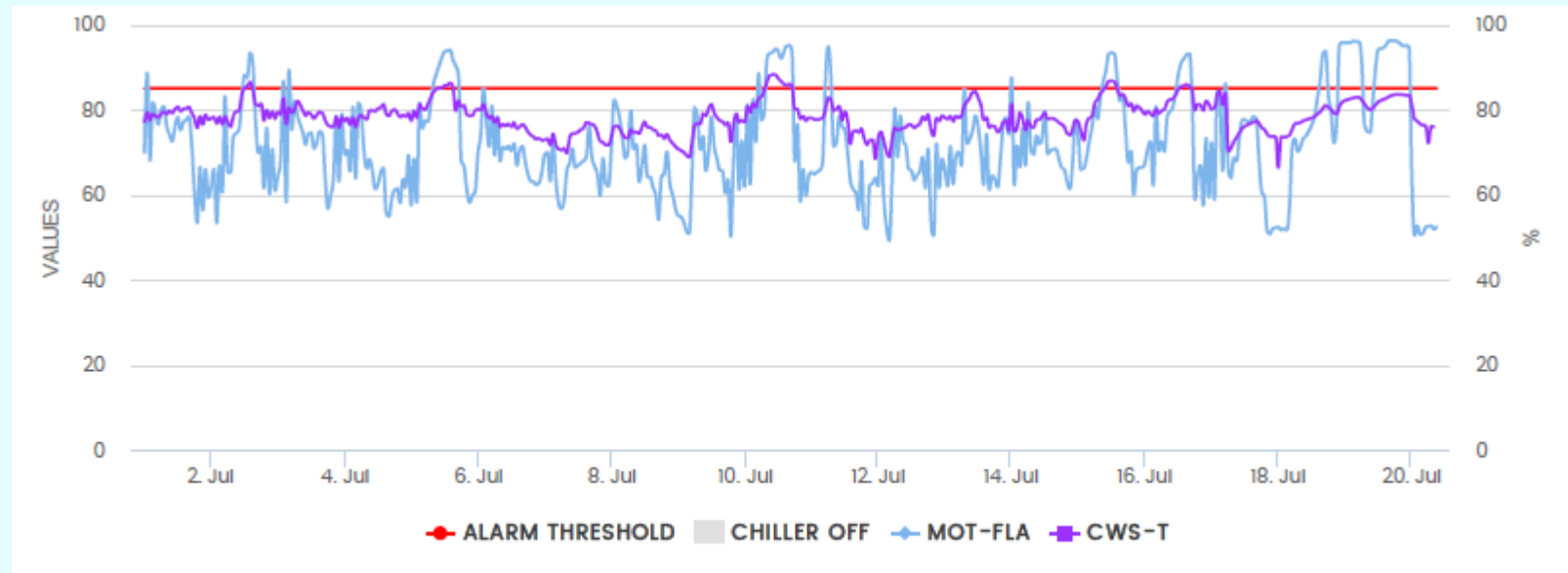
Entering condenser water temperature (ECWT) is a measure of the temperature of the water supplied to the chiller from the cooling tower. This chiller has spent a significant amount of time during the reporting period with ECWT above its design limit.

→ Possible Causes

1. Cooling tower mechanical malfunction
2. Incorrect cooling tower control programming or set points

○ → Possible Impacts

1. Increased chiller energy consumption
2. Reduced chiller cooling capacity



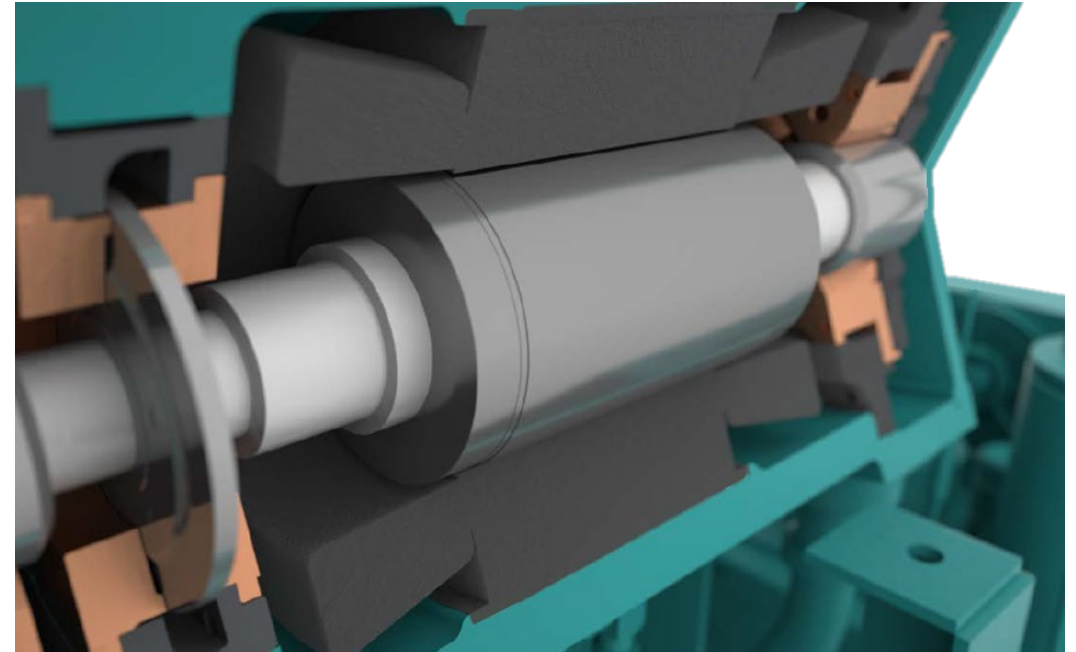
Rated Performance Comparison

	VSD Centrifugal Chiller Previously Installed	VSD Magnetic Bearing Centrifugal Chillers Installed
Capacity	300 Tons	300 Tons
Input Power	170.9 kW	163.9 kW
Full Load Efficiency	0.5697 kW/Ton	0.5463 kW/Ton
Part Load Efficiency	0.3935 kW/Ton	0.3216 kW/Ton

Full Load: + 4.1%
Part Load: + 18.3%

Magnetic Driveline Benefits

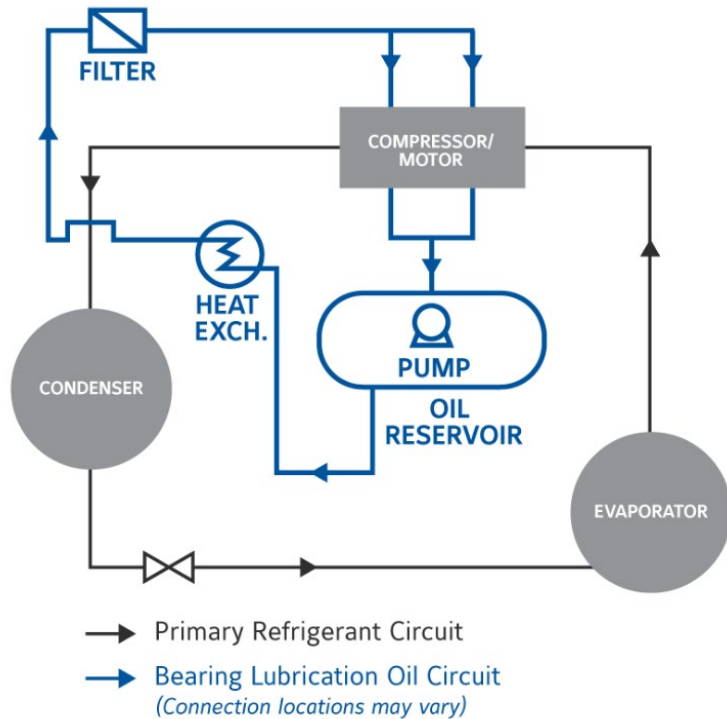
- Single moving assembly suspended in a magnetic field with no lubrication system
 - 80% fewer moving parts
 - Non-contact design
- Magnetic bearings deliver
 - Extraordinary efficiency & wide operating map
 - Superior durability
 - Simplified maintenance



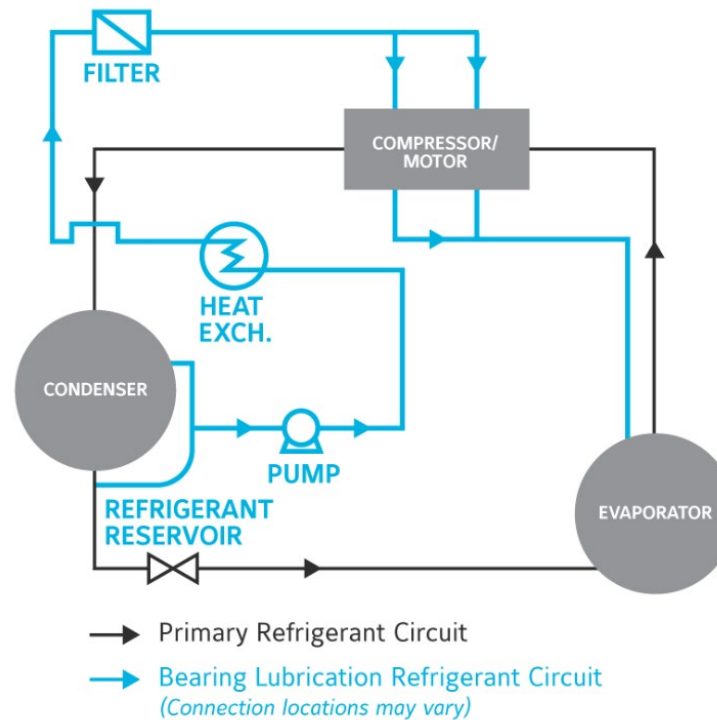
Enhanced longevity & reduced maintenance!

Bearing Options for Centrifugal Chillers

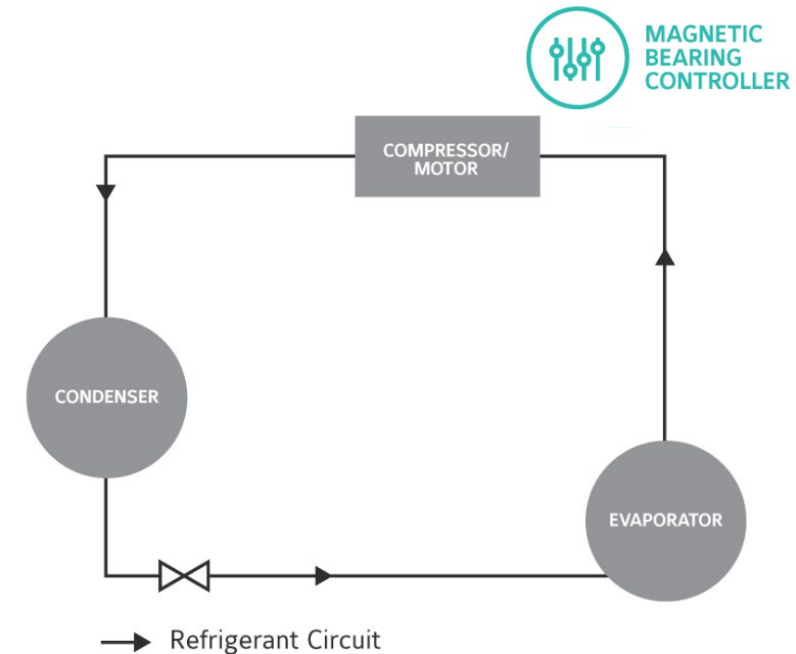
OIL-LUBRICATED BEARINGS



REFRIGERANT-LUBRICATED BALL BEARINGS



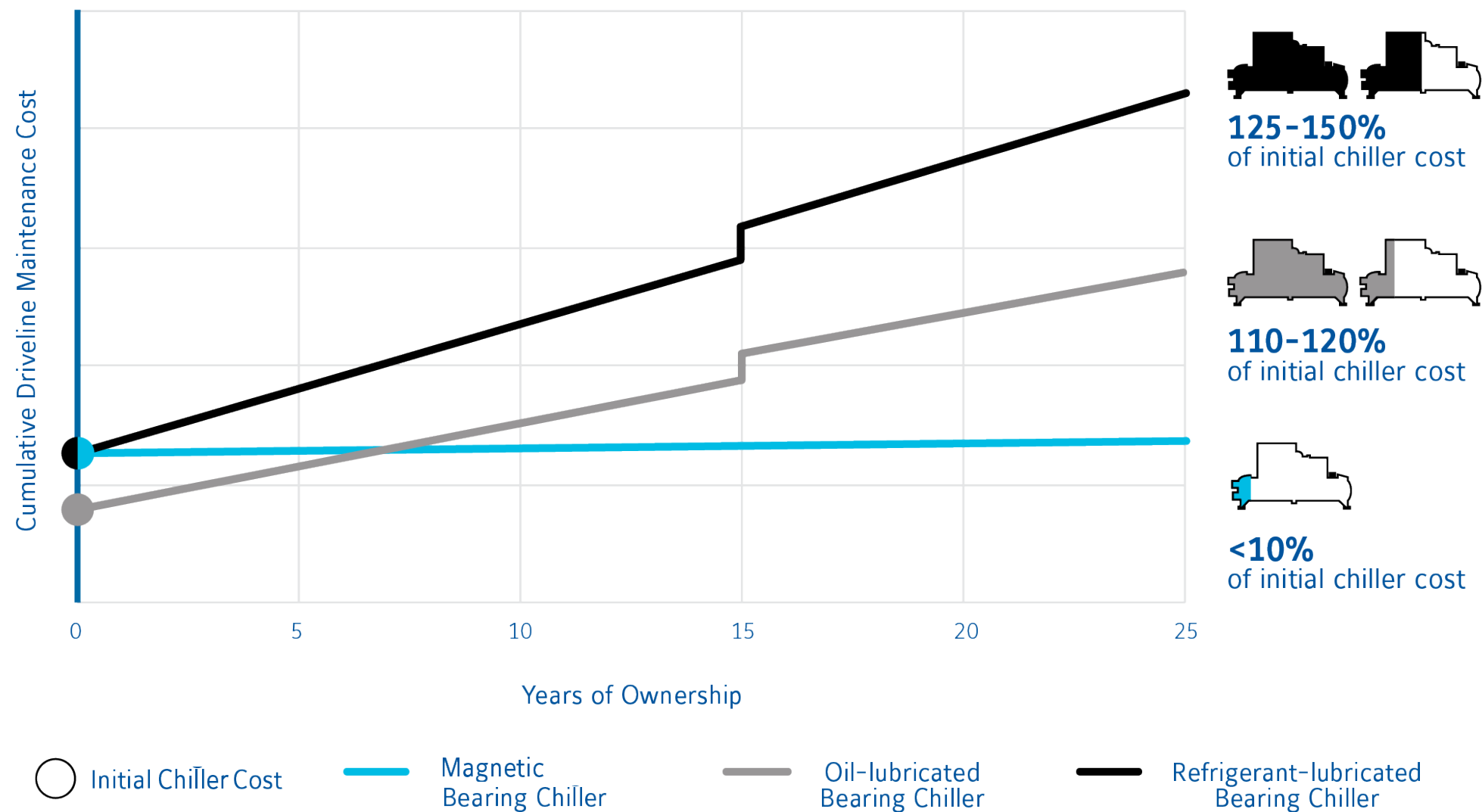
MAGNETIC BEARINGS



Lower Driveline Maintenance

Driveline Maintenance Tasks	Oil-lubricated Bearings	Refrigerant-lubricated Bearings	Magnetic Bearings
Check lubricant sump & temperature control operation	● Monthly	● Monthly	—
Check lubrication eductors	● Monthly	● Monthly	—
Lubricant analysis	● Annually	● Annually	—
Replace lubricant filter(s)	● Annually	● Annually	—
Vibration analysis	—	● Quarterly	—
Clean refrigerant pump strainer	—	● Monthly	—
Battery health test	—	● Periodically	● Periodically

Other Magnetic Bearing Benefits: Lower Driveline Maintenance



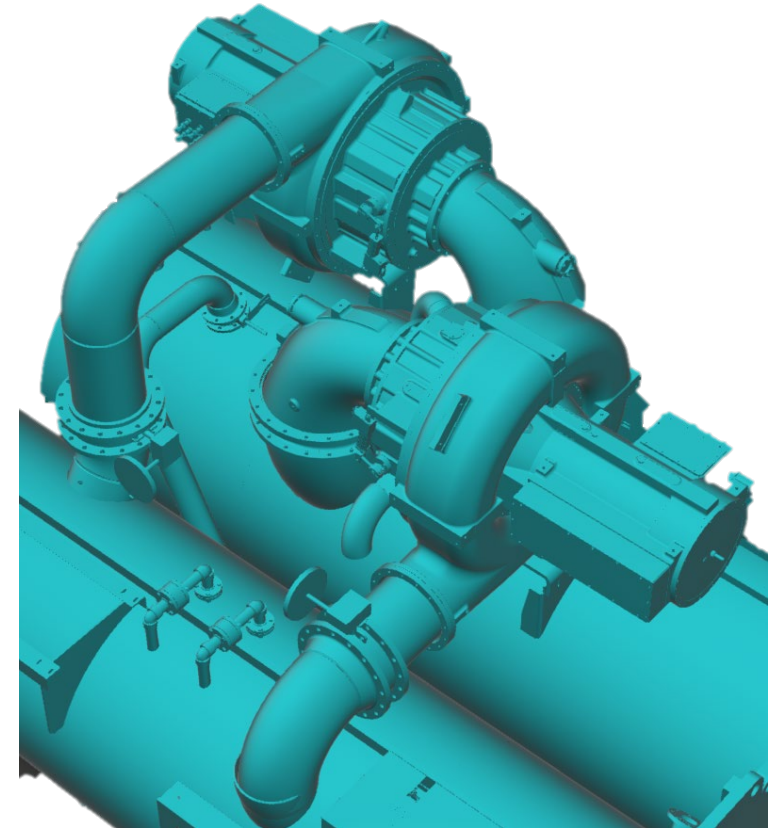
History of Magnetic Bearing Technology

- First patents came during WWII
- Magnetic bearing technology introduced in 1998 on critical naval applications
- Introduced in commercial HVAC in 2002
- Bearings support load using magnetic levitation



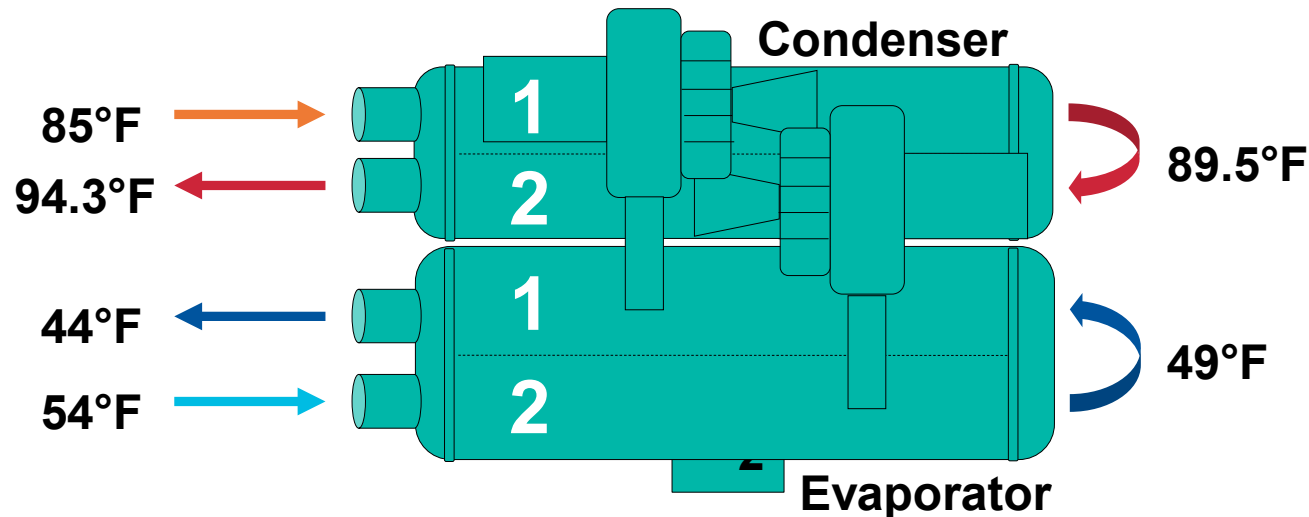
Advanced Aerodynamic System

- 2 single-stage compressors
- Paired in Series Counterflow arrangement
 - Reduces lift on each compressor
- ➔ Improves overall full load and part load performance
- Capability to run 1 compressor at a time
 - Redundancy in case of a shutdown or failure
 - Low load situations
- ➔ Increases turndown capability

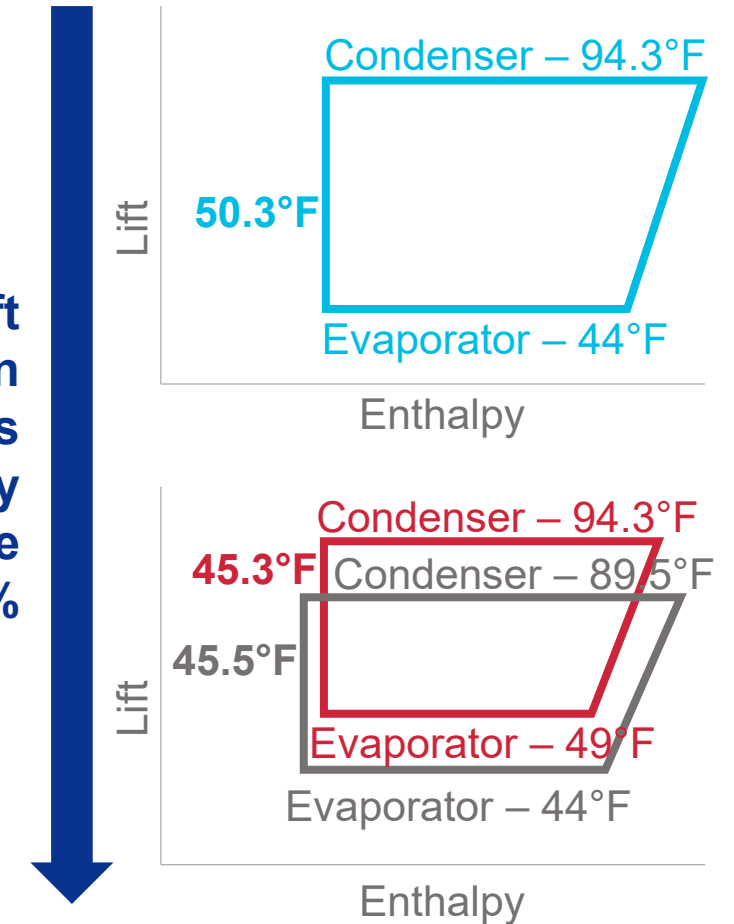


Series Counterflow Benefit

- Split shell design – 1 shell, 2 circuits
 - Patented technology
 - Only feasible with low pressure refrigerant
- High efficiency in a compact package
- Inherent 2 pass design



**10% lift
reduction
increases
efficiency
by more
than 5%**



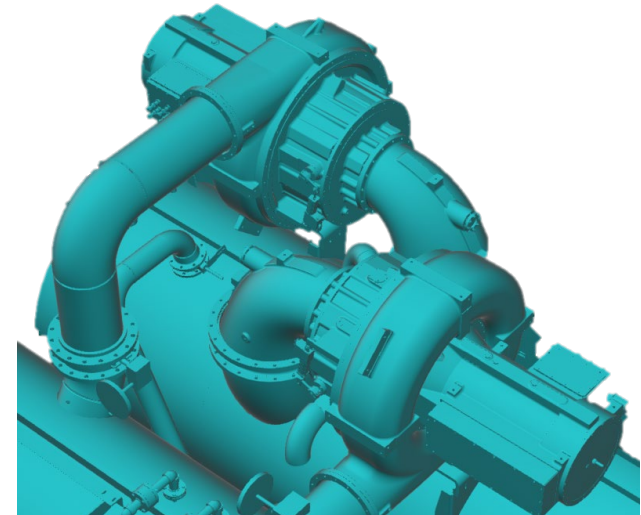
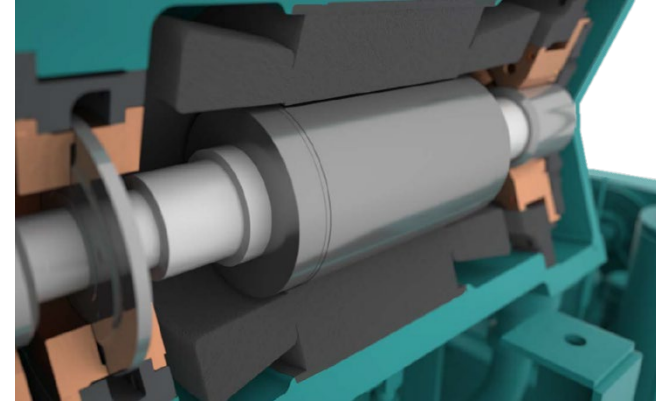
Series Counterflow Example

	2000 Ton Chiller at AHRI Conditions	
	Parallel Configuration	Series Counterflow
Input Power	1010.6 kW	945.9 kW
Full Load Efficiency	0.5053	0.4730
IPLV	0.3071	0.2788

Benefit
Full Load: + 6.4%
Part Load: + 9.2%

Summary

- Magnetic Bearing innovative technology works well for high tech – high demanding buildings
 - Improved energy efficiency
 - Reduced maintenance
- Now dual compressor design offers series counterflow benefit



QUESTIONS?

