Trane invites you to step into the future with



THE NEXT GENERATION CHILLERS

TRANE

The Next Generation Chillers Seminar

Next Generation Trane Chillers

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Product Portfolio Manager,
WC Chillers, Product
Management
Trane Commercial Systems



The Next Generation Chillers Seminar

Agenda:

- Regulations & Next Gen Refrigerants
- Trane Centrifugal Chiller Offering
  - CenTraVac Series E models with R1233zd
  - CenTraVac with R514A
- Trane Product Advantages

Ingersoll-Rand Commitment

Reducing Greenhouse Gas Emissions



50%

Reduction in the greenhouse gas refrigerant footprint of our products by 2020, and incorporating alternatives with lower GWP across the company's product portfolio by 2030.



35%

Reduction in greenhouse gas footprint of our own operations by 2020.



$500M

Investment in product-related research and development by 2020 to fund the long-term reduction of GHG emissions.

EcoWise™

The Ingersoll Rand EcoWise™ portfolio of products designed to lower environmental impact with next-generation, low global warming potential (GWP) refrigerants and high-efficiency operation is part of our climate commitment to increase energy efficiency and reduce the greenhouse gas emissions (GHG) related to our operations and products.

Regulations on HFC Refrigerants have changed!

10-15-2016 > *Montreal Protocol - Kigali Agreement*

– Agreement to phase down of HFC Consumption globally

9-26-2016 > EPA SNAP ruling

- All chillers using R-134a discontinued by 1/1/2024

TRANE has largest portfolio with Next Gen refrigerant options available to order



Centrifugal Chillers 120-4000T
-R123, R514A & R1233zd



Air Cooled Screw Chiller 110-500T
R134a and R513A

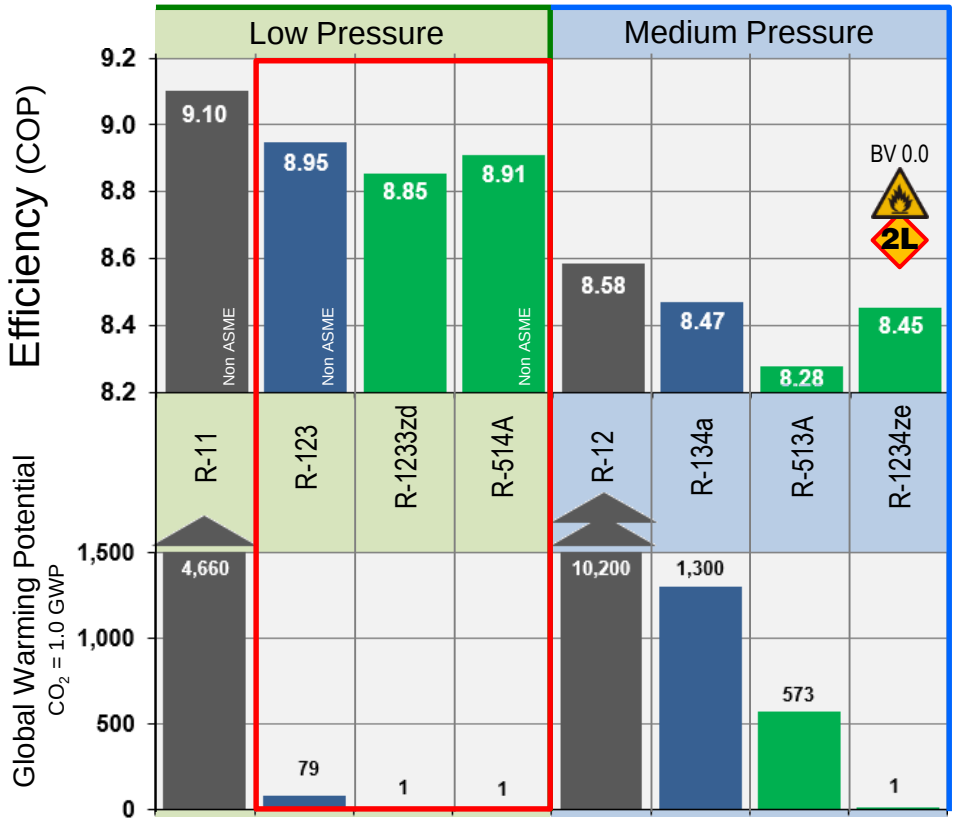


Water Cooled screw chiller 70- 250T
R134a, R513A & R1234ze

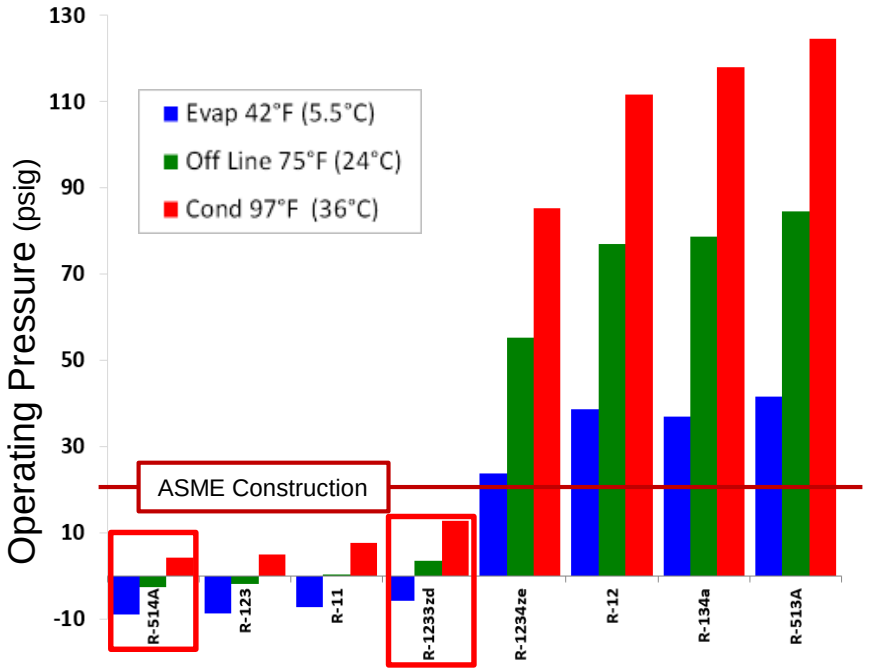
Delivering maximum value to customers – Efficient, reliable and Safe

With choices now available…

HVAC Industry Transition has started



	R-514A	R-123	R-11	R-1233zd	R-1234ze	R-12	R-134a	R-513A
EVAP	(8.95)	(8.63)	(7.34)	(5.87)	23.66	38.73	37.00	41.59
OFF	(2.58)	(1.99)	0.09	3.37	55.21	76.84	78.65	84.53
COND	4.15	4.96	7.65	12.85	85.16	111.53	117.96	124.45



R1233zd requires ASME due to operating temp range

R1233zd and R514A are Trane Centrifugal next gen low pressure offerings

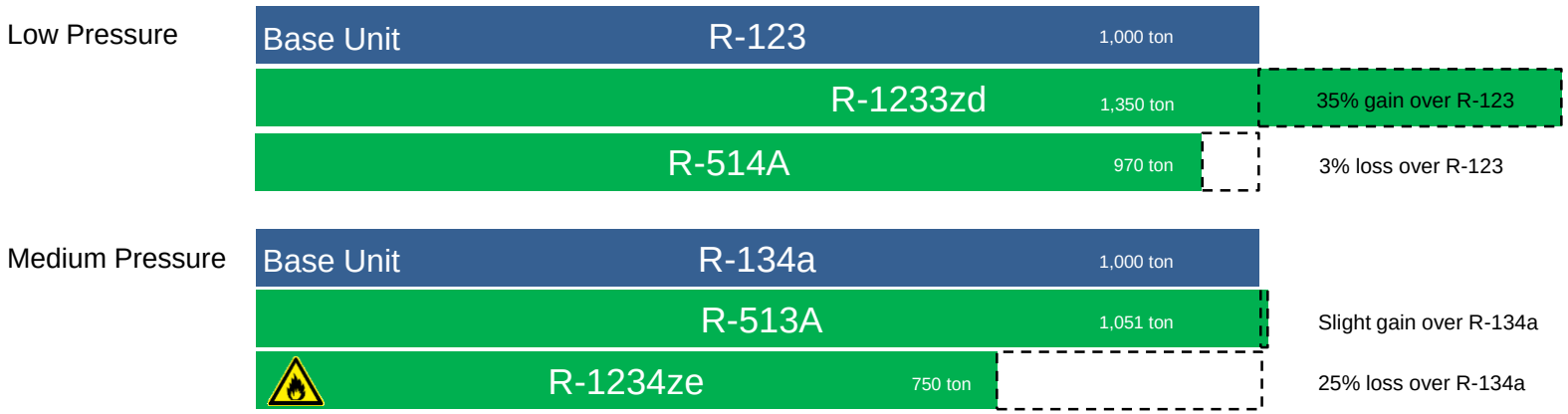
Centrifugal Refrigerant Choices & Comparison

Replacements for HFC/HCFC Large Chiller Offerings

Efficiency

	Low Pressure			Medium Pressure		
	R-123	R-1233zd	R-514A	R-134a	R-513A	R-1234ze
Flammability	Non (1)	Non (1)	Non (1)	Non (1)	Non (1)	Slight (2L)
Toxicity	Higher (B)	Lower (A)	Higher (B)	Lower (A)	Lower (A)	Lower (A)
Fluid Efficiency	9.4 COP	9.3 COP	9.4 COP	8.5 COP	8.3 COP	8.5 COP
Capacity Change	1	35% Gain	3% loss	1	Same	25% Loss
GWP	79	1	< 2	1300	573	1
	In Current Trane Product Offering			In Current Trane Screw Product Offering		

Capacity



R1233zd and R514A complimentary offerings for maximum choices

Series E with R1233zd(E)



Series E CenTraVac

Evolution of the CenTraVac™ Product Line

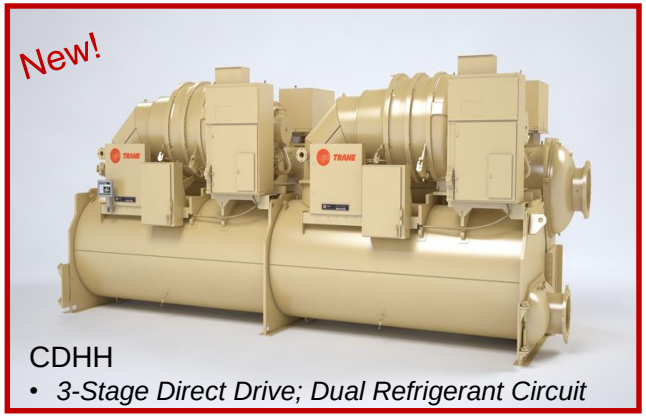


CVHH: *3-Stage Direct Drive*

Product Line expanded with an HFO refrigerant R1233zd(E) in a low pressure design
… to help the global transition to low GWP.

Advantages:

- Expanded 50Hz product offering (Capacity)
- Even higher efficiency ranges (full & part load) for the lowest cost of ownership
- Higher capabilities – Lift, Heat Pump, Energy storage



CDHH

- *3-Stage Direct Drive; Dual Refrigerant Circuit*

Update to Eurotunnel

There are 2 Chiller plants to support the tunnel – one each on UK and France side with 4 chillers each.

- Trane Series E™ CenTraVac™ Dulplex™ Chillers 2 x 9 MW (2,560 ton) CDHH 2250
  2 x 11 MW (3,130 ton) CDHH 3050
- Total Capacity 40 MW (11,380 tons)
- Mission critical to reduce tunnel temperature from 55°C (130°F) to 30°C (86°F)

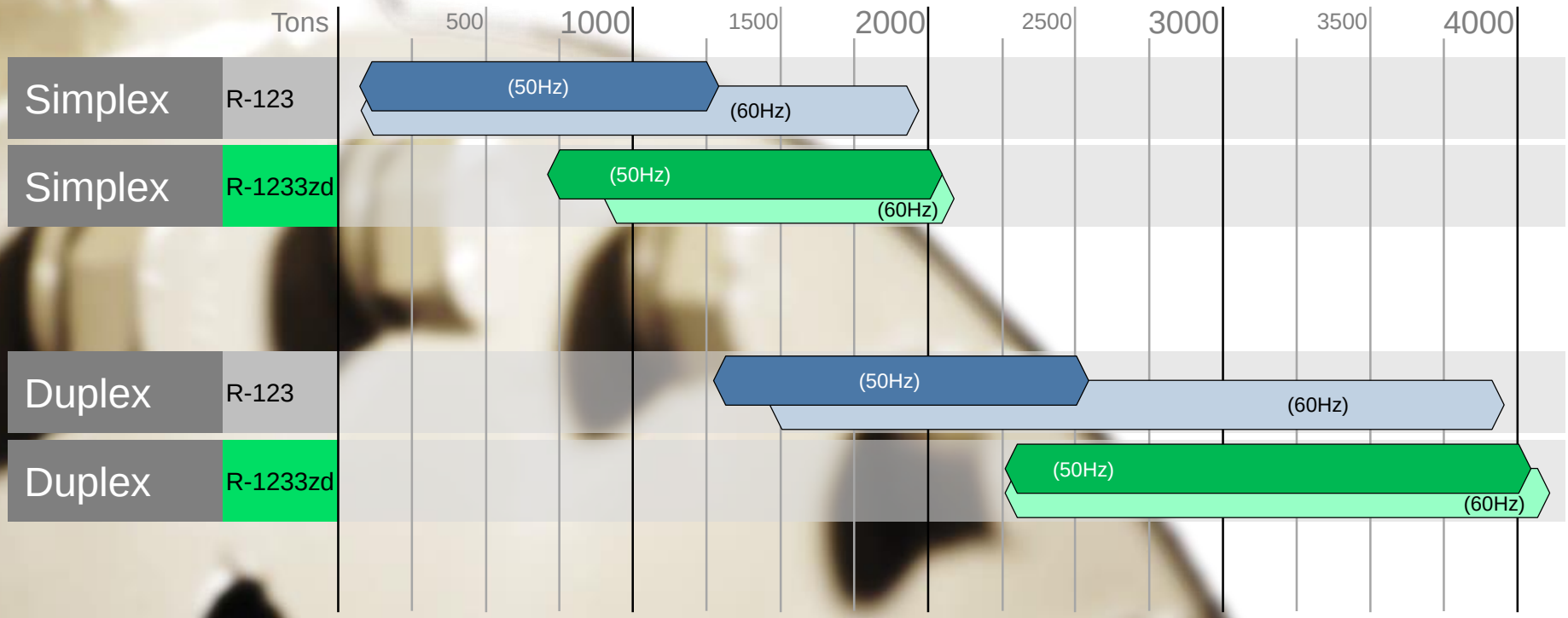
Original Calais chiller plant went on line in 1994 supporting the temperatures needed for the tunnel.

The chillers allow trains to operate with comfortable temperatures for passengers, maintain equipment safety and prevent tracks to buckle eventually.



Strength of Trane Performance and Efficiency

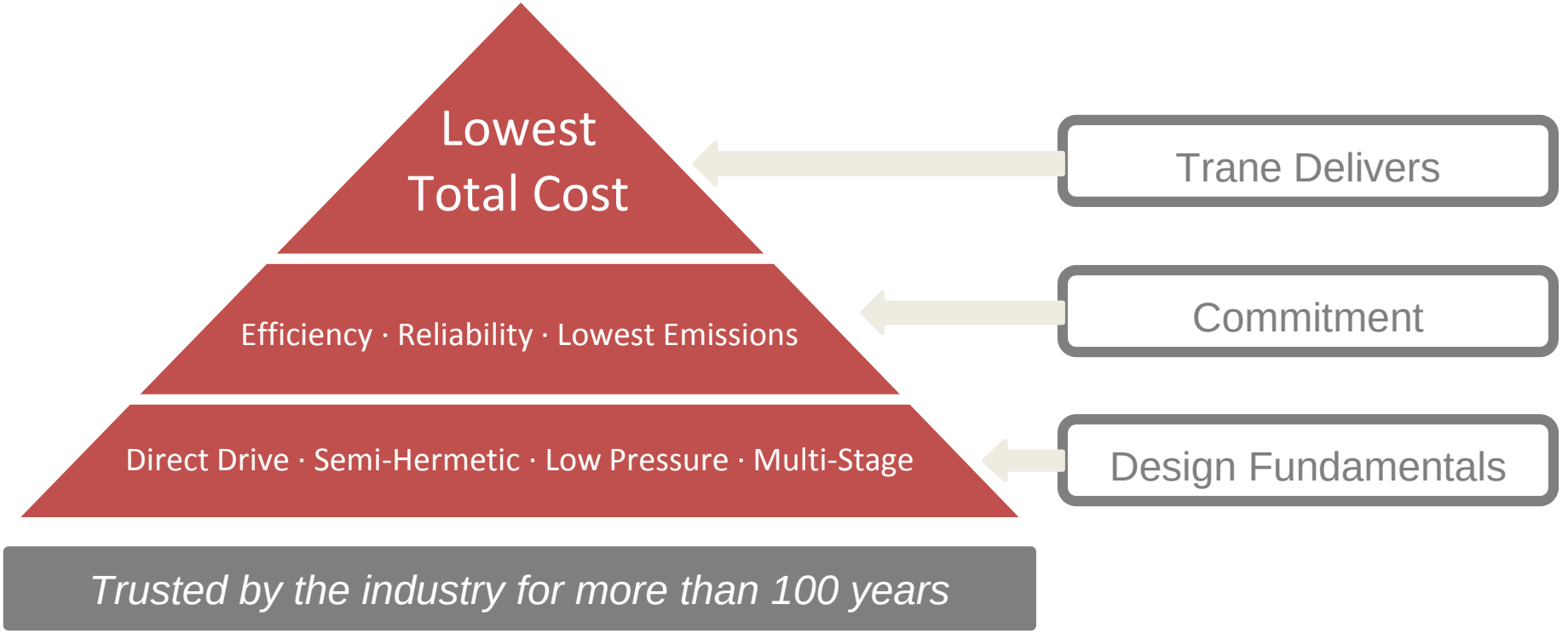
New Trane Centrifugal Chiller Offering



Expanding the “CHOICES” to the Centrifugal Chiller Offering

CenTraVac Advantage

Core Value Proposition

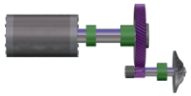


Technology Comparison

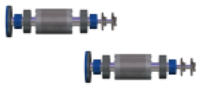
Advantages with Design Choices



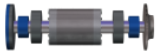
Open Gear Drive



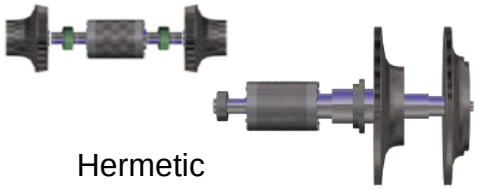
Hermetic Gear Drive



Multi Stage Maglev



Single Stage Maglev



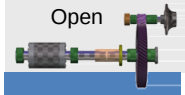
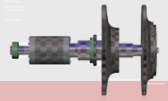
Hermetic Direct Drive

Characteristic	Design Choice				Benefits
Compressor Speed	High	☐	Low	☑	Delivering lowest acoustic and vibration characteristics
Motor Layout	Open Drive	☐	Semi-Hermetic	☑	Operation in a pristine environment, dissipating motor heat into condenser refrigerant
Operating Stability	Single-Stage	☐	Multi-Stage	☑	Stable operating envelope to meet the dynamic system needs and deliver the highest efficiency
Number of Bearings	Over 6-8	☐	Two	☑	Lowering the possibility of failure with fewer elements in the design
Operating Pressure	Med/High	☐	Low	☑	First charge is your last charge (efficiency)

Reliability advantage with Simplicity of Design!

Design Choices Impact Efficiency

Centrifugal Chiller Comparison

Refrigerant	R-134a 0.460 kW/ton	R-513A 0.469 kW/ton -2%	R-123 0.433 kW/ton +7%	R-1233zd 0.436 kW/ton +6%	R-514A 0.434 kW/ton +7%
Chiller Cycle	Sub-Cooler 0.415 kW/ton		Refrigerant Economizer 0.388 kW/ton +7%		
Compressor	Gear Drive		Direct Drive		Direct Drive
	Open	Hermetic	Single Stage	Mult Stage	Mult Stage
					 
Motor	95.0%	95.0%	97.0%	97.0%	95.0%	97.0%
Drive Train	97.9%	98.1%	100%	100%	100%	100%
Impeller	82.8%	81.4%	78.8%	75.1%	83.3%	84.1%

Product		Full Load	IPLV		Full Load	IPLV
@ 300 tons	Maglev (Multi Stage)	0.540 kW/ton	0.318 kW/ton	CVHS (300)	0.478 kW/ton	0.296 kW/ton
@ 700 tons	Maglev (Single Stage)	0.540 kW/ton	0.330 kW/ton	CVHF (700)	0.484 kW/ton	0.317 kW/ton
@ 1,500 tons	Gear Drive (Single Stage)	0.530 kW/ton	0.340 kW/ton	CVHH (1500)	0.504 kW/ton	0.312 kW/ton

Unit Design Choices Drive Real Efficiency Paybacks

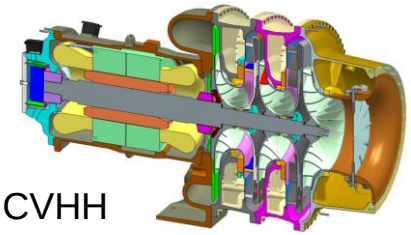
Trane Centrifugal Compressors

Maximum Customer value

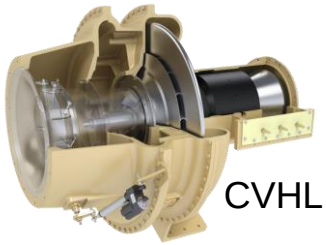
- Configured for a given application
- Latest technology for highest efficiency
- Lowest cost of ownership
- Maximum Reliability, Uptime and Life
- Various conditions – Lift, load, capacity, electrical

Design

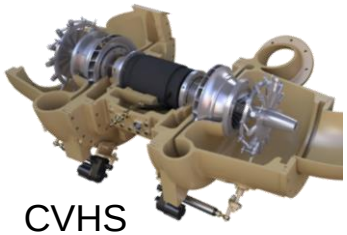
- Mixed Flow Impellers
- Induction & Permanent Magnet motors
- Refrigerant cooled motors
- Integrated motor controllers
- Oil & Oil Free machines
- Steel & Ceramic bearings



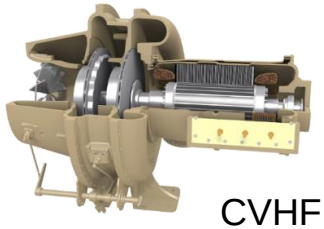
CVHH



CVHL



CVHS



CVHF

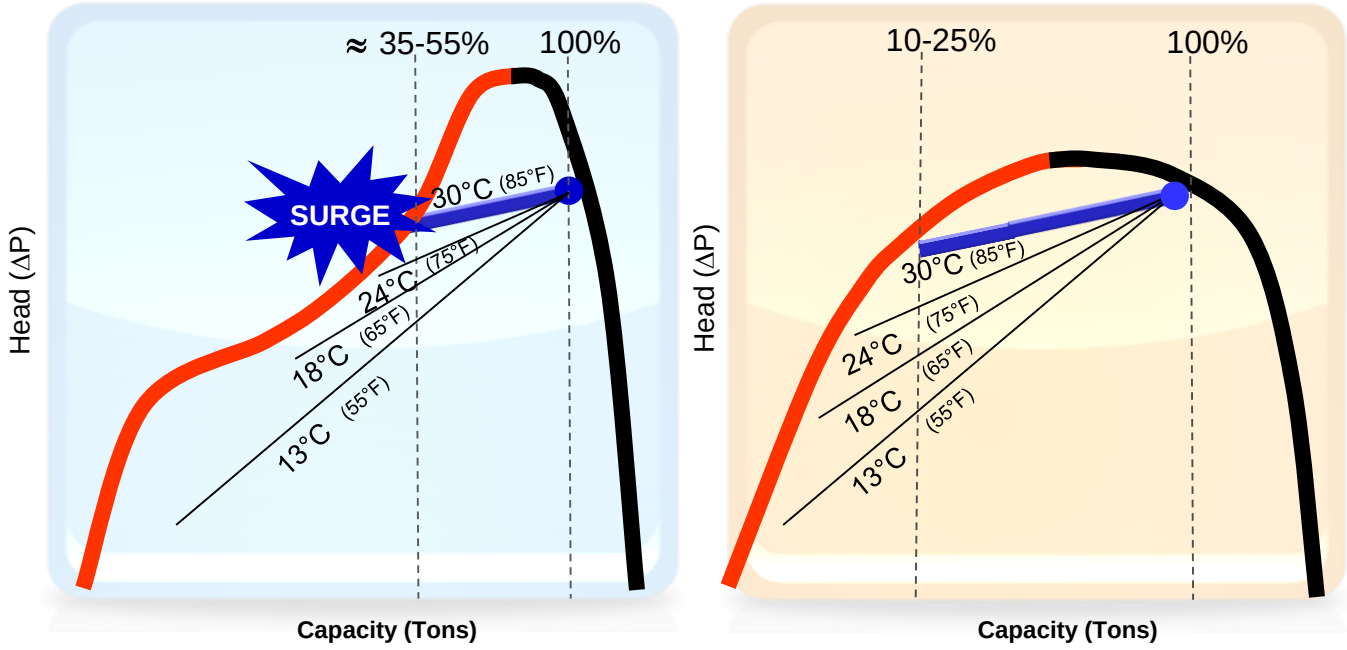
6 Families - 55 Compressors

Leading compressor technology for all Trane chillers

Centrifugal Compressors

Range of Stability Comparison

Compressor Characteristics Define Chillers Ability to Perform



Single-Stage ● Design Point **Multi-Stage**

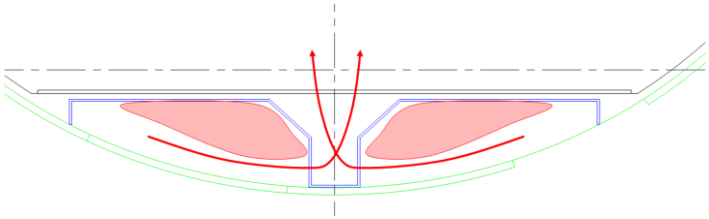
Multi-Stage Design Reliably Operates in All Real-World Conditions

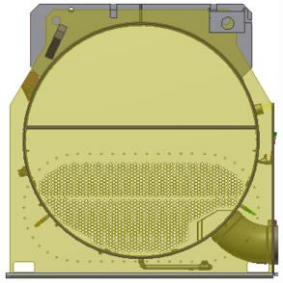
Heat Exchanger Designs

Advanced Thermal Engineering

Evaporator Designs

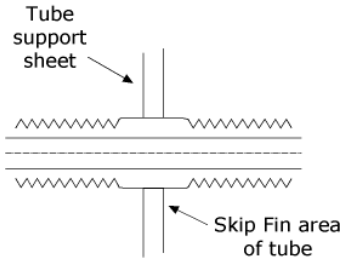
- Unique refrigerant distribution design
- Reduces Unit Refrigerant to industry leading 1.7 lbs/ton

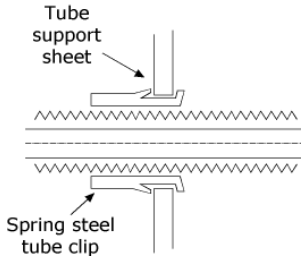




Tubes:

- Clip design provides 4% additional active area
- Enhances tube life with lower stress



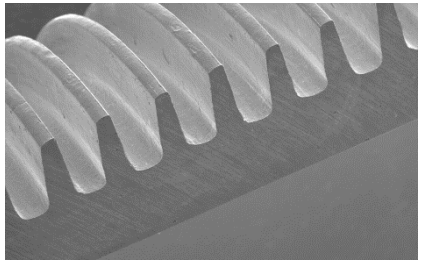


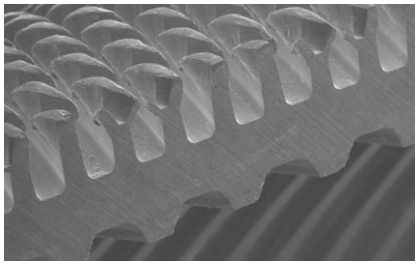


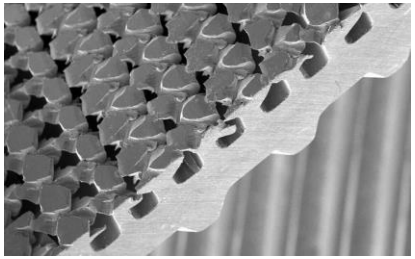
Lowest environmental impact over life of chiller

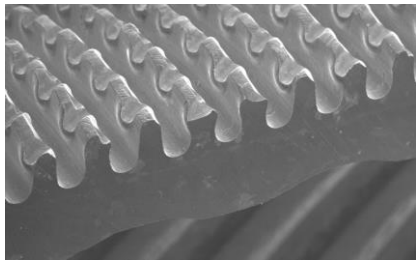
Advanced Tube Designs

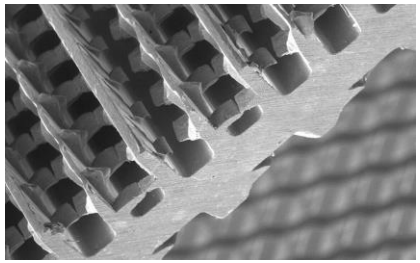
High Performance over life

















Comprehensive Options :

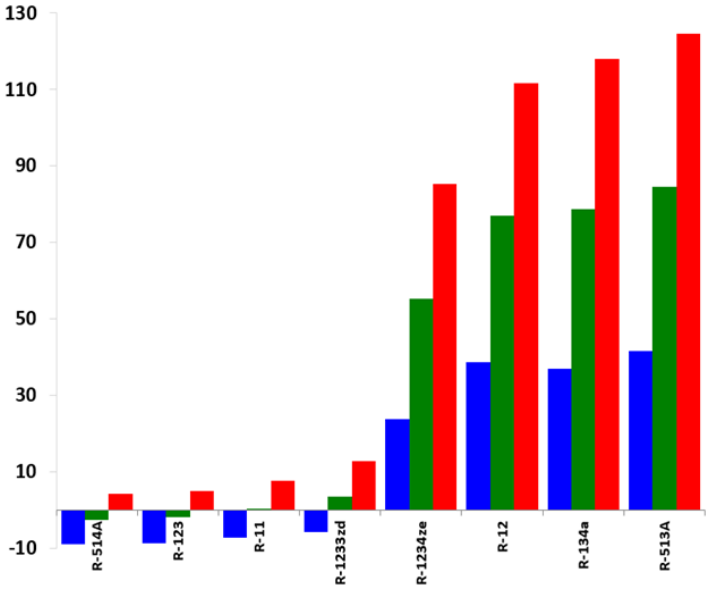
- Material: Copper, Titanium, Cu-Ni
- Thickness – 0.025,0.028,0.035
- Diameter – ¾”, 1”
- Unique tubes: Condensers and Evaporators
- Smooth, advanced, proprietary tubes

Trane has significant investments in Heat Exchanger technology

Environment & Social Responsibility



Low operating pressure, and automated EarthWise purge enables near-zero refrigerant loss

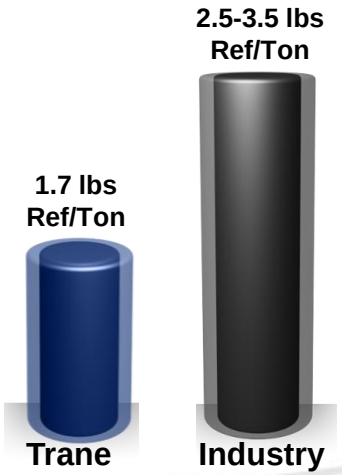


Operating Pressure

Zero Emission by Design:

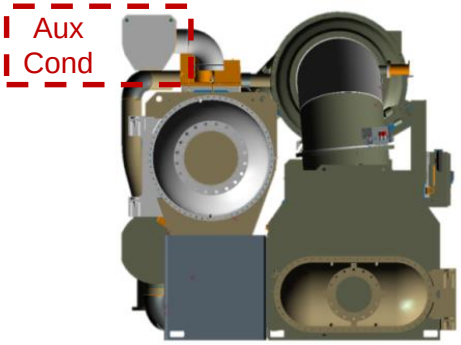
Trane Centrifugal Products have lowest field-verified leakage rate at 0.5%

…… with real time leak detection



Many Customers Enjoy the First Charge as their Last Charge

CVHH Feature Enhancements

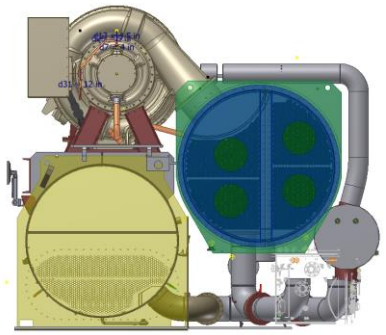


Auxiliary Condenser

- Captures energy that being generated
- Increases efficiency by increasing condenser heat transfer surface area and lowering condenser entering water temp

Double Bundle Heat Recovery

- Utilize heat that would otherwise be rejected to the atmosphere
- Efficiency improvement to lower costs
- Refrigerant flow goes directly to both condenser bundles
- Leaving temperatures up to 140°F depending on conditions
  - 80°F of lift standard
  - Higher lift possible on request



Improved Capability w/ Aux Condenser & Heat Recovery

Product Options – System Efficiency

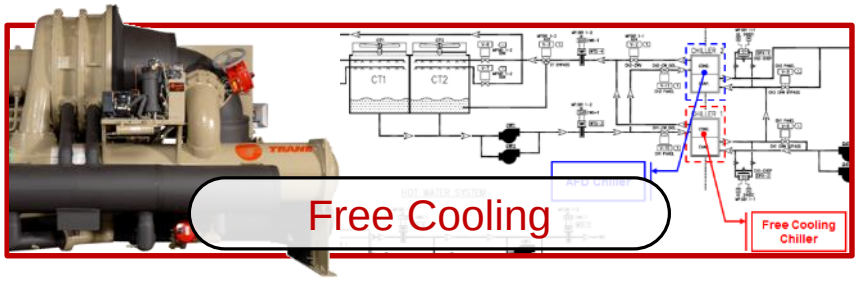
Enhanced Flow Management Package

- **Without**:
  - 10%/minute – Tight Temperature Control
  - 30%/minute – Unit remains On-Line
- **With**:
  - 30%/minute – Tight Temperature Control
  - 50%/minute – Unit remains On-Line



Free Cooling:

Take advantage of cold ambient conditions
- Better system efficiency
- No additional footprint
- Integrated control
- Low first, install, and maintenance costs
- Predictable performance



Product Options - continued



(ICE) down to -7.8°C (18°F)

- Reduce demand charges by shifting load demand
- Stability of cooling capacity & energy costs
- Dual-duty operation

Comply with US Seismic Regulations

- International Building Code (IBC) 2000,2003, 2006, 2009

- California Building Code (OSHPD – Office of Statewide Health Planning and Development)

- Shaker table tested



Chiller Controls

Industry leading Fourth Generation Microprocessor Controls

- Unprecedented accuracy
- Fastest reaction times
- Intuitive user interface



Tracer AdaptiView™ Controls Integrate Patented Industry-Leading Algorithms

- Adaptive Control™ keeps your unit on-line
- Feed Forward Control maximizes chiller performance
- Enhanced Flow Management provides unmatched performance in variable flow systems



Operating Options

- Base-Loading Control – Directly modulate capacity
- Hot Water control – Allows External controller to manage hot water control and set point instead of chilled water set point
- Ice-Making Control – Allows external controller to manage chiller load



Adaptive Controls Keeps Chiller on Target and at Task

Electrical Options

Motor Options

- Hermetic – Induction or PM (small sizes)
- 208V – 12 kV – 60Hz
- 380V – 13.8 kV – 50Hz
- RTD options – 2 or 4

Drives

- Refrigerant cooled – Reliable and Efficient
- Total Demand Distortion (TDD) down to 5 percent
- Water and Air cooled options on some models
- Low and Medium Voltage
- Integrated with Trane chiller controls



Dedicated Power Control Option

- Factory mounted and wired
- Available from 208 - 6600V
- 4kVA transformer UPS 480 to 115V
- Controls, purge and oil/refrigerant pump stay active in power outage



Starters:

- Wye Delta, Solid State, Primary Reactor, Auto transformer, Across line, Remote mount
- Power Factor Correction capacitors
- Protection – Surge, Lightning, Ground Fault
- Options: Transducers, Meters, switches
- MP 3000 Motor Protection Package
- Main Bus Sections
- NEMA 1 and NEMA 12 enclosures



Wide array of offerings to meet customer needs

Other Options

Water Connections

- Cast Iron Water Boxes: Fabricated or Domed
- Marine Water Boxes: Low Maintenance
- 150,300,450 psi ratings
- Victaulic, Flange, Welded Raised Face flanges
- Hinges, Mg or Zn Sacrificial Anodes, Coatings

Insulation

- Expanded closed-cell structure
- Two thicknesses (¾" & 1½")

Unit Disassembly Reassembly

- *Separable Shells*
- Compressor doweling
- All replacement gaskets

Refrigerant Monitors









Maximum options for application integration

CenTraVac with R514A



Future of CenTraVac

Evolution of the CenTraVac™ Product Line



Now offering R514A - HFO refrigerant on an industry leading portfolio ahead of R123 regulatory change

Delivering industry leading innovation

- Maintains performance and cost of ownership with complex refrigerant changes
- Provide Safe and reliable equipment

Launching New S Series model – with or without oil and current and next gen refrigerant – no change in performance



No compromises on value to customers

New Series S model - CVHM



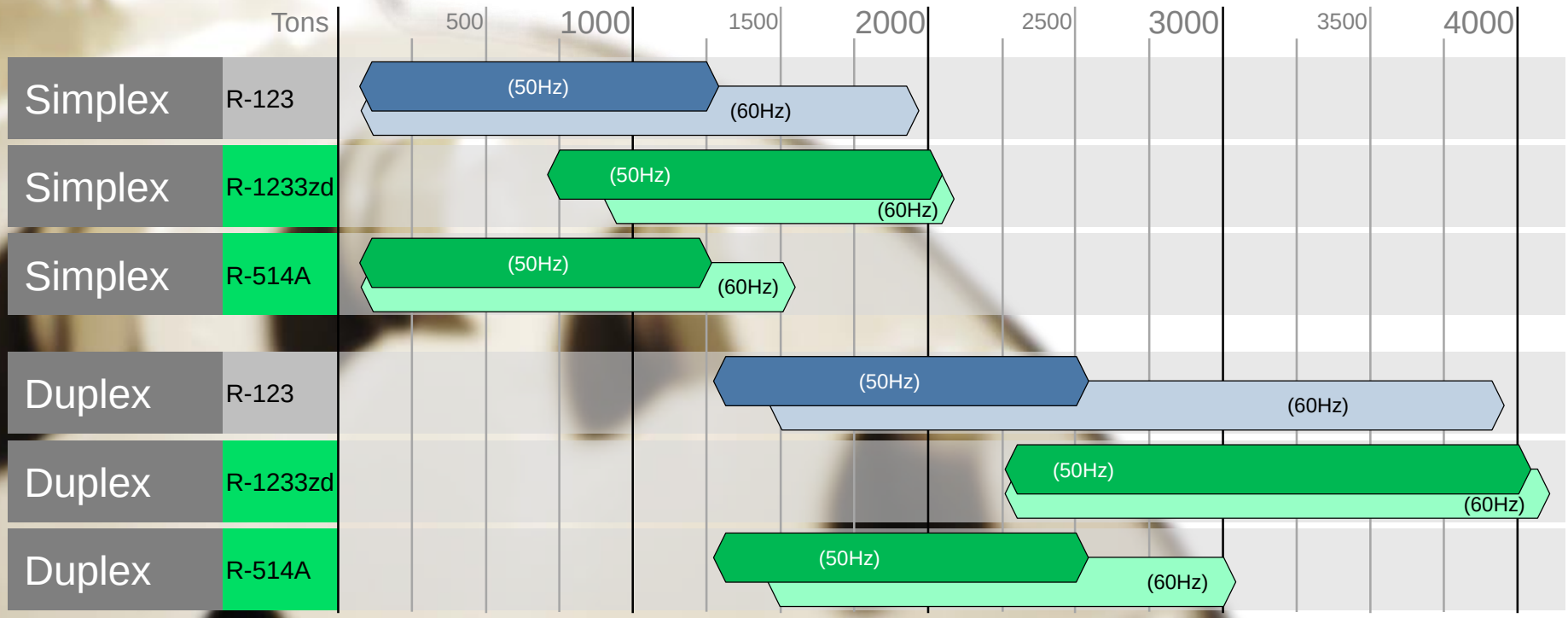
CVHS	CVHM
Oil-Free	Oiled
R-123	R-514A

Full Load
0.478 kW/ton

IPLV
0.296 kW/ton

Highest efficiency in the industry – oil or oil free

Complete Trane Centrifugal Chiller Offering



Expanding the “CHOICES” to the Complete Centrifugal Offering

Differences between R123 and R514A

Orders with new R514A chillers will have

- New Refrigerant and new Oil
- Optimized Software for new refrigerant
- Modified Purge Unit

Aftermarket conversion of existing R123 chillers

- Requires Oil and Refrigerant change
- Software change
- Purge Unit modification
- Impeller and/or Orifice plate change (in some cases …. Application dependent)

Purchase R123 chillers that are compatible for future conversion

- Chiller selection optimized for R514A and R123
- Avoid performance impact from change

Transition made easy… various options for customers

Trane Advantage - Performance Testing

Providing performance verification at your conditions

- Validate operating requirements through exact test points
- Precise control to replicate real-world operating conditions
- Authenticate performance and secure savings









- Rapid Restart
- Total Demand Distortion (TDD)
- Heat Recovery
- Cold Start
- Series Configurations
- Free Cooling
- Tight Tolerances
- Sound Testing
- Variable Flow
- Remote Test

Plus customizable options…

Make sure that what is specified… is what you get!



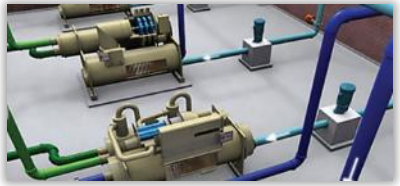
HVAC Equipment Supplies



Application and Design Support



Design & Economic Analysis



Systems Engineering



Controls

Why People Turn to Trane…



Service Solutions



ISO 9001 Certified Manufacturing



Research & Development



AHRI Certified Performance Testing



Global Parts Supplies

Thank you for your Time and Attention! … Questions?