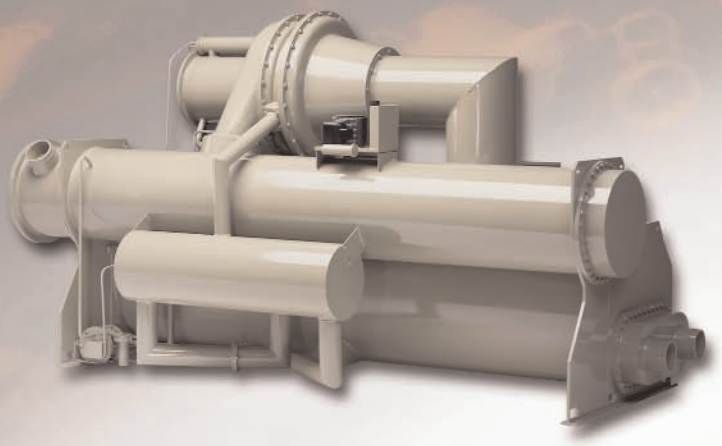
TRANE®

S-Series EarthWise™ CenTraVac™ Chiller

Oil-free, high-efficiency, low-emission technology for sustainable performance



Major technical breakthrough—no more oil lubricants.

Direct-drive design with refrigerant-lubricated, hybrid ceramic bearings.

Engineered for low total cost of ownership. Higher efficiency. Lower operating and maintenance costs.

S-Series technology reduces operating and maintenance costs by design, not by coincidence.

Leak-free and sustainable. Fewer fittings. Fewer worries.

Hermetic integrity for environmental protection—documented sustainability for reliable performance.

EarthWise and Integrated Comfort systems—optimized, engineered environments.

From concept through commissioning and operation, Trane system solutions put you in control.

Inside:

CTV-SLB014-EN

The difference lies in the dramatically different, yet simple, design.

Simple reliability.

Its simplicity has earned the direct-drive CenTraVac™ the reputation as the most reliable chiller in the world. By eliminating oil, Trane engineers have made an already simple design even simpler. Figure 1 demonstrates the percentage of parts reduction compared to CenTraVac CVHF models with an oil/refrigerant pump system.

Refrigerant lubricates the ceramic ball bearings.

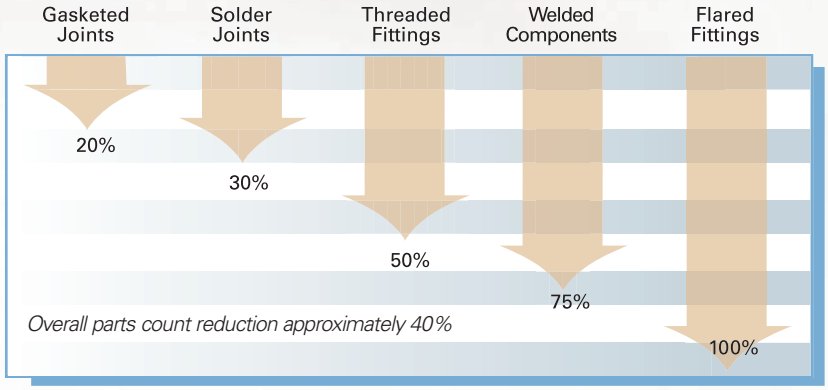
The S-Series EarthWise™ CenTraVac chiller uses an oil-free design that sets it apart from all other chillers.

The S-Series EarthWise CenTraVac uses hybrid ceramic ball bearings—with ceramic balls and steel raceways—that are lubricated with refrigerant, not oil. The ceramic balls are so hard that striking one with a hammer on a cement floor might crack the floor. It might dent the hammer. But nothing will happen to the ceramic ball.

The bearings are self-healing.

The hardness and character of the ceramic balls in hybrid ceramic bearings enable them to minimize, and potentially eliminate, bearing degradation and failure. The ceramic balls are much harder than the bearing steel and dissimilar to it. They therefore do not weld to the track, thus eliminating the potential for spalling—the flaking and resulting unevenness of the bearing track—that often leads to total bearing failure. In addition, imperfections in the raceway caused by dirt or other contaminants are worn smooth by the ceramic balls. This polishing action provides a self-healing effect in the bearing. In contrast, with an all-steel bearing, the races are made of the same steel as the balls. Under conditions of tremendous pressure and poor lubrication, the steel ball and steel raceway can come into contact and momentarily weld together. An instant later, when the ball is forced to advance, it tears some of the metal from the raceway along with it. Because both the raceway and the steel ball are affected, the process can degrade even further, frequently leading to bearing failure.

Figure 1—S-Series EarthWise CenTraVac percent reduction compared to previous Trane designs



Low-pressure HCFC-123 is the key.

Use of hybrid ceramic bearings alone will not eliminate the need for oil. The key to a completely oil-free design is the simplicity of the low-pressure, HCFC-123, direct-drive design utilized by the S-Series EarthWise CenTraVac.

The inherent properties of higher-pressure refrigerants typically necessitates the use of a gear-drive design. This is critical in that only a direct-drive design can be oil-free. To understand why consider the discussions accompanying the illustrations below.

Only a direct-drive design enables the elimination of oil.

As Figure 2 demonstrates, a direct-drive design uses impellers that are on the same shaft as the motor rotor. This characteristic eliminates the need for a gearset. In addition, there are only two main bearings that need lubrication.

It is essential to use a gear-free design, because gears require lubrication and there is no known technology to eliminate oil-based lubrication for gears. As shown in red on Figure 3, medium to high-pressure refrigerant chillers use gears. This limits the potential for using a gear drive in oil-free applications.

The situation is similar in open-compressor designs. For open designs, the gear set shown in red on Figure 4 is typically located within the compressor housing, to keep the gears clean and to allow the shaft seal to be applied on the lower-speed shaft. In these designs, the need to provide oil for the gears, gearset, and shaft sealing again prohibits their use in an oil-free design.

Figure 2 — Direct-drive design

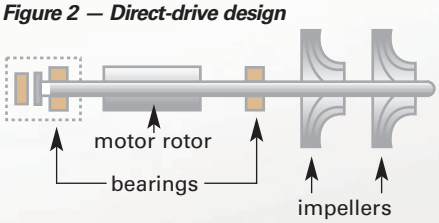


Figure 3 — Gear-drive design

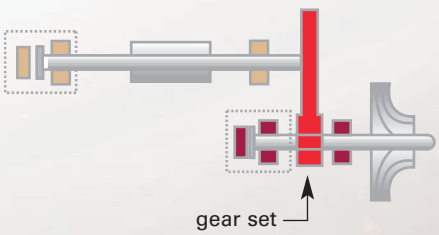
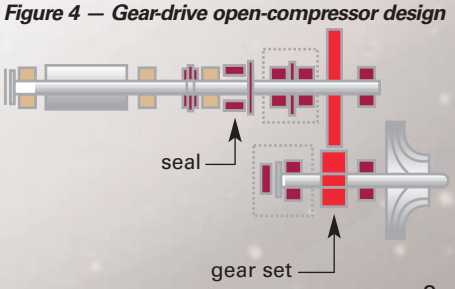


Figure 4 — Gear-drive open-compressor design



Trane's oil-free design is dollar-wise.

Until now, oil was necessary—and with costly consequences.

The oil necessary to lubricate other chillers has the potential to contaminate the refrigerant, degrading energy efficiency. Older CFC chiller designs typically allowed oil absorption of 3 to 7 percent, increasing operating costs by up to 15 percent. And while many of today's chillers are designed to minimize or recover oil losses to the refrigerant, the best way to ensure that oil contamination never occurs is to eliminate it altogether.

Oil-free design prevents refrigerant contamination, maintains optimal efficiency.

Data from the Trane advanced laboratory shows why it is important to have clean, oil-free refrigerant. Oil, as a contaminant, significantly impacts chiller efficiency. The more that oil contaminates the refrigerant, the more efficiency is lost and the more money is spent on energy. Figure 5 illustrates the effect that oil (shown as units of percent oil in refrigerant) can have on efficiency (shown as a percent of efficiency loss).

If the refrigerant charge in a chiller contained even 3.5 percent oil, it could mean up to an 8 percent loss in efficiency. An 8 percent efficiency loss will have a significant impact on operating cost.

In constant dollars over a 30-year lifetime, this would be almost $350,000 or ***over twice the initial cost of the chiller itself!***

In addition, it would increase the utility-generated greenhouse gas emissions by more than 4 million pounds of CO_2.

An efficiency-robbing and environmental risk can be removed by eliminating the need for oil altogether.

The typical concentration of oil in chillers today can be surprising. Figure 6 shows average oil content (as a percentage of refrigerant) in ten typical, older CFC-11 chillers to be 13 percent, with an efficiency impact of 15 to 20 percent or higher! Experience has shown oil contamination in older high-pressure chillers as well.

Do the math…

Consider the following example:

- A 1000-ton chiller
- 2000 equivalent full-load operating hours (EFLH)
- $0.08/kWh and $15/kW demand
- 0.576 kW/ton (ASHRAE 90.1 minimum efficiency)

Given the assumptions in this example, estimated annual energy cost would be:

Consumption:	1000 tons x 2000 EFLH x 0.576 kW/ton x $0.08/kWh =	$92,160
Demand charge:	1000 tons x 0.576 kW/ton x $15/kW x 6 months =	$51,840
Total energy cost per year:		$144,000

An 8 percent impact on this estimated annual cost of operation would be:

$144,000 x 0.08 = $11,520 per year.

Oil-free lubrication reduces maintenance cost.

While manufacturers' recommendations will vary, oil lubrication maintenance typically includes an annual oil check, an annual filter change, and, if required, an oil change. If an oil change is not required, typical cost ranges from $200 to $400 per year, or, in constant dollars over the 30-year life of the chiller, $6,000 to $12,000.

If an oil change is required, HFC chillers requiring the more expensive POE oil would cost an additional $600 to $1000 per oil change. For standard HCFC-123 chillers that use the less-expensive mineral-based oils, the additional cost typically ranges from $400 to $800 per oil change.

Assuming two to six oil changes during the lifetime of the chiller, in constant dollars the cost would be $1200 to $6000 for chillers requiring POE-based oil, and $800 to $4800 for chillers requiring mineral-based oil.

Oil-free design helps prevent energy loss.

The third and final cost acknowledges that chillers using oil-based lubrication typically have an oil sump heater, which uses energy. Due to wide variability of operating time and conditions, it is difficult to measure the actual energy consumption of these heaters. It is, however, instructive to estimate a typical cost.

An oil sump heater is typically 750 watts. Assuming 4000 hours of operation per year and energy costs of 8 cents/kWh:

	0.75 kW
x	4000 operating hours
x	$0.08
	$240/year

or, in current dollars over a 30-year lifetime, $7,200.

This represents energy loss that can be avoided entirely with an oil-free design.

When these maintenance and operating factors are considered, there are significant financial advantages to using an oil-free design that can represent tens or even hundreds of thousands of dollars in cost savings.

Figure 5—Percent efficiency loss

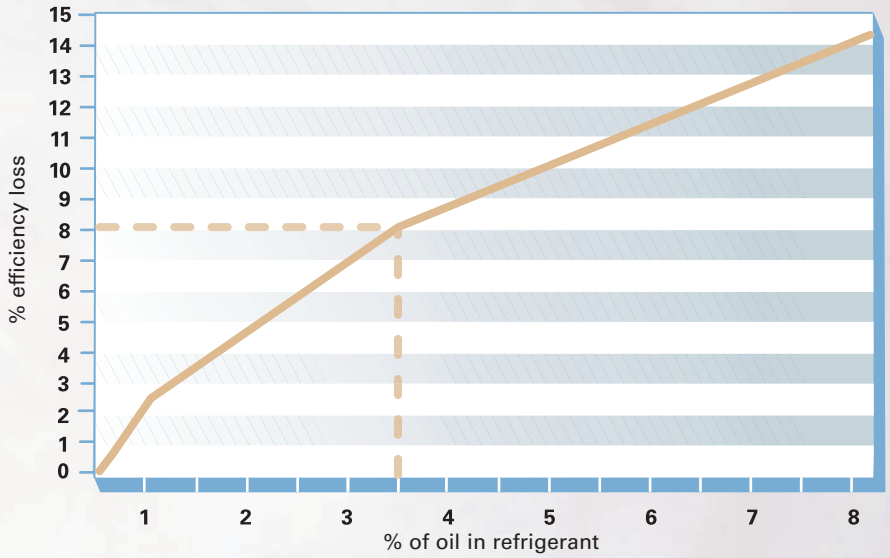
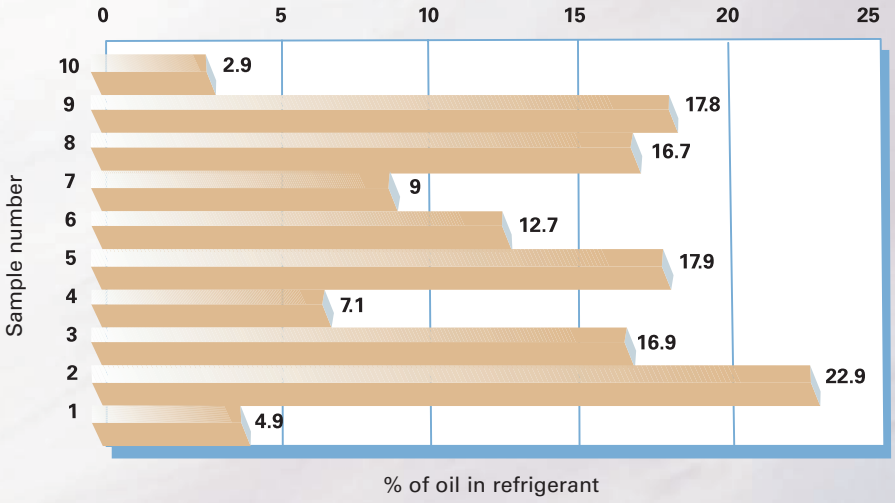


Figure 6—Oil content found in samples of older CFC centrifugals



Data taken from ASHRAE research project 601

Hermetically sealed for efficiency AND the environment

The initial refrigerant charge is the final charge.

The S-Series CenTraVac chiller's oil-free design turns the chiller into a hermetically-sealed application, similar to a home refrigerator. With no oil filters or oil to change, the potential for refrigerant loss during these routine maintenance operations is eliminated. The oil-free design significantly reduces the need for joints, gaskets, and fittings as well—further increasing the hermetic integrity of the chiller. The result of this application is a leak-free design that requires no addition of expensive refrigerant. This design reduces emissions to the environment and allows the initial refrigerant charge to be the final charge, saving money and decreasing the potential impact on the environment.

Leaks impact performance.

Systems that run with a partial refrigerant charge are less efficient, increasing energy consumption, costs, and utility-generated greenhouse gases. A hermetically-sealed design means the chiller runs with a full refrigerant charge at all times for optimal efficiency.

The percent of increased efficiency versus percent of refrigerant charge for a typical centrifugal chiller* is illustrated in Figure 7. This chart demonstrates the impact that leaks (refrigerant loss) have on sustainable performance.

From the chart in Figure 7, if the chiller did not trip out until a little under 35 percent of the refrigerant charge was lost, it would represent an 8 percent decrease in efficiency. If the chiller operated at or close to that condition for an extended period of time, significant and unnecessary energy costs would be incurred.

**This is a representative chiller. The actual impact of charge loss can vary by design and by machine.*

Do the math…

In the previous example, a 1000-ton chiller would cost approximately $144,000 per year to operate. Even if one assumes that the 8 percent efficiency decrease occurred for only half the hours of operation before the low refrigerant charge was discovered, it would cost an additional:

$144,000 x 0.08 x 0.5 = $5,760

And, it would increase utility-generated greenhouse gas emission by nearly 70,000 pounds of CO_2 annually.

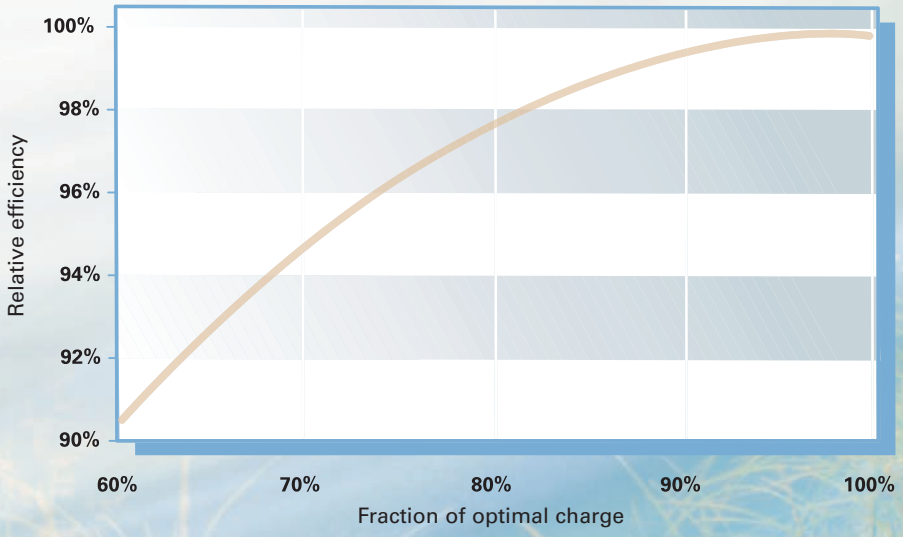
EarthWise purge—the world's best leak detector system—helps ensure peak efficiency.

The S-Series EarthWise CenTraVac comes standard with an EarthWise purge. This newly redesigned purge, specifically designed to help ensure sustainable performance, uses a microprocessor-controlled, regenerative cycle to automatically help keep the activated carbon in the purge unit at its peak efficiency. Refrigerant is recovered from the activated carbon and recycled directly back to the chiller, which helps keep the refrigerant charge at its 100 percent ideal charge level.

The best indicator of refrigerant leaks, by far, is to monitor purge run time. The monitoring and documentation of purge run time is provided as standard with every S-Series EarthWise CenTraVac, such that leaks can be found and fixed before even a small amount of refrigerant is lost.

In contrast, high-pressure chillers typically do not use purges. Owners typically discover that the high-pressure chiller refrigerant charge is low when the machine trips out on the low-pressure (or low-temperature) safety device. Usually, this does not occur until the chiller has lost from 35 to 45 percent of its refrigerant charge.

Figure 7—Efficiency loss vs. optimal charge size



James M. Calm, "Emissions and Environmental Impacts from Air-Conditioning and Refrigeration Systems," International Journal of Refrigeration © 2001 JMC

High efficiency is environmentally friendly.

HCFC-123 is key for efficiency.

The fundamental direct-drive design, and the low-pressure refrigerant HCFC-123, are key for enabling comfort-cooling applications to be typically 8 to 20 percent more efficient than chillers designed using any other CFC-alternative refrigerant. The highest efficiency that other alternative refrigerants can offer is approximately 0.54 kW/ton*. HCFC-123 enables efficiencies of 0.49 kW/ton essentially across the entire line of EarthWise CenTraVac chillers—and as low as 0.45 kW/ton in specific applications.

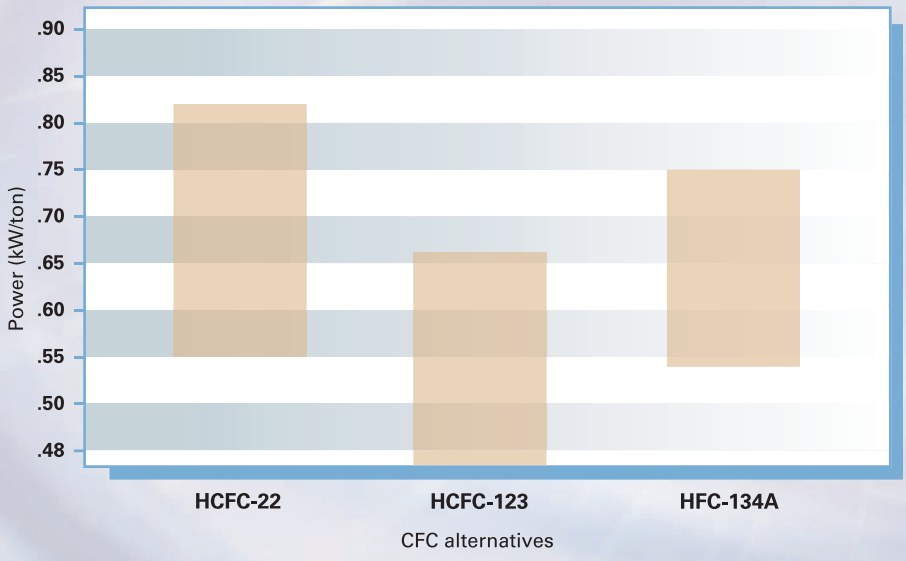
Figure 8 shows the ranges of efficiencies available today with HCFC-22, HCFC-123 and HFC-134a. What you'll notice is that HCFC-123 chillers are, on an average, approximately 8 to 20 percent more efficient than any other centrifugals using any other alternative refrigerant.

*All efficiency ratings at standard ARI conditions

Efficiency impacts the environment.

If every centrifugal chiller in the world operated at a 0.45 level of efficiency, attainable only with HCFC-123, the annual power plant emissions would be reduced by more than 18 billion pounds of CO_2, more than 72 billion grams of SO_2, and more than 30 billion grams of NO_X. In real-world terms, this would be equal to removing more than 2 million cars from the road or planting more than 500 million trees each year.

Figure 8—Chiller efficiencies: 400-ton, water-cooled chillers (all compressor types)



The "S" stands for sustainability.

Documented sustainability.

The key to optimal performance is to sustain this high level of efficiency and low level of emissions throughout the entire lifetime of the chiller. That's the heart of the S-Series EarthWise CenTraVac.

The goal of every S-Series EarthWise CenTraVac is **documented sustainability**. The S-Series EarthWise CenTraVac monitors and documents the key information needed to ensure proper, reliable, high-level performance. Notable examples include monitoring and documentation of:

- Purge run time: allows tracking of the most minute refrigerant leak.
- Condenser and evaporator approach temperatures: indicates possible tube fouling.
- Chiller kW/ton or ampere draws: provides real-time monitoring of energy consumption.
- Evaporator and condenser temperature differential: indicates capacity and accuracy of control.

One of the longest warranties in the industry.

This new industrial technology drastically reduces maintenance costs and provides sustainable high-efficiency, low-emissions performance. In addition to offering one of the longest chiller warranties available in the industry, Trane is demonstrating its commitment to this technology—and to our customers—by offering an optional, extended, full-coverage warranty including parts, labor, and refrigerant. This competitively-priced option is the best way for owners and system designers to see firsthand the total maintenance cost advantage of the S-Series EarthWise CenTraVac. It's that simple. That reliable. That good.

The chiller is part of a system.

As exciting as the S-Series CenTraVac is, one must never forget that the meter is not hooked to the chiller, it's hooked to the entire building. That is why the focus needs to be on the entire system. That is also why Trane offers system-based solutions; solutions called the EarthWise systems; systems that have at their heart the ability, via Trane's Integrated Comfort™ systems (ICS), to control, monitor, and document the performance of the entire system. Simply stated, documented, sustainable performance of the entire system is the future of our industry—a future that products and systems like the S-Series EarthWise CenTraVac and EarthWise systems are destined to lead.

However, EarthWise systems have something else that is driving them to become one of the industry's most sought-after designs: a characteristic referred to as the "Holy Grail" of engineering—the ability to reduce *both* operating cost and first cost. By incorporating a low-flow, low-temperature, high-efficiency approach, EarthWise systems inherently take money out of the HVAC infrastructure—the piping and ductwork—and put it into the HVAC assets—the chillers, air handlers, and controls. In addition, these are systems that have improved IAQ, acoustics, and comfort characteristics.

Trane EarthWise design for chilled-water systems.

Three principles at the foundation.

The EarthWise chilled-water system uses a sustainable design that is based on three primary tenets:

- **Low flow**
- **Low chilled-water and air temperatures**
- **High efficiency**

Trane applies these principles to the entire system, both airside and waterside, to deliver high efficiency and superior comfort for significantly less money than conventional designs. The heart of the EarthWise system is the Trane EarthWise CenTraVac chiller.

Saves space. Saves time. Saves money.

EarthWise system design requires smaller pumps, piping, and valves, freeing up more usable floor space and reducing design time by simplifying the HVAC layout. This unique design decreases the total cost of ownership by cutting both installation and operating costs. EarthWise design saves up to 60 cents per square foot on installation costs and up to 20 to 30 percent on operating costs compared to conventional chilled-water system designs.

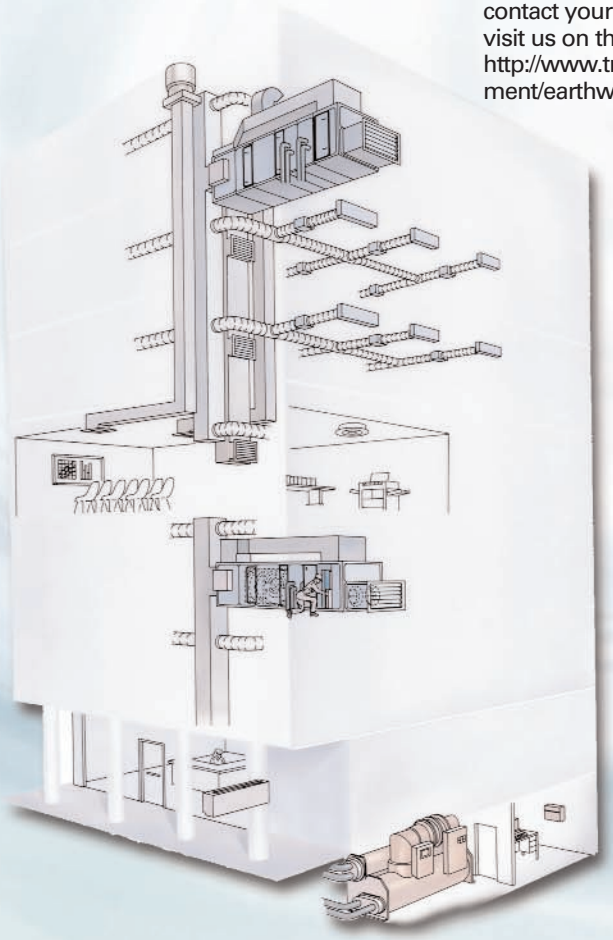
In HVAC designs incorporating a cooling tower, the EarthWise system provides increased cooling capacity from smaller new towers and enhanced performance from existing towers. Reducing the fan horsepower and energy required for water distribution minimizes the combined chiller and tower energy consumption for optimal efficiency.

Less airflow has benefits.

EarthWise design also reduces the required volume of airflow, allowing for smaller air-handling systems. This includes:

- Smaller air handlers
- Smaller ductwork
- Smaller terminals
- Smaller equipment rooms
- Lower construction costs (floor-to-floor height is reduced)

Supplying less airflow at colder temperatures permits quieter operation, reduces relative humidity in the building, and allows for higher thermostat settings. The results? Improved comfort and better indoor-air quality. The EarthWise system allows building owners to provide a better environment for tenants while reducing total cost of building ownership.



A winning combination with Integrated Comfort systems.

Get optimal results from the EarthWise system with Trane Integrated Comfort systems (ICS). Integrated Comfort systems incorporate factory-engineered and -commissioned controls that ensure:

- Consistent quality
- Fast, easy startup
- Reliable operation
- Simplified (single-source) maintenance and service
- Documented performance

Better for your building. Better for your tenants. Better for your bottom line.

HVAC costs account for up to half of a building's operating expenses. So why not install the only system that gives your tenants exceptional value and does what's best for the environment?

To learn more about EarthWise systems contact your local Trane sales office or visit us on the Web at: http://www.trane.com/commercial/equipment/earthwise_systems/

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Trane Integrated Comfort systems.

Today's building owners face several challenges when commissioning or recommissioning a building:

- High labor and field-installation costs
- Interoperability issues with existing equipment and systems
- Management of energy use and costs

Integrated Comfort systems is the way to link components, applications, and service expertise into a single reliable system that provides maximum comfort, control, and documented, sustainable, high efficiency from the first day through the life of the system.

Control your building. Don't let it control you.

With ICS, factory-installed microprocessor controls for HVAC components are linked to a Trane Tracer Summit™ building management system, providing superior building control and optimization.

Single-source responsibility for optimal results.
ICS offers seamless comfort, comprehensive building monitoring, and in-depth diagnostics from a single source. Trane.

Each Tracer™ controller is built and programmed to work on a specific piece of Trane equipment. This allows building managers to use Trane expertise to implement their preferred control strategies and satisfy necessary facility conditions.

Pre-engineered components for quick and easy startup.
The key to ICS is factory commissioning of controls. Controls are installed, connected, operated, and verified for functionality right in the factory. This ensures trouble-free installation and fast system startup, significantly reducing labor and field-startup costs. Building owners enjoy rapid commissioning and faster occupancy.

Incorporates existing components for more building solutions.
Facility additions, retrofits, or replacements benefit from ICS because it can be tied to equipment and systems originally built by other manufacturers.

Interoperability to meet today's systems needs.
The Trane Tracer Summit standard architecture supports BACnet® at the system level and LonTalk® at the unit control level, providing flexibility to support other protocols as needed.

Easy operation for better performance.
Tracer systems are designed for easy use, incorporating common-sense features such as automatic restart after a power outage to enhance reliability. ICS uncomplicates tasks like system monitoring and maintenance, making operating data from all system components available for evaluation and diagnosis. Better performance data simplifies preventive maintenance and allows reliable, accurate, and economical unattended operation.

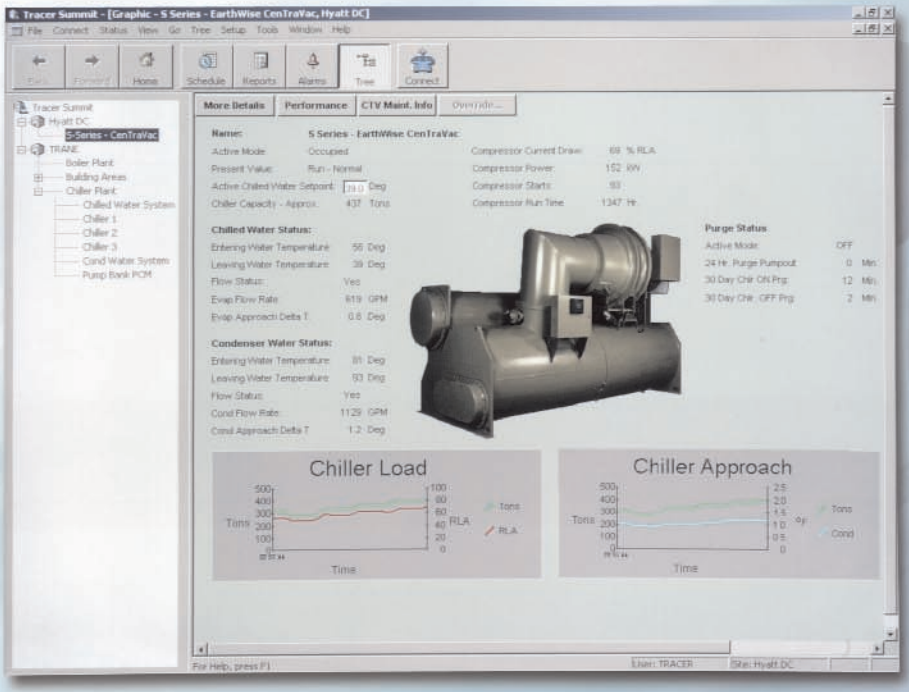
Trane offers several levels of training, as well as the Tracer Summit Users Network Web site, to help building operators get the most out of their Integrated Comfort system. Training is available at local Trane sales offices, regional locations, or the Trane ICS Institute in St. Paul, Minnesota, USA.

Efficient building control for energy use and cost management.
Effective building-control strategies help building owners use energy more efficiently, reducing energy costs. ICS enables system-optimization strategies to minimize HVAC energy use, while fully meeting the comfort requirements of the building.

Looking for system solutions? Look to Trane.

Trane is the only manufacturer to offer this universe of equipment and controls, as well as factory installation and commissioning. For more information, contact your local Trane sales office or visit us on the Web at:

http://www.trane.com/commercial/equipment/earthwise_systems/

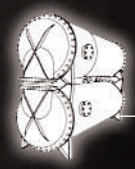


Recognition. And a history of innovation.

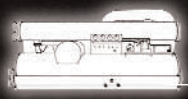
For more than half a century, the names of CenTraVac and its predecessor, the Trane TurboVac™, have been synonymous with the very best in large water chillers, providing cooling for large buildings and process applications. As the industry's most-efficient, lowest-emission chillers, more centrifugals shipping today bear the name CenTraVac than all competitive centrifugals combined.

In addition, the EarthWise CenTraVac is the only chiller to receive the U.S. EPA's highest environmental award, the Climate Protection Award.

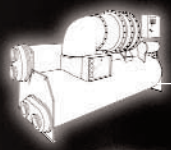
The CenTraVac has enjoyed a long and prestigious history:



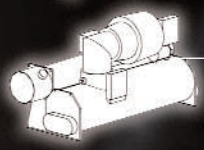
1938—Trane announces the world's first direct-drive, hermetic, multi-stage, centrifugal water chiller.



1964—Trane announces the first packaged CenTraVac.



1981—Trane announces the first 3-stage, direct-drive centrifugal chiller.



1993—Trane announces the EarthWise CenTraVac, the world's most-efficient, lowest-emissions chiller.

Now, in 2002, Trane announces the next generation of CenTraVac chillers—the "S-Series EarthWise CenTraVac."

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For more information contact your local district office or e-mail us at comfort@trane.com

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