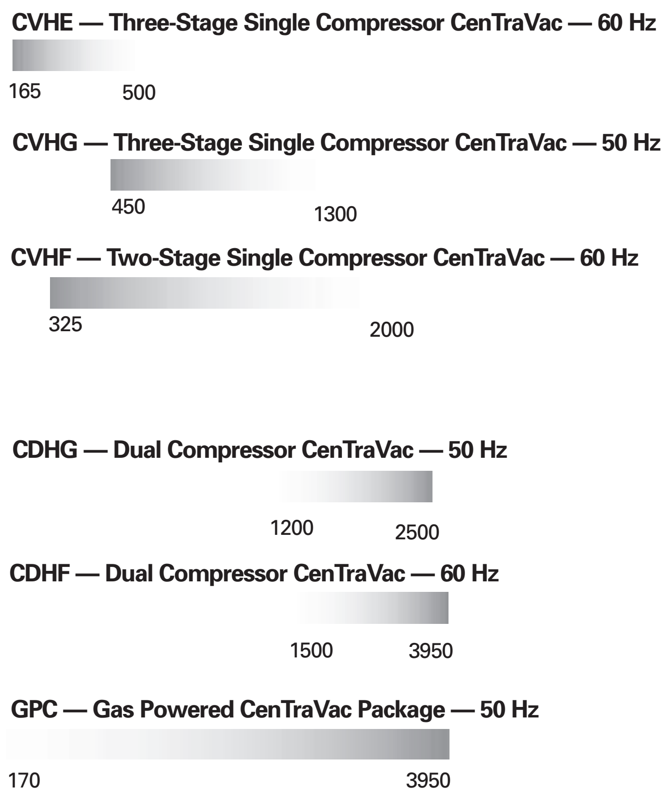
EarthWise™ CenTraVac™ Water-Cooled Liquid Chillers

165-3950 Tons
50 and 60 Hz

Tonnage Ranges By CenTraVac Model Number



October 2002

CTV-PRC007-EN

TRANE

Introduction

World's Most Efficient Lowest Emissions Chiller

A Continuous Standard of Operational Excellence

At Trane we've found that the straightest path to reliability is simplicity. The Trane CenTraVac chiller has only one moving part — a single rotating shaft supported by two aircraft-turbine-rated bearings. This direct-drive concept minimizes the chance of failure by reducing the number of critical parts — there are no gear boxes, couplings, extra shafts, or shaft seals. This simpler design reduces wear and drag on parts, resulting in more sustainable, reliable and efficient operation.

Engineered to be Economically and Environmentally Superior

The Trane EarthWise CenTraVac has a proven track record as literally the world's most efficient, lowest emissions chiller. In fact, a portion of the product line is selectable at an unmatched efficiency level of .48 kW/ton, at standard ARI rated conditions. This is an efficiency level of 16 to 25 percent better than competitive chillers, which are typically in the .56 to .60 kW/ton range.

The Trane EarthWise chiller also has the lowest total refrigerant emissions in the industry. So low that it's essentially a closed system.

DuPont's Suva-123 For The Lowest Total Refrigerant Emissions In The Industry

The key to the industry's highest energy efficiency and lowest leak rate is the use of a low pressure refrigerant DuPont calls SUVA-123; a refrigerant that has the lowest direct-effect global warming potential and the highest thermodynamic efficiency of all non-CFC refrigerants; a refrigerant in use in more new centrifugals today than all other alternatives combined.

Tracer™ CH530 Chiller Controller

The Tracer™ CH530 is a new chiller controller technology developed by Trane for use on large chillers. CenTraVac™ chiller control now includes feedforward algorithms that dramatically shorten chiller response time energy-saving variable pumping strategies; and enhanced adaptive™ control to keep the chiller on line, even under adverse operating conditions. The CH530 controller includes unit mounted control panel, main processor and DynaView operator interface.

Feedforward Adaptive Control Strategies

Feedforward is a predictive control strategy designed to anticipate and compensate for load changes via entering water temperatures. The following control capabilities are now possible with Trane CenTraVac chillers:

- Soft loading
- Multi-objective limit arbitration
- Fast restart
- Adaptive frequency drive control (AFD)
- Variable primary flow (VPF)
- Variable flow compensation
- VPF with AFD
- 34°F leaving water temperature

EarthWise™ HVAC System Designs

The EarthWise System is a design philosophy that reduces first cost, lowers operating costs, and is substantially quieter than traditional applied systems. Central to the design are low flow, low temperature, and high efficiency for both airside and waterside systems, along with optimized control algorithms for sustainable performance.

EarthWise Systems are less expensive to install and operate than conventional designs. Trane Integrated Comfort system (ICS) control technology assures that the EarthWise System delivers optimal, reliable performance.

With smaller equipment and ductwork, the EarthWise concept reduces design time by simplifying the HVAC layout. Supplying less airflow at colder temperatures permits quieter operation and reduces relative humidity in the building, improving indoor air quality.

Compared to conventional designs, an EarthWise chilled water system can reduce the total cost of ownership by cutting installation and operational costs.

To learn more about EarthWise Systems, visit

www.trane.com/commercial/issues/earthwise_systems

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Introduction The Trane Name

System Design Flexibility

When a source of energy other than electricity is required, the Trane CenTraVac has a pre-engineered control option that allows it to be coupled to a Waukesha Enginator. The Gas-Powered Chiller* option allows you to convert natural gas to chilled water. With COPs in the range of 1.5 to 2.2, this option is a very simple and attractive alternative when an alternative fuel source is desired.

The CenTraVac chiller and Waukesha engine are capable of both base and peak shaving. Further, the packaging of the GPC allows for the engine to be set remote from the chiller. This is helpful in situations when floor space or sound sensitive areas are being considered.

Unmatched Local Expertise

The performance and reliability of a CenTraVac™ chiller is backed by a local team of engineers that can help answer your questons or solve your problems regarding system design application, installation or evaluate equipment alternatives. No other manufacturer can offer that degree of support to its customers.

Delivery And Design Flexibility

If delivery time is a priority, Trane can meet your needs with a variety of quick shipment choices.

Design flexibility means Trane can custom build a unit to specific job requirements. Design parameters such as shell type, compressor, kW/ton, waterside pressure drop, as well as full and part load performance can be built to meet requirements.

ISO 9001 Certification

ISO 9001 Certified Quality System applies to the Trane La Crosse Business Unit. The sysem documents office, manufacturing and testing procedures for maximum consistency in meeting or exceeding customer expectations. ISO 9001 requires extensive documentation on how quality assurance activities are managed, performed, and continuously monitored. Included in the system are verification checkpoints from the time the order is entered until final shipment. In addition, product development is subjected to formal planning, review and validation.

Performance ARI Standard Certified

Trane centrifugal chillers tested within the scope of the ARI program display the ARI symbol of compliance to certification sections of ARI Standard 550/590. The EarthWise™ purge is rated in accordance with ARI Standard 580.

Those applications in this catalog specifically excluded from the ARI certification program are:

- Low temperature applications, including ice storage
- Glycol
- Chillers above 2000 tons
- Free cooling
- Heat recovery
- Auxiliary condenser
- Chillers that use 50 Hz power

*Limited availability for International orders – Please contact International CenTraVac Marketing Group.

District Cooling

Trane's Adaptive Control™ algorithms and the multistage design allow all Trane CenTraVac chillers to operate at low leaving water temperatures without the use of glycol. This reduces the cost of delivering cooling capacity over long distances. Pre-engineered thermal storage systems using Trane chillers extend the chiller's exceptional reliability to the rest of the district cooling plant.

Turbine Inlet Cooling

Trane chillers are frequently used in conjunction with combustion turbines to increase the power capacity, efficiency, and life of the turbine. Turbine inlet cooling can eliminate the need for inlet water spray for reducing NOx emissions. With turbine inlet cooling, plants can delay or even avoid the need for additional turbines, because more capacity can be obtained from existing turbines.

Features and Benefits

Comparing the Attributes of Low Pressure Chiller Operation to High Pressure Chiller Operation

Trane CenTraVac chillers continue to offer time-tested and proven low-pressure refrigerants, including the environment friendly HCFC-123. Trane CenTraVac chillers provide the safety of low-pressure with continued product improvement in leak proof design. Consider the benefits of low-pressure over high-pressure chillers:

Table 1 — Low Pressure to High Pressure Comparison

	Low Pressure	Medium/High Pressure
Evaporator	• Always at negative pressure • Air leaks inward at low rate • Refrigerant lost: (# air leak in) x purge efficiency* • No refrigerant loss is into equipment room (vented to the outside via purge)	• Always at positive pressure • Refrigerant leaks outward at moderate rate • Refrigerant loss is into equipment room
Condenser	• At slightly positive pressure during operation • Usually at negative pressure during inactivity (air leaks inward) • Refrigerant leaks outward at very low rate during operation	• Always at high positive pressure • Refrigerant leaks outward at very high rate
Monitoring of leak rate	• Trane EarthWise purge is able to continuously monitor in-leakage with the run meter • Refrigerant monitor as required by ASHRAE • Purge can be connected to a building automation system for notification of increased purge operation (in-leak). Similarly, the refrigerant monitor can be connected to the building automation system.	• Only ways to monitor leak rate on high pressure chiller are — periodic leak checks — purchase refrigerant monitor • Refrigerant monitor as required by ASHRAE • Normally the only time that a leak is detected on a high pressure chiller is during spring startup. This means that a chiller which develops a leak in the summer may leak continuously until the following spring.
	HCFC-123	**HFC-134a**
Typical Pressures (38°F evap.) (100°F cond.)	Evap: 18.7 inches of Mercury Cond: 6.1 psig	Evap: 33.1 psig Cond: 124.1 psig

*Trane EarthWise purge efficiency does not exceed 0.02 lbs./refrigerant/lbs.-air

DynaView Operator Interface

DynaView™ is the unit-mounted control panel and also serves as the main processor and operator interface. It has a touch-sensitive overlay on a 1/4 VGA display.

DynaView presents information through an intuitive, tabbed- navigation system. Alternate languages can be downloaded to the control panel, which can hold English plus two other languages at one time.

DynaView receives information from and communicates information to the other devices on the chiller's communications link. DynaView performs the Leaving Chilled Water Temperature and Limit Control algorithms, arbitrating capacity against any operating limit against which the chiller may find itself working.

- Auto/Stop commands
- Status (all subsystems)
- Setpoint adjustment (daily user points)
- 10 active diagnostics
- Mode overrides
- ASHRAE chiller log

DynaView can be connected to the service tool using a standard 9-pin male, 9-pin female RS-232 serial cable. The serial connection is located at the bottom of the DynaView panel behind a sliding door.

Serviceability

Previous Trane chiller controllers included a user interface that presented all chiller data necessary for both daily tasks and service or maintenance tasks. The amount of information presented on a limited display made a number of tasks difficult. A service technician's ability to assess and resolve chiller problems was hampered by the limited presentation of multiple pieces of chiller information.

The Tracer chiller controller adds a level of sophistication better served by a PC application that improves service technician effectiveness and minimizes chiller downtime. The Tracer chiller controller provides a user interface and main processor, DynaView, that is intended to serve only typical daily tasks. The portable, PC-based service tool software, TechView, supports service and maintenance tasks.

The Tracer chiller controller will be gradually applied to all Trane chillers. TechView will then serve as a common interface to all Trane chillers, and will customize itself based on the properties of the chiller with which it is communicating. Thus, the service technician learns only one service interface.

The panel bus is easy to troubleshoot, using LED verification of sensors. Only the defective device is replaced. Captive screws ensure that the appropriate mounting hardware is available. TechView can communicate with individual devices or groups of devices.

TechView

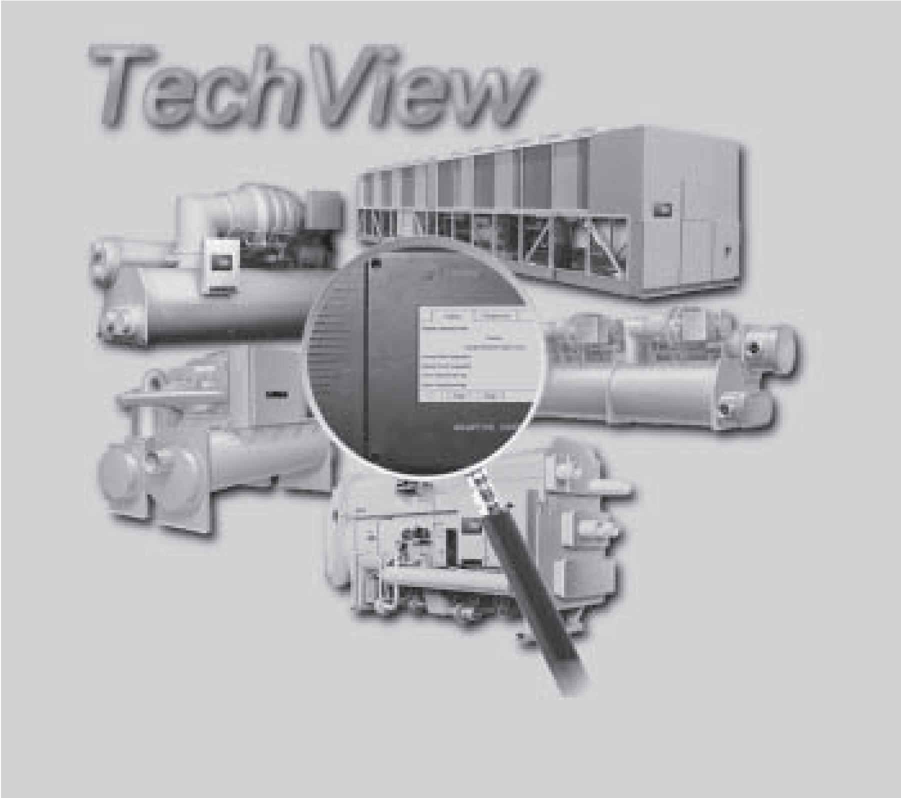
All chiller status, machine configuration settings, customizable limits, and up to 60 active or historic diagnostics are displayed through the service-tool software interface. Any PC that meets the system requirements may download the service interface software and DynaView updates from Trane's Web site at www.trane.com.

LEDs and their respective TechView indicators visually confirm the availability of each connected sensor, relay, and actuator.

TechView is designed to run on a customer's laptop, which connects to DynaView with a serial cable. DynaView's serial port is located behind a sliding door on the bottom of the DynaView enclosure. It uses a standard 9-pin male and 9-pin female RS-232 cable.

Hardware requirements for TechView:

- Pentium II, III, or higher processor
- 128 MB RAM
- 1024 x 768 resolution
- CD-ROM
- 56K modem
- 9-pin RS232 serial connection
- Windows® 95, 98, 2000



Standard Features

The following features are provided as standard with all Trane CenTraVac™ chillers:

- Tracer™ Chiller Control Strategies
- Low-pressure operation that minimizes the chance for outward refrigerant leaks.
- Hermetically sealed and precision cooled by liquid refrigerant that keeps the motor, drive, and equipment room temperatures controlled, monitored and predictable by design. Taking predictable reliability to yet another level, this feature also protects against motor-destroying elements such as dust, grit, metal shavings, high humidity, high ambient operating temperatures, and process liquids or gases.
- Designed to be rugged and simple, yet amazingly quiet, the CenTraVac is directly driven, in low speed, by a motor shaft that is supported by two aircraft-turbine-rated bearings. The design includes industrial-grade components and only one moving part. Likewise, the design purposely excludes speed-increasing gears and lightweight parts that, while accessible, have a higher failure rate.
- On-line tolerance for quick changes in refrigerant loop conditions, variable pumping strategies, and other atypical operating requirements.
- Purge capability when chiller is off
- Heat exchanger control
- Two-stage or single stage economizer
- Prewired instrument and control panel
- Oil and refrigerant charge
- Oil heater
- Isolation pads
- Wiring and conduit for purge and oil system interconnection to the main control panel
- Installation, operation, and maintenance instructions
- High efficiency purge system with automatic regeneration capability

- Entering condenser water temperature to 50 degrees F maintaining 3 psi differential pressure
- Phase voltage sensors (3-phase)
- Meet or exceeds ASHRAE 90.1-1999
- Startup and operator instruction service
- Protection - See Control Section
- Motor control and compressor protection
- Hot water control and Ice-making control

Optional Features

Trane offers a selection of optional features to augment the standard chiller installation or to modify the chiller for special purpose applications.

- Medium-voltage (over 600 volts) compressor motor
- Complete line of compressor motor starters - factory installed prewired if you prefer
- Marine waterboxes for evaporators and condensers
- Proof of promised performance and sound pressues
- High-pressure (300 psig) water side construction
- Energy saving free cooling, heat recovery, or auxiliary condenser
- Special tubing: smooth bore; CuNi; various tube wall thickness; and internally enhanced
- Refrigerant monitor
- Factory-applied thermal insulation
- Spring isolators
- Building automation systems (BAS) interface
- Chilled water reset based upon outside air temperature
- Leaving water temperature to 34 degrees F w/o glycol
- Variable speed drives
- UL Label
- Three-pass or one-pass evaporator
- Chiller break apart (disassembly)
- Special paint and controls for outdoor use or corrosive environments
- Enhanced condenser limit control
- Extended operation control for external ice-building, base loading and making hot-water

Features and Benefits

Factory Testing for Assured Performance

Trane is part of the ARI 550/590 certification program. The selection program and machines bear the ARI seal of approval. Performance testing is a key part of this program. While the certification program is technically sound, a factory run test, with your machine on the test stand, is still the best way to confirm machine performance and a trouble-free startup.

To prove that your chiller will perform as promised, Trane offers factory performance testing, which you can witness. Testing confirms chiller efficiency, chiller capacity, and makes trouble free startup significantly more predictable.

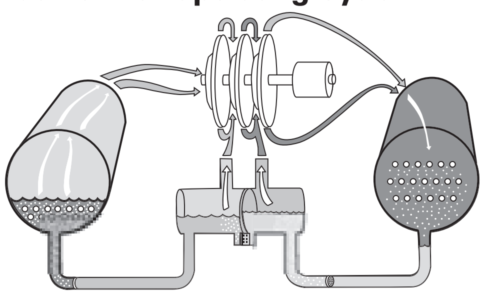
Testing is in accordance with ARI Standard 550/590 and calibration of instrumentation meets or exceeds the National Institute of Standards Technology (NIST).

Trane offers two levels of CenTraVac performance testing:

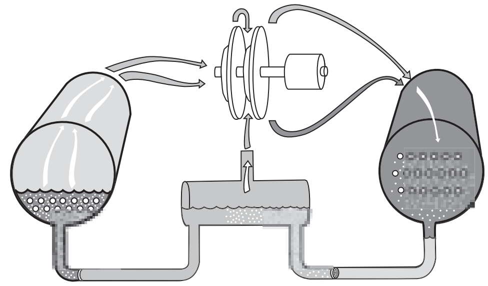
- A performance test at design conditions plus a certified test report.
- A customer-witnessed performance test at design conditions plus a certified test report.

During customer witnessed performance tests of Trane CenTraVac chillers, a nickel can be balanced on the edge of the compressor-motor assembly, demonstrating the extremely low vibrations generated by the unit while operating at full and part load conditions.

The CenTraVac™ Chiller Operating Cycle



Three Stage Refrigerant Flow



Two Stage Refrigerant Flow

CenTraVac Motor
The motor provided in the Trane CenTraVac chiller is a specially designed squirrel-cage, two-pole induction motor suitable for 50 and 60 hertz, three-phase current.

Trane CenTraVac motors are cooled by liquid refrigerant surrounding the motor windings and rotor. Using liquid refrigerant results in uniform low temperatures throughout the motor, which prolongs the life of the motor.

Design Simplicity
Impellers are keyed directly to the motor shaft for high reliability and performance and low life-cycle costs.

Fixed Orifice Flow Control
For proper refrigerant flow control at all load conditions, the CenTraVac design incorporates the Trane patented fixed orifice system. It eliminates float valves, thermal expansion valves and other moving parts. Since there are no moving parts, reliability is increased.

Quiet Operation
With only one moving component — the rotor and impeller assembly — the Trane low speed, direct drive design operates exceptionally quietly. The smoothly rotating CenTraVac compressor is inherently quieter than other compressor types. Typical CenTraVac chiller sound measurements are among the quietest in the industry. Trane can guarantee sound levels with factory testing and measurements in accordance with ARI standard 575.

The Reliability Standard
Just as a multistage turbine is more efficient than a single stage turbine, the CenTraVac multistage compressors are more efficient and reliable than single-stage designs.

Direct Drive Design — No Gear Losses
The direct drive compressor operates without speed increasing gears, thus eliminating gear energy losses. Compressors using gears suffer mesh losses and extra bearing losses in the range of three to five percent at full load. Since these losses are fairly constant over the load range, increasingly larger percentage losses result as load decreases.

Multiple Stages of Compression
The compressor operates more efficiently over a wide range of capacities, virtually eliminating the need for energy wasting hot gas bypass as typically found on single stage chillers.

The radial component of velocity determines the ability of the chiller to resist interruption of smooth refrigerant flow when operating at light loads and with high condensing temperatures. This interruption in flow and unstable operation, called "surge" is avoided with the two-stage design.

Inlet Guide Vanes
Part load performance is further improved through use of moveable designed variable inlet guide vanes. Inlet guide vanes improve performance by throttling refrigerant gas flow to exactly meet part load requirements and by prerotating refrigerant gas for optimum entry into the impeller. Prerotation of refrigerant gas minimizes turbulence and increases efficiency.

Two-Stage Economizer
The CVHE/CVHG CenTraVac chiller has a two-stage economizer — providing up to seven percent greater efficiency than designs with no economizer. Since the CVHE/CVHG uses three impellers, it is possible to flash refrigerant gas at two intermediate pressures between the evaporator and condenser pressures, significantly increasing chiller efficiency. This improvement in efficiency is not possible in single-stage chillers since all compression is done by one impeller.

Single Stage Economizer
The CVHF CenTraVac chiller has a single-stage economizer — providing up to 4½ percent greater efficiency than designs with no economizer.

Since the CVHF CenTraVac uses two impellers, it is possible to flash refrigerant gas at an intermediate pressure between the evaporator and condenser pressures, significantly increasing chiller efficiency. This improvement in efficiency is not possible in single-stage chillers since all compression is done by one impeller.

Refrigerant/Oil Pump Motor
The oil pump motor is a 120 volt, 50/60 hertz, ¾ hp, 1 phase motor with protective fusing and panel mounted contactor.

EarthWise Purge System
The new purge design features a high-efficiency carbon filter with an automatic regeneration cycle. The filter collects and scrubs refrigerant and noncondensable gas and returns collected refrigerant vapor back into the chiller. When the tank senses that it is full, the regeneration cycle begins, and reclaimed refrigerant is automatically returned to the chiller. This keeps the purge efficiency at its peak without the need to exchange carbon cannisters.

Normal operating efficiency does not exceed 0.02 lbs. of refrigerant lost per pound of dry air removed. The purge system can be operated at any time, independent of chiller operation, per ASHRAE Standard 147.

Figure 1 — Three-Stage CenTraVac P-H Diagram

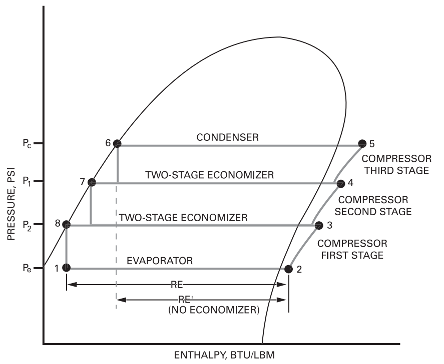
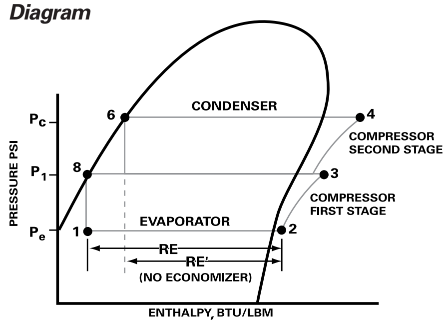


Figure 2 — Two-Stage CenTraVac P-H Diagram



CenTraVac™ Two-Stage and Three-Stage P-H Diagram

The pressure-enthalphy (P-H) diagram describes refrigerant flow through the major chiller components. The diagrams confirm the superior operating cycle efficiency of the three- stage compressor and two-stage economizer respectively.

Evaporator — A liquid-gas refrigerant mixture enters the evaporator at state point 1. Liquid refrigerant is vaporized to state point 2 as it absorbs heat from the system cooling load. The vaporized refrigerant then flows into the compressor first stage.

Compressor First Stage — Refrigerant gas is drawn from the evaporator into the first stage compressor. The first stage impeller accelerates the gas increasing its temperature and pressure to state point 3.

Compressor Second Stage — Refrigerant gas leaving the first stage compressor is mixed with cooler refrigerant gas from the low pressure side of the two-stage economizer. This mixing lowers the enthalpy of the mixture entering the second stage. The second stage impeller accelerates the gas, further increasing its temperature and pressure to state point 4.

Compressor Third Stage — For CenTraVac chillers with three stage compression, the refrigerant gas leaving the compressor second stage is mixed with cooler refrigerant gas from the high pressure side of the two-stage economizer. This mixing lowers the enthalpy of the gas mixture entering the third stage compressor. The third stage impeller accelerates the gas, further increasing its temperature and pressure to state point 5, then discharges it to the condenser.

Condenser — Refrigerant gas enters the condenser where the system cooling load and heat of compression are rejected to the condenser water circuit. This heat rejection cools and condenses the refrigerant gas to a liquid at state point 6.

For three-stage CenTraVac chillers with the patented two-stage economizer and refrigerant orifice system-liquid refrigerant leaving the condenser at state point 6 flows through the first orifice and enters the high pressure side of the economizer. The purpose of this orifice and economizer is to preflash a small amount of refrigerant at an intermediate pressure called P1. P1 is between the evaporator and condenser pressures. Preflashing some liquid refrigerant cools the remaining liquid to state point 7.

Refrigerant leaving the first stage economizer flows through the second orifice and enters the second stage economizer. Some refrigerant is preflashed at intermediate pressure P2. Preflashing the liquid refrigerant cools the remaining liquid to state point 8.

To complete the operating cycle, liquid refrigerant leaving the economizer at state point 8 flows through a third orifice system. Here, refrigerant pressure and temperature are reduced to evaporator conditions at state point 1.

For two-stage CenTraVac chillers with economizer and refrigerant orifice system-liquid refrigerant leaving the condenser at state point 6 flows through the first orifice and enters the economizer. The purpose of this orifice and economizer is to preflash a small amount of refrigerant at an intermediate pressure called P1. P1 is between the evaporator and condenser pressures. Preflashing some liquid refrigerant cools the remaining liquid to state point 8.

Another benefit of flashing refrigerant is to increase the total evaporator refrigeration effect from RE' to RE. The economizer of two-stage CenTraVac chillers provides a 4½ percent energy savings and the two-stage economizer of the three-stage CenTraVac chillers provides a 7% savings, compared to chillers with no economizer. To complete the operating cycle, liquid refrigerant leaving the economizer at state point 8 flows through a second orifice system. Here, refrigerant pressure and temperature are reduced to evaporator conditions at state point 1.

Unit Options

Starters

A Wide Array of Low and Medium Voltage Starters

Trane starters can be applied to low- or medium-voltage applications. The current draw of the compressor motor determines the size of the starter. The starter current draw must be greater than, or equal to, the compressor motor current draw.

Low Voltage (200 to 600 volts)

- Star (wye)-delta closed transition
- Autotransformer, closed transition
- Solid-state starters

Medium Voltage (2300 to 6000 Volts)

- Full voltage
- Primary reactor, closed transition
- Autotransformer, closed transition

Factory Installed or Remote Mounted Starters

All factory installed or remote-mounted starters provided by Trane offer the following standard features for safe, efficient application and ease of installation:

Standard Features

- NEMA 1 starter enclosure
- 120 volt, 60 hertz, 1-phase fused pilot and safety circuits
- Control power transformer (4.0 KVA) with 120 volt, 50 or 60 hertz, single-phase
- One pilot relay to initiate start sequence from CenTraVac control circuit signal
- Starter enclosures capable of being padlocked
- 3-phase incoming line terminals
- 6 output load terminals factory-connected to the motor
- Automatic transfer from wye to delta on any two-step starter (unit-mounted)

Optional Features

- A standard interrupting capacity circuit breaker is mechanically interlocked to disconnect line power from the starter when the starter door is open.
- A high interrupting capacity circuit breaker interlocks to disconnect line power from the starter when the starter door is open.
- Circuit Breaker with Ground Fault — Protection is available with either standard or high interrupting capacity circuit breakers. An indicating light is provided to indicate if a ground fault has occurred.
- Current Limiting Circuit Breaker — Incorporates the current limiters with fuse links is available. A fault current in excess of the circuit breaker capacity will blow the fuse links and interrupt the fault current. The circuit breaker cannot be reset until the blown current limiters are replaced.
- Ground fault detection and protection (only with circuit breaker options)
- Ammeters and voltmeters
- Special function pilot lights
- Special NEMA enclosures
- Ground fault protection
- Power factor correction capacitors
- I.Q. Data Plus monitoring device

Factory-Installed Starters:

- Reduces starter installation costs 20 to 35 percent
- Eliminates chiller-to-starter field wiring
- Eliminates starter-to-disconnect switch field wiring (when optional circuit breaker is used)
- Eliminates field-installed disconnect switch (when optional circuit breaker is used)
- Eliminates starter mounting-pad and required equipment room floor space
- Enhances electrical system reliability
- Reduces the number of field electrical connections
- Factory quality control of the starter-to-chiller electrical connections
- Factory-tested chiller/starter combination
- Optimizes control of the CenTraVac motor/compressor start and protection subsystem
- Reduces system design time-- starter components and interconnecting wiring are pre-engineered and selected.
- Complete package available with Agency Approval

Figure 3 – Typical Equipment Room Layout – Conventional Remote Star-Delta Starter

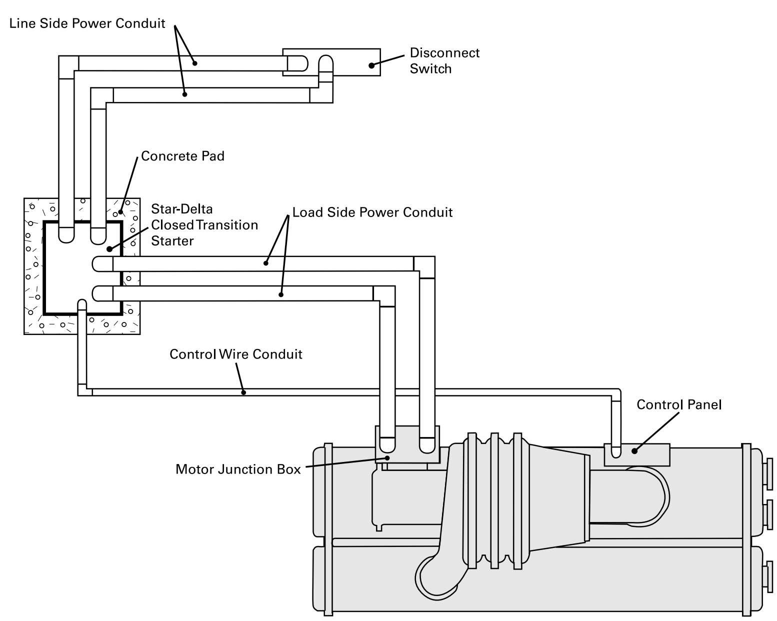
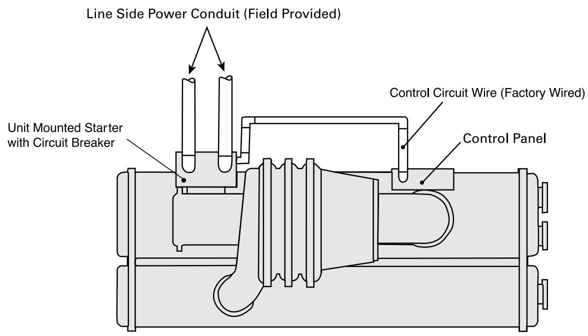


Figure 4 – Typical Equipment Room Layout – Unit-Mounted Star-Delta Starter



Starter by Others

If CenTraVac starting equipment is provided by others, the starter must be designed in accordance with the current Trane standard engineering specification "Water-Cooled CenTraVac™ Starter Specification." It is also recommended that two copies of the interconnecting and control circuit wiring diagrams be forwarded to Trane for review. This service is provided at no charge, and is intended to help minimize the possibility that Trane CenTraVac chillers will be applied in improper starting and control systems. However, the responsibility for providing proper starting and control systems remains with the system designer and the installer.

Star (Wye)-Delta Starters

One type of low-voltage starter that can be unit-mounted is a star (wye)-delta, closed-transition, reduced-voltage starter as shown in Figure 3 and Figure 4. When starting and during acceleration, the motor is connected in its wye configuration. Because of this arrangement the voltage applied to the motor windings is reduced to the inverse of the square root of three or 0.58 times line voltage. This reduction in winding voltage results in a reduction in inrush current. The inrush current is 0.33 times the full-voltage locked rotor current rating of the motor. The accelerating torque of the motor is also reduced to 0.33 times the full-voltage torque rating. This is sufficient to fully accelerate the compressor motor. The chiller controller monitors the motor current during operation via current transformers located in the starter enclosure. During acceleration, when the line current drops to approximately 0.85 times rated load current, transition is initiated. The closed transition feature provides for a continuous motor current flow during transition by placing resistors in the circuit momentarily. This prevents buildup of damaging torques to the system during this period. With the completion of transition, the motor windings are connected in the delta configuration with full line voltage.

Three precision current transformers monitor phase current. Contactor position and various voltage signals provide extensive interlocking between the starter and the chiller controller. All logic and subsequent instruction originate in the chiller controller. Protection against the following starter defects is provided:

- High motor current (starting and running)
- Improper starter circuitry
- Excessive accelerating time
- Incomplete starting sequence
- Loss of phase
- Phase amperage unbalance
- Phase reversal
- Distribution fault

Solid-State Starters

A solid-state starter controls the starting characteristics of a motor by controlling the voltage to the motor. It does so through the use of SCRs (Silicon Controlled Rectifiers), which are solid-state switching devices, and an integral bypass contactor for power control.

SCRs
An SCR will conduct current in one direction only when a control signal (gate signal) is applied. Because the solid-state starter is for use on AC (alternating current), two SCRs per phase are connected in parallel, opposing each other so that current may flow in both directions. For three-phase loads, a full six-SCR configuration is used.

During starting, control of current or acceleration time is achieved by gating the SCR on at different times within the half-cycle. The gate pulses are originally applied late in the half-cycle and then gradually applied sooner in the half-cycle. If the gate pulse is applied **late in the cycle,** only a **small increment of the wave form** is passed through, and the **output is low.**

If the gate pulse is applied **sooner in the cycle,** a greater increment of the wave form is passed through, and **the output is increased.** So, by controlling the SCRs output voltage, the motor's acceleration characteristic and current inrush can be controlled.

Integral Bypass Contactors
When the SCRs are fully "phased on," the integral bypass contactors are energized. The current flow is transferred from the power pole to the contactors. This reduces the energy loss associated with the power pole, which is otherwise about one watt per amp per phase.

When the starter is given the stop command, the bypass contactors are de-energized, which transfers the current flow from the contactors back to the power poles. Two-hundred fifty milliseconds later, the SCRs are turned off, and the current flow stops.

Unit Options

Medium-Voltage Starters

Factory-Installed AMPGARD® Medium-Voltage Starters*

The AMPGARD® medium-voltage starter family by Cutler-Hammer, built to Trane specifications, is now available as a factory-installed option for use with CenTraVac chillers. That's right, Trane now mounts, wires, and tests 2300-6600 volt starters at the factory, so you don't have to. This reduces, or eliminates altogether, the time, expense, and any added risk associated with having the starter installed and wired at the job. This unit-mounted convenience is currently only available from Trane.

AMPGARD reduces starter size to nearly half
Medium-voltage starters have traditionally been freestanding, due to their large size and weight. Not until recent advances in contactor technology and component layout have medium-voltage starters been small enough to make unit-mounting feasible. This way, the starter becomes an integral part of the chiller, saving on equipment floor space.

Selecting a Medium-Voltage Starter

The things to consider when selecting a starter include: line voltage, available current, first cost, reliability, and installation. Unit-mounted medium voltage starters from Trane will be offered in three starter types. All three starters provide the torque required to meet the needs of starting the chiller compressor. However, the magnitude of inrush-current control that each starter has is different from one starter type to another. The starter inrush-current rating is factored as a percentage of locked rotor amps (LRA). When choosing the starter type, the system designer considers the starter LRA, motor voltage, and motor current draw, for compatibility with the rest of the power system.

* Unit-mounted medium-voltage starters are only available on units equipped with the Tracer chiller controller.

Across-the-Line (Full-Voltage)

An across-the-line starter is the smallest medium-voltage starter option. At startup, these starters draw the highest inrush current at 100% of LRA, and they have the shortest acceleration time (3-5 seconds).

Across-the-line starters make sense in medium-voltage applications
The rules for selecting a starter type for medium-voltage applications are different than for low-voltage. In low-voltage applications, across-the-line starters are seldom used because of their high current inrush. Because medium-voltage motors use less current, the inrush is lower. This makes across-the-line a reasonable choice for many medium-voltage applications. For more sensitive applications, reduced-inrush starter types such as primary reactor and autotransformer are also available to mount on the CenTraVac chiller.

Primary Reactor

Primary reactor type starters have an inrush current draw of 65% of LRA at startup. Their acceleration time (3-8 seconds) is slightly higher than an across-the-line starter.

Autotransformer

Autotransformer starters have the lowest inrush current draw of 45% of LRA at startup. They have an acceleration time of 3-8 seconds.

Standard Features

- UL approved
- Cutler-Hammer AMPGARD, designed and built to Trane specifications
- Types: Across-the-line (full-voltage), Primary Reactor, Autotransformer
- Unit-mounted or remote-mounted
- Factory-installed (unit-mounted only)
- Voltage range 2300-6600 volts
- Phase voltage sensors for volts/phase protection, kW and under/overvoltage
- Non-load-break isolation-switch and current-limiting fuses
- NEMA Class E2 fused interrupting ratings
  @3000V 200 MVA
  @4600V 400 MVA
  @6600V 750 MVA

Optional Features

- IQ300 and IQDP 4130 electrical metering packages
- Factory-installed power factor correction capacitors sized specific to motor, factory-wired and mounted inside the starter
- Ground fault protection

Unit Options

Adaptive Frequency Drive

Benefits

Trane Adaptive Frequency drives provide motor control, but they are much more than just starters. They also control the operating speed of the chiller compressor motor by regulating output voltage in proportion to output frequency. Varying the speed of the compressor motor can translate into significant energy cost savings.

Reliable, Optimized Compressor Efficiency for Energy Savings
Conventional chillers use inlet vanes to provide stable operation at part-load conditions. Capacity is reduced by closing the vanes while maintaining a constant motor speed. The drive can be used to significantly reduce power consumption by reducing motor speed at low load conditions. Trane patented AFD Adaptive Control™ logic safely allows inlet guide vane and speed control combinations that optimize part-load performance.

Soft Starts Avoid Mechanical Stress
Controlled "soft" start with linear acceleration results in limited starting current to eliminate motor stress, reduce power line disturbance and provide a lower power demand on start. Reduced motor speed as a result of reduced chiller load means less current drawn, less heat generated, increased motor winding life. This translates into longer time between compressor maintenance and less downtime throughout the life of the machine.

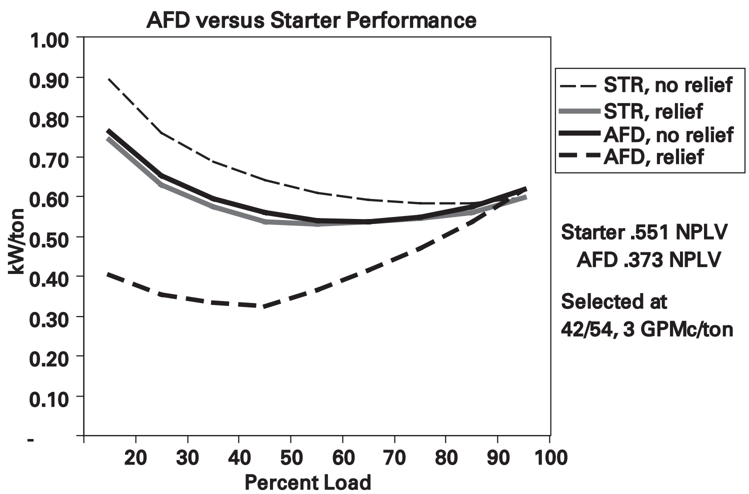
Application

Certain system characteristics favor installation of an AFD because of energy cost savings and shorter payback. Among them are:

High part-load operating hours annually
Figure 5, based on a CVHE500, 500-ton load at standard ARI conditions, shows that major kW savings occur at part-load conditions, typically below 90 percent load.

Condenser water temperature relief or chilled-water reset
Compressor lift reduction is required for a chiller application, both to provide stable chiller operation at part-loads and to achieve greater energy savings.

Figure 5 — CVHE500 Part Load Efficiencies with/without AFD



Intelligent control to reduce condenser water temperature, or chilled-water reset strategies are key to AFD savings in chiller applications.

High kW Charges
Electric utility bills normally include both peak-based and consumption-based energy components. The demand or distribution charges are still significant portions of the energy bill, even in deregulated markets. These charges are established by usage during utility peak hours, by individual peak usage or a combination. This portion may or may not be influenced by installation of an AFD, because an AFD-equipped chiller draws more power at full load. If the peak chiller load coincides with utility peak hours, then the peak-based portion of the energy bill will increase.

The energy or kWh portion will almost certainly be reduced because of the improved efficiency of the chiller plant during part-load conditions throughout the year. The greater the kWh charge, and the smaller the demand or distribution charges, the shorter the payback.

Operation

The Trane AFD controls the speed of the chiller compressor by regulating the output voltage in proportion to the output frequency to provide a nominally constant rate of voltage to frequency as required by the characteristics of the compressor motor. Motor speed is proportional to this applied frequency.

The Trane AFD is a voltage source, pulse-width modulated (PWM) design. It consists of two basic power sections:

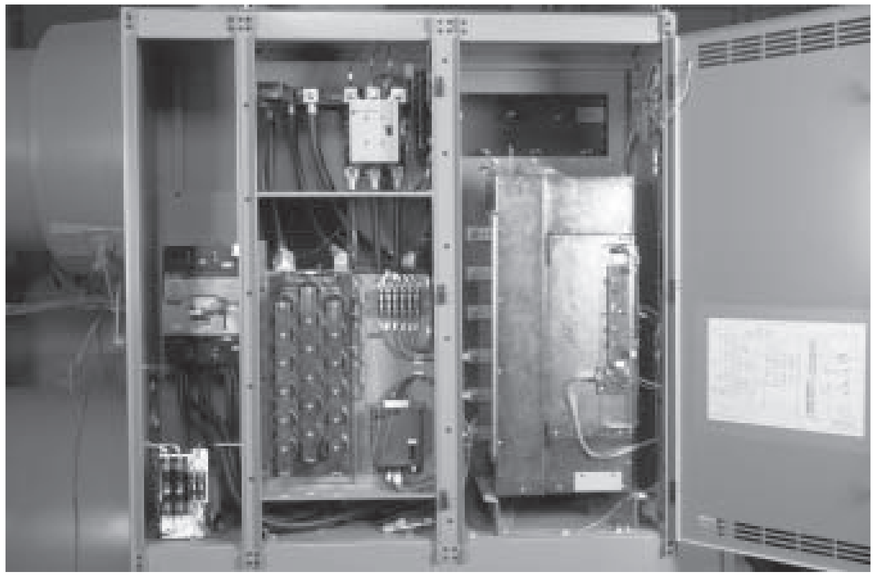
- Rectifier - An IGBT active rectifier takes incoming AC power and converts it to a fixed DC voltage. The active rectifier significantly reduces the amount of ripple on the DC bus.
- Inverter - Converts the DC bus voltage into a sinusoidal synthesized output AC voltage using PWM. This synthesized output controls both the voltage and frequency which is applied to the motor.

The water cooled design consists of three basic power sections:

- Converter — Semi-conductor bridge rectifier takes incoming AC power and converts it to a fixed voltage DC bus.
- DC bus filter — The converted DC bus voltage contains a significant amount of ripple. The DC bus filter smooths the voltage ripple from the converter with capacitors and a DC link reactor to supply a fixed constant voltage to the inverter section. It also minimizes the electrical harmonics generated by the drive back to the distribution system.
- Inverter — Converts the DC voltage into a sinusoidal synthesized output AC voltage. This synthesized output controls both the voltage and frequency which is applied to the motor.

Unit Options

Adaptive Frequency Drive



Patented Adaptive Control

A fourth element of AFD design is the microprocessor control logic which is the intelligence for the power section. It also includes all feedback sensors required for stability in the system and any required shutdown due to a fault.

The combination of speed control and inlet guide-vane position is now optimized mathematically and controlled simultaneously. The increased performance of the microprocessor allows the chiller to operate longer at higher efficiency and with greater stability.

Simultaneously adjusts inlet guide vanes and speed to spend more hours at optimum efficiency
AFD speed and IGV position are simultaneously adjusted to meet the dual requirements of water-temperature control and efficiency. The Tracer chiller controller adjusts speed unconditionally —it does not have to wait for water-temperature control to reach setpoint or for stable cooling load.

The Tracer chiller controller will adjust speed as needed to track changing load or water-loop conditions. At the same time, it adjusts the inlet guide vanes to prevent the water temperature from deviating from its setpoint.

When the vanes are fully open, the compressor speed is controlling the water temperature. Reducing the chiller load or increasing the head conditions will cause the compressor to move toward a surge condition.

When conditions are within the surge boundary, vanes and speed will modulate to control both surge margin and chiller capacity.

Mathematically optimizes inlet guide vanes and speed
The Tracer chiller controller will reduce speed until the surge pressure coefficient boundary is reached. Periodically, the AFD speed control will evaluate whether the boundary should be optimized. If optimization is required, the pressure-coefficient boundary will be raised until surge is detected. Upon surge, the boundary will be reset and surge recovery will occur. The decision to optimize is based on whether the vane position has changed by an amount greater than the optimization sensitivity since the last optimization was done. After the boundary is established, speed control will make adjustments to follow the boundary as conditions change.

Instability is not an issue

- *Variable water-flow designs*—will work in conjunction with an AFD, provided the chiller control is a Tracer chiller controller with the variable flow compensation option installed. Chiller control with rapid water-flow variations and large turndown have been demonstrated with and without variable frequency drives.
- *Rapid changes in load*—Feedforward control improves chilled-water temperature response.
- *Short chilled-water loop*—Feedforward control cancels out the effect of short water loops.
- *Parallel chiller with poor control is causing temperature variations*— The Tracer chiller controller changes speed and adjusts cooling load at the same time. Even if there is a poorly controlled chiller in parallel, a CTV with the Tracer chiller controller will maintain excellent water-temperature control at the best efficiency.
- *Waiting for leaving temperature to exceed threshold*—The Tracer chiller controller reduces speed to the surge boundary based on the current differential operating pressure, making instantaneous corrections to speed and vane settings as conditions change.

Free Cooling Allows Reduced Operating Costs

Consider a CenTraVac™ chiller option that can provide up to 45 percent of the nominal chiller capacity — without operating the compressor. Think of the significant energy and cost savings possible in many applications. This option is available on all Trane chillers, factory installed.

Free cooling operation is based on the principle that refrigerant migrates to the area of lowest temperature. When condenser water is available at temperatures lower than the required leaving chilled water temperature (typically 50 to 55°F), the unit control panel starts the free cooling cycle automatically.

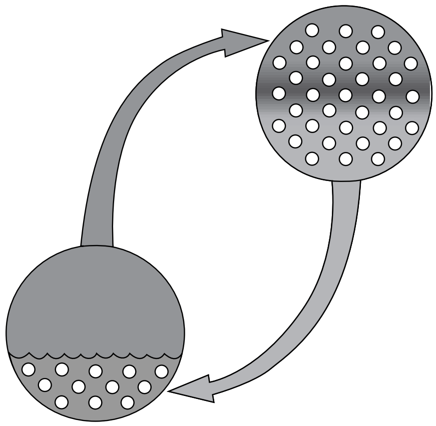
When the free cooling cycle can no longer provide sufficient capacity to meet cooling requirements, mechanical cooling is restarted automatically by the unit control panel.

For example, a building with a high internal cooling load is located in a climate with cold winters. It is possible to cool the building exclusively with free cooling three to six months of the year! Free cooling payback can easily be less than a year.

Free cooling is completely factory installed and requires no more floor space or piping than the standard CenTraVac chiller (unlike plate frame heat exchangers).

Benefits
The Trane patented free cooling accessory for Trane CenTraVac™ chillers adapts the basic chiller so it may function as a simple heat exchanger using refrigerant as the working fluid. When condenser water is available at temperatures lower than the desired chilled liquid temperature, free cooling can provide up to 45 percent of nominal chiller capacity without operation of the compressor. This feature may result in substantial energy cost savings on many installations.

Free Cooling Operation Schematic



Reliability
Two simple valves are the only moving parts.

Single-Source Responsibility
Free cooling is Trane engineered, manufactured and installed.

Ease of Operation
Changeover on free cooling by single switch control.

Ease of Installation
Completely factory-installed and leak-tested components. All valve operators and controls are factory wired.

Application
Modern buildings often require some form of year-round cooling to handle interior zones, solar loads, or computer loads. As the outside air temperature decreases below the inside air design temperature, it is often possible to use an outside air economizer to satisfy the cooling requirements. There are a number of instances, however, where CenTraVac free cooling offers a number of advantages over the use of an outside air economizer. It is possible for the free cooling chiller to satisfy the cooling load for many hours, days, or months during the fall, winter, or spring seasons without operation of the compressor motor. This method of satisfying the cooling requirement can result in significant total energy savings over other types of systems. The savings available are most easily determined through the use of a computer energy analysis and economic program, such as TRACE™ (Trane Air Conditioning and Economics).

The suitability of free cooling for any particular installation depends upon a number of factors. The availability of low temperature condensing water, the quality of the outside air, the type of airside system, the temperature and humidity control requirements, and the cost of electricity all have a direct impact on the decision to use a free cooling chiller.

The use of CenTraVac free cooling depends on the availability of cold condenser water from a cooling tower, river, lake, or pond. As a general rule of thumb, locations which have a substantial number of days with ambient temperatures below 45°F wet bulb or more than 4000 degree-days per year are well suited to free cooling operation. A cooling tower usually must be winterized for off-season operation and the minimum sump temperature is limited by some cooling tower manufacturers. Cooling tower manufacturers should be consulted for recommendations on low temperature operation. With river, lake or pond supply, condenser water temperatures down to freezing levels are possible. Areas which have badly fouled air may be more conducive to free cooling operation than the use of an outside air economizer.

Airside systems which both heat and cool the air can often effectively use a free cooling chiller. Dual-duct, multizone, and reheat systems fall into this general category. As the outside temperature begins to fall, the cool outside air satisfies the cooling requirements (through an outside air economizer). As the outdoor air temperature becomes very low, the outdoor air may need to be heated in order to maintain the design supply air temperature when it is mixed with return air. This “heating penalty” can be eliminated by using CenTraVac free cooling. Warm chilled water temperatures provided by the free cooling chiller would allow a warmer air temperature off the chilled water coils, eliminating the heating energy required by using only an outside air economizer. With today’s high cost electricity in most areas of the country, this heating penalty can be very significant.

Temperature and humidity control requirements are important considerations when evaluating the use of CenTraVac free cooling. Low temperature outside air (from the outside air economizer) often requires a large amount of energy for humidification purposes. Free cooling operation helps to reduce these humidification costs on many applications.

It is important to note that those applications which require extremely precise humidity control typically cannot tolerate warmer than design chilled water temperatures. Therefore, since free cooling chillers normally deliver warmer than design chilled water temperatures, free cooling operation is usually not applicable with systems which require precise humidity control.

Also, free cooling is generally not used in conjunction with heat recovery systems, since mechanical cooling must be used to recover heat that will be used elsewhere in the building for simultaneous heating.

Operation
Free cooling operates on the principle that refrigerant flows to the area of lowest temperature in the system. The Tracer™ system/Chiller Plant Manager (CPM) can be used for automatic free cooling control. When condenser water is available at a temperature lower than the required leaving chilled water temperature, the CPM starts the free cooling cycle. If the load cannot be satisfied with free cooling, the CPM or a customer supplied system can automatically switch to the powered cooling mode. If desired, the chiller can be manually switched to the free cooling mode at the unit control panel. Upon changeover to free cooling, the shutoff valves in the liquid and gas lines are opened and a lockout circuit prevents compressor energization. Liquid refrigerant drains by gravity from the storage tank into the evaporator, flooding the tube bundle. Since the refrigerant temperature and pressure will be higher in the evaporator than in the condenser, due to the water temperature difference, the refrigerant gas boiled off in the evaporator will flow to the condenser. The gas then condenses and flows by gravity back to the evaporator. This automatic refrigeration cycle is sustained as long as a temperature difference exists between the condenser water and evaporator water.

The difference in temperature between the condenser and evaporator determines the rate of refrigerant flow between the two shells and hence the free cooling capacity.

If the system load becomes greater than the free cooling capacity either the operator manually stops free cooling, a binary input from a customer-supplied system disables free cooling or the CPM can automatically perform this function. The gas and liquid valves close and the compressor starts. Refrigerant gas is drawn out of the evaporator by the compressor, compressed and introduced into the condenser. Most of the condensed liquid first takes the path of least resistance by flowing into the storage tank which is vented to the high pressure economizer sump by a small bleed line. When the storage tank is filled, liquid refrigerant must flow through the bleed line restriction. The pressure drop through the bleed line is greater than that associated with the orifice flow control device, hence liquid refrigerant flows normally from the condenser through the orifice system and into the economizer.

The free cooling accessory consists of the following factory-installed or supplied components:

- A refrigerant gas line, including an electrically actuated shutoff valve, installed between the evaporator and condenser.
- A valved liquid return line including an electrically activated shutoff valve, between the condenser sump and evaporator.
- A liquid refrigerant storage vessel.
- Added refrigerant charge.
- Manual free cooling controls on the unit control panel.

For specific information on free cooling applications, contact the local Trane sales office.

Figure 6 — Compressor Operation Schematic

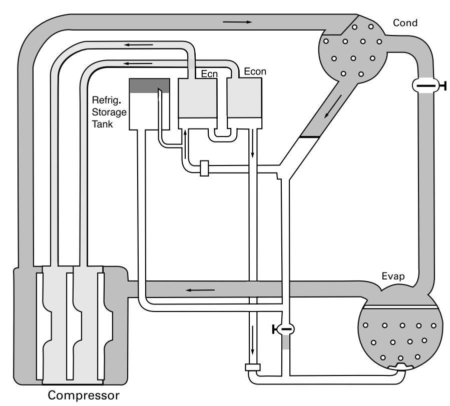
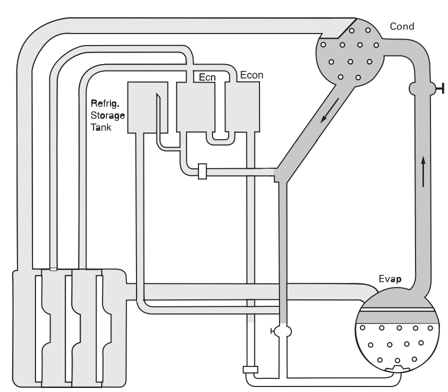


Figure 7 — Free Cooling Operation Schematic



Heat Recovery

Use of the Heat Recovery CenTraVac™ can significantly reduce the energy operating costs of many buildings by using heat which normally would be rejected to the atmosphere. Typical uses for this heat are perimeter zone heating, reheat air conditioning systems and any hot water requirements. Any building with a simultaneous heating and cooling load is a potential candidate.

Most heating applications require water temperatures higher than the 85°F to 95°F typically sent to the cooling tower. Therefore, most heat recovery chillers are required to produce higher leaving condenser water temperatures, and thus will not duplicate the energy efficiencies of cooling-only machines. Figure 9 illustrates the typical operating cycles of a cooling-only machine and a heat recovery machine. The most noticeable differences are:

1. The pressure differential provided by the compressor is much greater for the heat recovery cycle.
2. The amount of heat rejected from the heat recovery condenser is greater than that which would be rejected in cooling-only operation.
3. There is a decrease in the refrigeration effect. (RE) Higher condensing pressures increase the intermediate pressure in the economizer. Therefore, the liquid in the economizer has a higher enthalpy during the heat recovery mode than during standard chiller operation and the refrigeration effect is slightly decreased. Because of this decreased refrigeration effect, the compressor must pump more gas per ton of refrigeration.

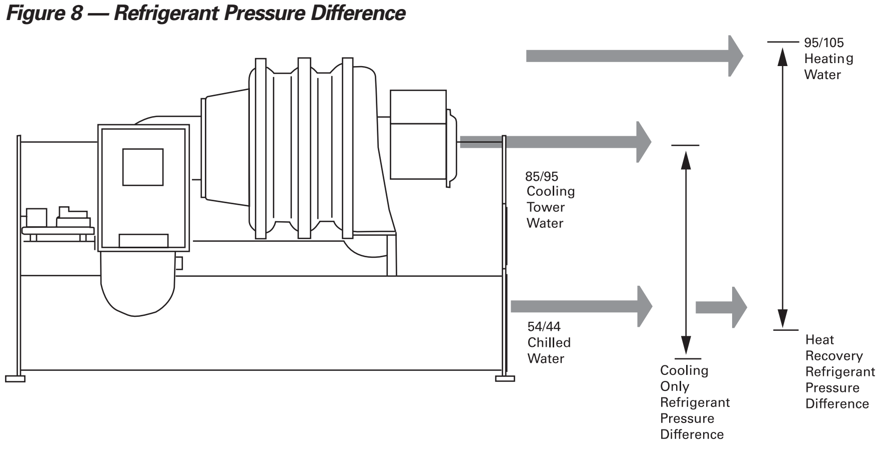
The effect of this increased pressure differential and decreased refrigeration effect is a heat recovery machine which has a higher kW/ton energy consumption during heat recovery operation.

Typical catalog kW/ton for heat recovery machines operating in the heat recovery mode range from .64 to .84 kW/ton compared to a range of .61 to .79 for a cooling-only machine. Not only can there be an energy consumption penalty paid due to the inherent differences in operating cycles for heat recovery machines, but traditional machine design can add to that energy handicap. In the past, a heat recovery machine's operating efficiency was normally penalized year- round by having the capability to produce high heating water temperatures. Impellers are selected to produce the maximum required refrigerant pressure difference between the evaporator and condenser, Figure 8. Usually, that meant the impeller diameters were determined by the heat recovery operating conditions.

During cooling-only operation, the condensing pressures and temperatures are normally lower than during the heat recovery operation. So, in essence, the impeller diameters were oversized. This would result in a compressor efficiency during cooling- only season which was lower than if the impellers had been selected for a cooling-only application.

The multistage compressor and advanced impeller design on the CenTraVac™ chiller reduce this costly energy penalty. Neither the capacity nor the power consumption changes substantially as the heat recovery operating conditions divert from the cooling-only condition. The multistage compressor allows a closer match of impeller size to the operating condition. In addition, the computer designed impellers and crossover are designed to reduce losses as the kinetic energy of the refrigerant gas is converted to static pressure.

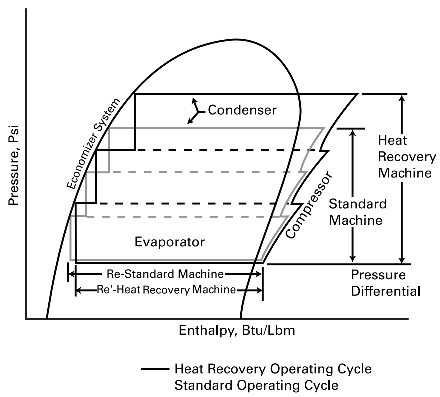
Figure 8 — Refrigerant Pressure Difference



System Options

Heat Recovery (Cont.)

Figure 9 — Typical Operating Cycles



Simultaneous Heating and Cooling
The Trane Heat Recovery CenTraVac™ chiller is an excellent choice for applications requiring simultaneous heating and cooling. CenTraVac models save energy by recovering heat normally rejected to the atmosphere and putting that energy to use providing space heating, building hot water or process hot water. This heat is provided at a fraction of conventional heating systems cost. A heat recovery CenTraVac can provide 95 to 120°F hot water.

An advanced computer selection program chooses a heat recovery condenser to match your needs. Two separate condenser shells are used with the Heat Recovery CenTraVac chiller. The heating circuit and cooling tower circuit are separate, preventing cross contamination. Refrigerant gas from the compressor flows into both condenser shells allowing heat rejection to one or both condenser water circuits.

The reliability of the Heat Recovery CenTraVac chiller has been proven in installations around the world. This option is completely factory packaged.

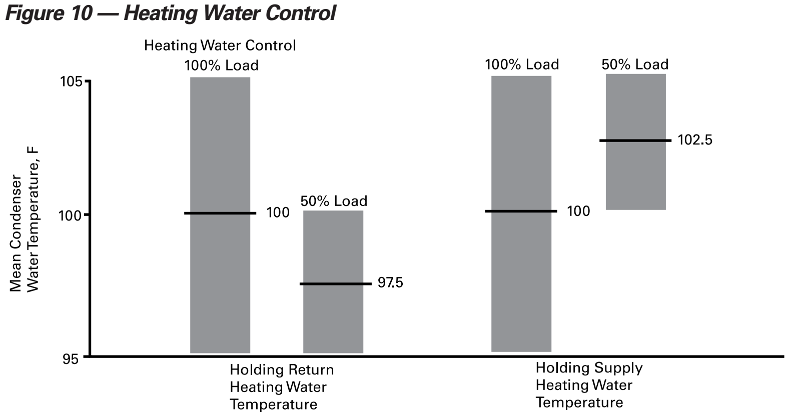
To further reduce the system energy requirements, the following design considerations should be incorporated into any heat recovery system.

Heating Water Temperatures and Control — It is always desirable to use as low a heating water temperature as the application allows. Experience has shown that a design heating water temperature of 105 to 110°F can satisfy most heating requirements. Lower heating water temperatures increase the chiller operating efficiency both in the heating mode and in the cooling mode. In general, the heat recovery power consumption will increase 7 to 14 percent for every 10°F increase in the design heating water temperature. A consideration which is just as important as the design heating water temperature is how that temperature is controlled. In most cases, the heating water temperature control should be designed to maintain the return heating water temperature. By allowing the supply water temperature to float, the mean water temperature in the system drops as the chiller load decreases and less heat is rejected to the condenser. As the mean heating water temperature drops, so does the refrigerant condensing temperature and pressure difference which the compressor is required to produce at part load. This increases the unloading range of the compressor.

When the supply heating water temperature to the building system is maintained and the return heating water temperature to the condenser is allowed to float, the mean heating water temperature actually rises as the chiller load decreases and less heat is rejected to the condenser. As Figure 10 illustrates, when the compressor unloads, the pressure difference that it must oppose to prevent surging remains essentially the same, while the compressor's capability to handle the pressure difference decreases. Therefore, the unit's capability to unload without the use of hot gas bypass is reduced.

Hot gas bypass artificially increases the load on the compressor (cfm of refrigerant gas) by diverting refrigerant gas from the condenser back to the compressor. Although hot gas bypass increases the unit's power consumption by forcing the compressor to pump more refrigerant gas, it will increase the heat available to recover for those applications where significant heating loads remain as the cooling load decreases.

Figure 10 — Heating Water Control



System Options

Auxiliary Condenser

Auxiliary Condenser For Economical Heat Recovery

The Trane auxiliary condenser provides economical heat recovery for applications with small heating demand. The Trane auxiliary condenser option consists of a separate condenser connected in parallel with the standard condenser to provide simple heat recovery capability for applications where full heat recovery or high heating water temperatures are not required. Decreased life cycle operating costs result through use of the auxiliary condenser option because heat, which normally would be rejected by the cooling tower circuit, is now used for building heating requirements.

Application

A simultaneous demand for heating and cooling is necessary to apply any heat recovery system. Typical uses for this water include domestic water preheat, boiler makeup water preheat, and reheat air conditioning systems and swimming pools, as opposed to traditional heat recovery applications where higher temperature water is used to satisfy a building heating load, provide full heat input for domestic hot water, or provide the typically larger flow rates of hot water for process applications. Building use is not limited to the traditional heat recovery candidates. Schools, hospitals, office buildings, and hotels have all proved to be excellent applications for the auxiliary condenser option.

Increased Chiller Efficiency

The auxiliary condenser not only captures energy otherwise lost, it also increases chiller efficiency by increasing condenser heat transfer surface area and lowering the pressure differential the compressor must generate. .

Auxiliary condensers are available in two sizes: standard and large. Because the auxiliary condenser is a separate condenser, there is no cross contamination between the cooling tower water and the heat recovery water circuits.

No temperature controls are required. Auxiliary condensers are factory mounted and tested.

System Options

Auxiliary Condenser (Cont.)

Controls
The auxiliary condenser was designed for simplicity of operation. Machine load, water flow rate, and temperature determine the amount of heat recovered. There are no controls needed for heating water temperature because no attempt is made to maintain a specific hot water temperature in or out of the auxiliary condenser.

Operation
The auxiliary condenser is a factory-mounted, separate, shell and tube heat exchanger available on water-cooled CenTraVac chillers.

Because hot refrigerant gas always migrates to the area of lowest temperature, auxiliary condenser operation is simple. As hot gas leaves the compressor, it is free to flow to the auxiliary condenser or the standard condenser. Since water entering the auxiliary condenser is normally colder than that entering the standard condenser, the auxiliary condenser will have a lower bundle temperature and will attract the refrigerant gas. The auxiliary condenser will recover as much heat as the machine cooling load, heating water temperature, and flow rate will allow. All remaining heat will automatically be rejected through the standard condenser to the atmosphere through the cooling tower. No controls are needed to balance heat rejection in the two condensers.

Good system design will include a heated water bypass to ensure that water does not circulate through the auxiliary condenser when the chiller is de-energized. There are several ways to bypass the auxiliary condenser. When the hot water system is installed as shown in the figure below, the bypass is automatic if the heating water pump is interlocked with the chiller compressor motor.

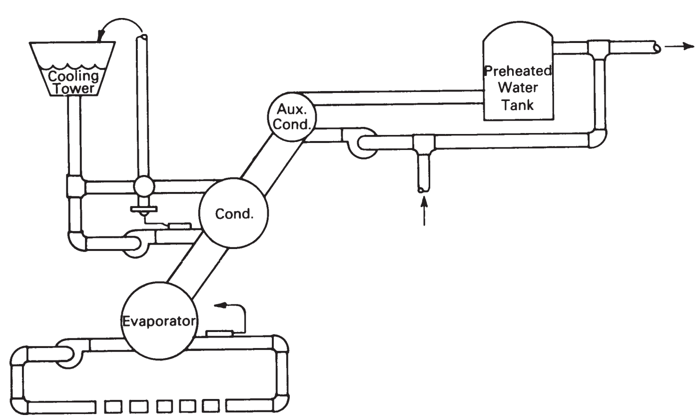
Another bypass arrangement is to install a diverting valve. When interlocked with the compressor motor, this valve diverts the heating water flow to the conventional heating system whenever the chiller is not operating. These are only examples of the many ways of accomplishing a bypass.

Contact your local Trane sales office for further specific information.

Table 2 — Auxiliary Condenser Flow Limits and Connection Sizes

Auxiliary Condenser Bundle Size	Two Pass				Connection Size (In.)
	Inter Enhanced		Smooth Bore		
	Minimum Gpm	Maximum Gpm	Minimum Gpm	Maximum Gpm	
Standard (80)	74	276	70	258	5
Large (130)	121	453	115	423	5

Figure 11



Ice Storage Provides Reduced Electrical Demand

Ice storage is the hottest thing in cooling today. It has been accepted by building owners and tenants who are concerned about utility costs.

An ice storage system uses a standard chiller to make ice at night when utilities charge less for electricity. The ice supplements or even replaces mechanical cooling during the day when utility rates are at their highest. This reduced need for cooling results in big utility cost savings.

Another advantage of ice storage is standby cooling capacity. If the chiller is unable to operate, one or two days of ice may still be available to provide cooling. In that time the chiller can be repaired before building occupants feel any loss of comfort.

The Trane CenTraVac chiller is uniquely suited to low temperature applications like ice storage because it provides multiple stages of compression. Competitive chillers provide only one stage. This allows the CenTraVac chiller to produce ice efficiently, with less stress on the machine.

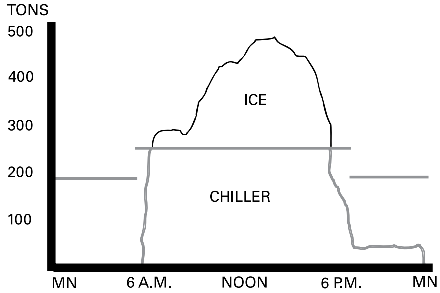
Simple and smart control strategies are another advantage the CenTraVac chiller has for ice storage applications. Trane Tracer™ building management systems can actually anticipate how much ice needs to be made at night and operate the system accordingly. The controls are integrated right into the chiller. Two wires and preprogrammed software dramatically reduce field installation cost and complex programming.

Trane centrifugal chillers are well suited for ice production. The unique multi-stage compressor design allows the lower suction temperatures required to produce ice and the higher chiller efficiencies attributed to centrifugal chillers. Trane three stage and two stage centrifugal chillers produce ice by supplying ice storage vessels with a constant supply of 22 to 24°F glycol. Centrifugal chillers selected for these lower leaving fluid temperatures are also selected for efficient production of chilled fluid at nominal comfort cooling conditions. The ability of Trane chillers to serve "double duty" in ice production and comfort cooling greatly reduces the capital cost of ice storage systems.

A glycol solution is used to transfer heat from the ice storage tanks to the centrifugal chiller and from the cooling coils to either the chiller or ice storage tanks. The use of a freeze protected solution eliminates the design time, field construction cost, large refrigerant charges, and leaks associated with ice plants. Ice is produced by circulating 22-24°F glycol through modular insulated ice storage tanks. Each tank contains a heat exchanger constructed of polyethylene tubing. Water in each tank is completely frozen with no need for agitation. The problems of ice bridging and air pumps are eliminated.

When cooling is required, ice chilled glycol is pumped from the ice storage tanks directly to the cooling coils. No expensive heat exchanger is required. The glycol loop is a sealed system, eliminating expensive annual chemical treatment costs. The centrifugal chiller is also available for comfort cooling duty at nominal cooling conditions and efficiencies. The modular concept of glycol ice storage systems and the proven simplicity of Trane Tracer™ controls allow the successful blend of reliability and energy saving performance in any ice storage application.

Figure 12 — Ice Storage Demand Cost Savings



The ice storage system is operated in six different modes: each optimized for the utility cost of the hour.

1. Provide comfort cooling with chiller
2. Provide comfort cooling with ice
3. Provide comfort cooling with ice and chiller
4. Freeze ice storage
5. Freeze ice storage when comfort cooling is required
6. Off

Tracer optimization software controls operation of the required equipment and accessories to easily transition from one mode of operation to another. For example:

Even with ice storage systems there are numerous hours when ice is neither produced or consumed, but saved. In this mode the chiller is the sole source of cooling. For example, to cool the building after all ice is produced but before high electrical demand charges take effect, Tracer sets the centrifugal chiller leaving fluid setpoint to its most efficient setting and starts the chiller, chiller pump, and load pump.

When electrical demand is high, the ice pump is started and the chiller is either demand limited or shut down completely. Tracer controls have the intelligence to optimally balance the contribution of ice and chiller in meeting the cooling load.

The capacity of the chiller plant is extended by operating the chiller and ice in tandem. Tracer rations the ice, augmenting chiller capacity while reducing cooling costs.

When ice is produced, Tracer will lower the centrifugal chiller leaving fluid setpoint and start the chiller, chiller and ice pumps, and other accessories. Any incidental loads that persists while producing ice can be addressed by starting the load pump and drawing spent cooling fluid from the ice storage tanks.

For specific information on ice storage applications, contact your local Trane sales office.

Application Considerations

Condenser Water Limitations

Trane CenTraVac™ chillers start and operate over a range of load conditions with controlled water temperatures. Reducing the condenser water temperature is an effective method of lowering the chiller power input. However, the effect of lowering the condenser water temperature may cause an increase in system power consumption.

In many applications Trane CenTraVac chillers can start and operate without control of the condenser water temperature. However, for optimum system power consumption, and for any applications with multiple chillers, control of the condenser water circuit is recommended. Integrated control of the chillers, pumps and towers is easily accomplished with the onboard Tracer chiller controller and/or Tracer Summit system.

Water Treatment
The use of untreated or improperly treated water in a chiller may result in scaling, erosion, corrosion, algae or slime. It is recommended that the services of a qualified water treatment specialist be used to determine what treatment, if any, is advisable. Trane assumes no responsibility for the results of untreated, or improperly treated water.

Water Pumps
Avoid specifying or using 3600 rpm condenser and chilled water pumps. Such pumps may operate with objectionable noises and vibrations. In addition, a low frequency beat may occur due to the slight difference in operating rpm between water pumps and CenTraVac motors. Where noise and vibration-free operation are important, Trane encourages the use of 1750 rpm pumps.

Chillers are designed to ARI conditions of 85°F, but Trane CenTraVac chillers can operate with a 3 psig pressure differential between the condenser and evaporator at any steady state load without oil loss, oil return, motor cooling, refrigerant hang-up or purge problems. And this differential can equate to safe minimum entering condenser water temperatures at or below 55°F, dependent on a variety of factors such as load, leaving evaporator temperature and component combinations. Startup below this differential is possible as well, especially with the Tracer chiller controller's soft start and Adaptive Control features.

Water Flow
Today's technology challenges ARI's traditional design of three gpm per ton through the condenser. Reduced condenser flows are a simple and effective way to reduce both first and operating costs for the entire chiller plant. This design strategy will require more effort from the chiller. But pump and tower savings will typically offset any penalty. This is especially true when the plant is partially loaded or condenser relief is available.

In new systems, the benefits can include dramatic savings with:
- Size and cost for condenser lines and valves
- Size and cost of the cooling tower.
- Size and cost of the water pumps.
- Pump energy (30 to 35% reduction).
- Tower fan energy (30 to 35% reduction).

Replacement chiller plants can reap even greater benefits from low flow condensers. Because the water lines and tower are already in place, reduced flows would offer a tremendous energy advantage. Theoretically, a 2 GPM/ton design applied to a system that originally used 3 GPM/ton would offer a 70% reduction in pump energy. At the same time, the original tower would require a nozzle change but would then be able to produce about two degrees colder condenser water than before. These two benefits would again typically offset any extra effort required by the chiller.

Contact your local Trane Sales Office for information regarding optimum condenser water temperatures and flow rates for a specific application.

Electrical Information

Minimum Circuit Ampacity
To properly size field electrical wiring, the electrical engineer or contractor on a project needs to know the minimum circuit ampacity of the CenTraVac machine. The National Electrical Code (NEC), in Article 440-33, defines the method of calculating the minimum circuit ampacity. The minimum circuit ampacity is defined as the sum of two amperages: 125 percent of the compressor motor Rated Load Amps (RLA), plus the Full Load Amps (FLA) of all remaining loads on the same circuit. For starter to motor wiring, there are no other remaining loads. For main power supply to the starter, there is a remaining load consisting of the 4 KVA control power transformer which supplies power to the controls, the oil pump motor, oil sump heater and the purge unit motor. Therefore, the remaining load FLA equals 4000 divided by the unit design voltage.

As an example, calculate the minimum circuit ampacity of a machine which has a design RLA of 350 amps and is to be operated on a 460 volt power supply:

Minimum Circuit Ampacity =

$$(125\% \times 350 \text{ Amps}) + \frac{4000 \text{ VA}}{460 \text{ V}}$$

= 437.5 Amps + 8.7 Amps

= 446.2 Amps

After the minimum circuit ampacity has been determined, the electrical engineer or contractor will refer to the appropriate conductor sizing table in the NEC to determine the exact conductors required. A typical table for 75°F conductors is included in the Trane submittal. The selection of conductors is based on a number of jobsite conditions (i.e. type of conductor, number of conductors, length of conductors, ambient temperature rating of conductors).

Branch-Circuit Short-Circuit and Ground Fault Protection
Circuit breakers and fused disconnects should be sized by the electrical engineer or contractor in strict accordance with NEC Article 440-21 and in accordance with all local codes. This protection should be for motor type loads and should not be less than 150 percent of the compressor motor rated load amps (RLA).

Selection Procedure

Selection

The CenTraVac™ centrifugal chiller product line provides more than 200,000 individual unit selections over a capacity range of 170 through 2800 tons. Chiller selections and performance data can be obtained through the use of the CenTraVac chiller selection program available in local Trane sales offices. This program can provide a list of chiller selections optimized to closely match specific project requirements. Nominal data and physical data for typical compressor-evaporator- condenser combinations are given by product family.

Trane Model Number

The Trane model number defines a Trane CenTraVac with its particular component combination. These components along with the project design conditions are required to determine chiller performance from the CenTraVac computer selection program:

- Compressor size and voltage
- Evaporator bundle size, bundle length, and number of water passes
- Condenser bundle size, bundle length, and number of water passes
- Leaving chilled water temperature, evaporator water flow rate, temperature drop through the evaporator
- Entering condenser water temperature, condenser water flow rate, and temperature rise through the condenser
- Water side fouling factors for the evaporator and condenser
- Refrigerant type for operating on HCFC-123.

Performance

The CenTraVac computer selection program provides performance data for each chiller selection at the full load design point and part load operating points as required.

The Trane computer selection program is certified by ARI in accordance with ARI Standard 550/590. To assure that the specific chiller built for your project will meet the required performance, and to ensure a more troublefree startup, it is recommended that the chiller be performance tested.

The CenTraVac computer selection program has the flexibility to select chillers for excessive field fouling allowances.

Fouling Factors

ARI Standard 550/590 includes a definition of clean tube fouling. Recommended field fouling allowances have not changed on a relative basis; the standard fouling adjustment is a 0.0001 increment from 0.0000 “clean” on the evaporator and 0.00025 increment from 0.0000 “clean” on the condenser.

Chiller specifications should be developed using the most current standard fouling factors.

It should be noted that changing the number of water passes or water flow rates may significantly alter the performance of a particular chiller.
To obtain the maximum benefit from the wide range of selections available, designers are encouraged to develop performance specifications and use the computer selection program to optimize their selections. This will allow the selection of the particular compressor-evaporator-condenser combination which most closely meets the job requirements. All selections should be made by using the computer selection program.

Unit Performance With Fluid Media Other Than Water

CenTraVac chillers can be selected with a wide variety of media other than water. Typically used media include ethylene glycol or propylene glycol either in the evaporator, condenser or both. Chillers using media other than water are excluded from the ARI 550/590 Certification Program, but are rated in accordance with ARI 550/590. Trane factory performance tests are only performed with water as the cooling and heat rejection media. For media other than water, contact the local Trane sales office for chiller selections and information regarding factory performance testing.

Flow Rate Limits

Flow rate limits for all pass combinations for evaporators and condensers are tabulated in the data section for the appropriate chiller family. For applications outside of these limits, contact your local Trane office.

Selection Procedure

Roughing-in Dimensions
The dimensional drawings illustrate overall measurements of the chiller. The recommended space envelope indicates clearances required to easily service the CenTraVac chiller. A view of the unit is superimposed on this drawing with unit support feet shown.

All catalog dimensional drawings are subject to change. Current submittal drawings should be referred to for detailed dimensional information. Contact the local Trane sales office for submittal and template information, or generate Trane product templates online: www.trane.com/commercial/equipment/product-templates

Evaporator and Condenser Data Tables
Evaporator and condenser data is shown in the Performance Data section. It includes minimum and maximum water flow limits and water connection sizes for all standard pass configurations and tube type. Pressure drops are calculated by the CenTraVac computer selection program.

Full Load and Part Load Performance

The CenTraVac chiller possesses excellent performance characteristics over its full range of operation. The multistage direct-drive compressor enables stable and efficient operation over a wide range of capacities, virtually eliminating the need for energy wasting hot gas bypass typically found on single stage chillers.

An in-depth examination of project-specific conditions and energy rate structures should be performed to appropriately evaluate total energy costs over a period of time. TRACE™, Trane's unique energy analysis program, is particularly well suited for this type of analysis, as well as for economic evaluation of equipment and system alternatives.

Local utilities may offer substantial monetary rebates for centrifugal chillers with specific operating kW ratings. Contact your local utility representative or Trane sales office for further information.

The electrical rate structure is a key component of an economic evaluation. Most power bills are constituted of a significant demand charge in addition to the usage charge. The full load power consumption of the chiller plant is likely to set the kW peak and demand charge for the billing period. This places an increased emphasis on the need to keep the full load consumption of the chiller plant low.

There are a number of variables that should be considered in developing an accurate chiller load profile to use for measuring how one machine compares with another machine at part load. The use of outdoor air economizers, variations in chiller sequencing and chiller plant load optimization strategies should be considered. Decoupled, primary/secondary water loops or variable primary flow designs are more efficient ways to control multiple chiller water plants. These control strategies result in one chiller operating at a more fully loaded condition rather than multiple chillers operating at part load, which would require more pumping energy.

ARI Standard 550/590 provides chiller performance certification for the full load condition and the "NPLV" (non-standard part load value). The NPLV uses a generic weighted chiller load profile to simplify certification of part load performance data. Although these values are not necessarily a precise indicator of actual energy use, they do provide a basis for comparison.

Performance Data

Evaporator Flow Rates

Table 3 — Minimum/Maximum Evaporator Flow Rates (GPM)

Shell	Bundle	One Pass			Two Pass			Three Pass		
Size	Size	SBCU	TECU	IECU	SBCU	TECU	IECU	SBCU	TECU	IECU
EVSZ	EVBS	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max
032S	200	216 / 1187	230 / 1237	143 / 1050	108 / 593	115 / 618	72 / 525	72 / 396	77 / 412	48 / 350
032S	230	242 / 1331	258 / 1388	165 / 1212	121 / 666	129 / 694	83 / 606	81 / 444	86 / 463	55 / 404
032S	250	267 / 1465	284 / 1527	177 / 1293	134 / 733	142 / 764	88 / 646	89 / 488	95 / 509	59 / 431
032S/L	280	304 / 1672	324 / 1743	201 / 1474	152 / 836	162 / 871	101 / 737	102 / 557	108 / 581	67 / 491
032S/L	320	340 / 1868	362 / 1947	229 / 1676	170 / 934	181 / 973	115 / 838	114 / 623	121 / 649	76 / 559
032S/L	350	— / —	— / —	251 / 1838	— / —	— / —	126 / 919	— / —	— / —	84 / 613
050S	320	340 / 1868	362 / 1947	232 / 1696	170 / 934	181 / 973	116 / 848	114 / 623	121 / 649	77 / 565
050S	360	383 / 2105	399 / 2194	254 / 1858	192 / 1052	200 / 1097	127 / 929	128 / 702	133 / 731	85 / 619
050S	400	424 / 2332	442 / 2431	284 / 2080	212 / 1166	221 / 1215	142 / 1040	142 / 777	148 / 810	95 / 693
050S/L	450	482 / 2652	503 / 2764	322 / 2363	241 / 1326	252 / 1382	161 / 1181	161 / 884	108 / 921	108 / 788
050S/L	500	535 / 2941	558 / 3066	361 / 2646	268 / 1470	279 / 1533	181 / 1323	178 / 980	186 / 1022	121 / 882
050S/L	550	— / —	— / —	397 / 2908	— / —	— / —	198 / 1454	— / —	— / —	132 / 969
080S	500	535 / 2941	558 / 3066	361 / 2646	268 / 1470	279 / 1533	181 / 1323	178 / 980	186 / 1022	121 / 882
080S	560	602 / 3312	628 / 3453	400 / 2928	301 / 1656	314 / 1726	200 / 1464	201 / 1104	210 / 1151	133 / 976
080S	630	676 / 3715	704 / 3872	452 / 3312	338 / 1857	352 / 1936	226 / 1656	226 / 1238	235 / 1291	151 / 1104
080S/L	710	758 / 4169	790 / 4346	517 / 3756	379 / 2084	395 / 2173	259 / 1878	253 / 1390	264 / 1449	171 / 1252
080S/L	800	861 / 4736	898 / 4937	576 / 4221	431 / 2368	449 / 2469	288 / 2110	288 / 1579	300 / 1646	192 / 1407
080S/L	890	— / —	— / —	642 / 4706	— / —	— / —	321 / 2353	— / —	— / —	214 / 1569
142M/L	890	863 / 4746	900 / 4948	645 / 4726	432 / 2373	450 / 2474	323 / 2363	288 / 1582	300 / 1649	215 / 1575
142M/L	980	966 / 5314	1008 / 5540	716 / 5251	483 / 2657	504 / 2770	358 / 2625	322 / 1771	336 / 1847	239 / 1750
142M/L	1080	1075 / 5912	1121 / 6163	807 / 5917	538 / 2956	561 / 3082	404 / 2959	358 / 1971	374 / 2054	269 / 1972
142M/L/E	1220	1208 / 6645	1260 / 6927	895 / 6564	604 / 3323	630 / 3464	448 / 3282	403 / 2215	420 / 2309	299 / 2188
142M/L/E	1420	1345 / 7398	1402 / 7712	1041 / 7634	673 / 3699	701 / 3856	521 / 3817	449 / 2466	468 / 2571	347 / 2545
210L	1610	1318 / 7244	1373 / 7551	1146 / 8402	659 / 3622	687 / 3775	573 / 4201	440 / 2415	458 / 2517	382 / 2801
210L	1760	1471 / 8090	1534 / 8433	1286 / 9432	736 / 4045	767 / 4216	643 / 4716	490 / 2697	512 / 2811	429 / 3144
210L	1900	1634 / 8987	1704 / 9369	1421 / 10421	817 / 4494	852 / 4684	711 / 5211	545 / 2996	568 / 3123	474 / 3474
210L	2100	1802 / 9906	1878 / 10326	1509 / 11067	901 / 4953	939 / 5163	755 / 5534	601 / 3302	626 / 3442	503 / 3689
250E	2300	1948 / 10710	2030 / 11165	1640 / 11930	974 / 5355	1015 / 5583	820 / 5965	650 / 3570	677 / 3722	547 / 3977
250E	2500	2145 / 11794	2236 / 12295	1790 / 13060	1073 / 5897	1118 / 6147	895 / 6530	715 / 3931	746 / 4098	597 / 4353
210D	1610	1373 / 7550	1403 / 7719	1148 / 8421						
210D	1850	1623 / 8927	1659 / 9126	1311 / 9613		Not Applicable			Not Applicable	
210D	2100	1870 / 10282	1911 / 10511	1471 / 10784						
250D	2100	1877 / 10325	1919 / 10555	1471 / 10784						
250D	2300	2030 / 11164	2075 / 11413	1628 / 11935		Not Applicable			Not Applicable	
250D	2500	2235 / 12294	2285 / 12568	1782 / 13066						
250M	2100	1877 / 10325	1919 / 10555	1471 / 10784						
250M	2300	2030 / 11164	2075 / 11413	1628 / 11935		Not Applicable			Not Applicable	
250M	2500	2235 / 12294	2285 / 12568	1782 / 13066						
250X	2100	1877 / 10325	1919 / 10555	1471 / 10784						
250X	2300	2030 / 11164	2075 / 11413	1628 / 11935		Not Applicable			Not Applicable	
250X	2500	2235 / 12294	2285 / 12568	1782 / 13066						

Note: The minimum evaporator water velocity is 1.5 ft/sec for IECU tubes and 2.0 ft/sec for all other tubes. For a variable evaporator water flow system, the minimum GPME is generally not applicable at full load.

Table 3 (Continued) — Minimum/Maximum Evaporator Flow Rates (Liters/Second)

Shell	Bundle	One Pass			Two Pass			Three Pass		
Size	Size	SBCU	TECU	IECU	SBCU	TECU	IECU	SBCU	TECU	IECU
EVSZ	EVBS	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max
032S	200	14 / 75	14 / 78	9 / 66	7 / 37	8 / 39	5 / 33	5 / 25	5 / 26	3 / 22
032S	230	16 / 84	16 / 88	11 / 76	8 / 42	8 / 44	5 / 38	6 / 28	6 / 29	4 / 25
032S	250	17 / 92	18 / 96	11 / 82	9 / 46	9 / 48	6 / 41	6 / 31	6 / 32	4 / 27
032S/L	280	20 / 105	20 / 110	13 / 93	10 / 53	10 / 55	7 / 47	7 / 35	7 / 37	4 / 31
032S/L	320	22 / 118	22 / 123	15 / 106	11 / 59	12 / 61	7 / 53	8 / 39	8 / 41	5 / 35
032S/L	350	— / —	— / —	16 / 116	— / —	— / —	8 / 58	— / —	— / —	6 / 39
050S	320	22 / 118	22 / 123	15 / 107	11 / 59	12 / 61	8 / 54	8 / 39	8 / 41	5 / 36
050S	360	24 / 133	26 / 138	16 / 117	12 / 66	13 / 69	8 / 59	8 / 44	9 / 46	6 / 39
050S	400	27 / 147	28 / 153	18 / 131	14 / 74	14 / 77	9 / 66	9 / 49	10 / 51	6 / 44
050S/L	450	31 / 167	32 / 174	22 / 149	16 / 84	16 / 87	10 / 75	10 / 56	11 / 58	7 / 50
050S/L	500	34 / 186	36 / 193	23 / 167	17 / 93	18 / 97	12 / 83	12 / 62	12 / 64	8 / 56
050S/L	550	— / —	— / —	25 / 183	— / —	— / —	13 / 92	— / —	— / —	9 / 61
080S	500	34 / 186	36 / 193	23 / 167	17 / 93	18 / 97	12 / 83	12 / 62	12 / 64	8 / 56
080S	560	38 / 209	40 / 218	25 / 185	19 / 104	20 / 109	13 / 92	13 / 70	14 / 73	9 / 62
080S	630	43 / 234	45 / 244	29 / 209	22 / 117	22 / 122	14 / 104	14 / 78	15 / 81	10 / 70
080S/L	710	48 / 263	50 / 274	33 / 237	24 / 131	25 / 137	16 / 118	16 / 88	17 / 91	11 / 79
080S/L	800	54 / 299	57 / 311	37 / 266	28 / 149	28 / 156	18 / 133	18 / 100	19 / 104	12 / 89
080S/L	890	— / —	— / —	41 / 297	— / —	— / —	20 / 148	— / —	— / —	14 / 99
142M/L	890	55 / 299	57 / 312	41 / 298	28 / 150	29 / 156	21 / 149	18 / 100	19 / 104	14 / 99
142M/L	980	61 / 335	63 / 349	45 / 331	31 / 168	32 / 175	23 / 166	20 / 112	22 / 116	15 / 110
142M/L	1080	68 / 373	71 / 389	51 / 373	34 / 186	36 / 194	26 / 187	23 / 124	24 / 130	17 / 124
142M/L/E	1220	76 / 419	80 / 437	57 / 414	38 / 210	40 / 218	28 / 207	26 / 140	27 / 146	19 / 138
142M/L/E	1420	85 / 467	89 / 487	66 / 482	43 / 233	44 / 243	33 / 241	28 / 156	30 / 162	22 / 161
210L	1610	84 / 457	87 / 476	73 / 530	42 / 228	44 / 238	36 / 265	28 / 152	29 / 159	24 / 177
210L	1760	86 / 510	97 / 532	81 / 595	47 / 255	49 / 266	41 / 297	31 / 170	32 / 177	27 / 198
210L	1900	104 / 567	108 / 591	90 / 657	52 / 283	54 / 296	45 / 329	35 / 189	36 / 197	30 / 219
210L	2100	114 / 625	119 / 651	95 / 698	57 / 312	60 / 326	48 / 349	38 / 208	40 / 217	32 / 233
250E	2300	123 / 676	128 / 704	104 / 752	62 / 338	64 / 352	52 / 376	41 / 235	43 / 235	35 / 250
250E	2500	136 / 744	142 / 776	113 / 824	68 / 372	71 / 388	57 / 411	46 / 248	48 / 259	38 / 274
210D	1610	87 / 476	89 / 487	72 / 531						
210D	1850	102 / 563	105 / 576	83 / 606		Not Applicable			Not Applicable	
210D	2100	118 / 649	121 / 663	93 / 680						
250D	2100	118 / 651	121 / 666	93 / 680						
250D	2300	128 / 704	131 / 720	103 / 753		Not Applicable			Not Applicable	
250D	2500	141 / 775	144 / 793	112 / 824						
250M	2100	118 / 651	121 / 666	93 / 680						
250M	2300	128 / 704	131 / 720	103 / 753		Not Applicable			Not Applicable	
250M	2500	141 / 775	144 / 793	112 / 824						
250X	2100	118 / 651	121 / 666	93 / 680						
250X	2300	128 / 704	131 / 720	103 / 753		Not Applicable			Not Applicable	
250X	2500	141 / 775	144 / 793	112 / 824						

Note: The minimum evaporator water velocity is 1.5 ft/sec for IECU tubes and 2.0 ft/sec for all other tubes. For a variable evaporator water flow system, the minimum GPME is generally not applicable at full load.

Performance Data

Condenser Flow Rates

Table 4 — Minimum/Maximum Condenser Flow Rates (GPM)

Shell Size CDSZ	Bundle Size CDBS	SBCU Min / Max	TECU Min / Max	IECU Min / Max
		Two Pass		
032S	230	214 / 784	209 / 767	218 / 798
032S/L	250	239 / 877	234 / 857	245 / 899
032S/L	280	267 / 980	261 / 958	273 / 1000
032S/L	320	295 / 1083	289 / 1059	306 / 1121
050S	360	336 / 1233	329 / 1205	347 / 1272
050S/L	400	378 / 1388	370 / 1357	391 / 1434
050S/L	450	426 / 1563	417 / 1528	441 / 1616
050S/L	500	473 / 1733	462 / 1695	490 / 1797
080S	500	473 / 1733	462 / 1695	490 / 1797
080S	560	529 / 1940	517 / 1896	548 / 2010
080S/L	630	595 / 2182	582 / 2133	614 / 2252
080S/L	710	673 / 2466	657 / 2411	689 / 2525
080S/L	800	756 / 2770	739 / 2708	774 / 2838
142L	890	853 / 3126	833 / 3056	876 / 3211
142L	980	948 / 3477	927 / 3399	975 / 3575
142L	1080	1060 / 3885	1036 / 3798	1091 / 3999
142L	1220	1185 / 4344	1158 / 4246	1217 / 4463
142L	1420	1335 / 4896	1305 / 4786	1407 / 5160
210L	1610	1331 / 4881	1301 / 4771	1495 / 5483
210L	1760	1473 / 5402	1440 / 5280	1655 / 6069
210L	1900	1615 / 5923	1579 / 5790	1812 / 6645
210L	2100	1760 / 6454	1721 / 6309	1964 / 7200
250L	2100	1760 / 6454	1721 / 6309	1950 / 7140
250L	2300	1935 / 7094	1891 / 6934	2140 / 7840
250L	2500	2113 / 7749	2066 / 7575	2330 / 8530
		One Pass		
210D	1610	2543 / 9324	2602 / 9541	2998 / 10991
210D	1760	2814 / 10320	2880 / 10560	3318 / 12165
210D	1900	3086 / 11315	3158 / 11578	3632 / 13319
210D	2100	3363 / 12330	3441 / 12617	3936 / 14432
250D	2100	3363 / 12330	3441 / 12617	3931 / 14412
250D	2300	3696 / 13552	3782 / 13868	4317 / 15829
250D	2500	4038 / 14804	4131 / 15149	4698 / 17226
250M	2100	3363 / 12330	3441 / 12617	3931 / 14412
250M	2300	3696 / 13552	3782 / 13868	4317 / 15829
250M	2500	4038 / 14804	4131 / 15149	4698 / 17226
250X	2100	3363 / 12330	3441 / 12617	3931 / 14412
250X	2300	3696 / 13552	3782 / 13868	4317 / 15829
250X	2500	4038 / 14804	4131 / 15149	4698 / 17226

Note: The minimum/maximum condenser water velocity is 3 / 11 ft/sec.

TRANE

Performance Data

Condenser Flow Rates

Table 4 (Continued) — Minimum/Maximum Condenser Flow Rates (Liters/Second)

Shell Size CDSZ	Bundle Size CDBS	Two Pass SBCU Min / Max	Two Pass TECU Min / Max	Two Pass IECU Min / Max
032S	230	13 / 49	13 / 48	14 / 50
032S/L	250	15 / 55	15 / 54	15 / 57
032S/L	280	17 / 62	16 / 60	17 / 63
032S/L	320	19 / 68	18 / 67	19 / 71
050S	360	21 / 78	21 / 76	22 / 80
050S/L	400	24 / 88	23 / 86	25 / 90
050S/L	450	27 / 99	26 / 96	28 / 102
050S/L	500	30 / 109	29 / 107	31 / 113
080S	500	30 / 109	29 / 107	31 / 113
080S	560	33 / 122	33 / 120	35 / 127
080S/L	630	38 / 138	37 / 135	39 / 142
080S/L	710	42 / 156	41 / 152	43 / 159
080S/L	800	48 / 175	47 / 171	49 / 179
142L	890	54 / 197	53 / 193	55 / 203
142L	980	60 / 219	58 / 214	62 / 226
142L	1080	67 / 245	65 / 240	69 / 252
142L	1220	75 / 274	73 / 268	77 / 282
142L	1420	84 / 309	82 / 302	89 / 326
210L	1610	84 / 308	82 / 301	94 / 346
210L	1760	93 / 341	91 / 333	104 / 383
210L	1900	102 / 374	100 / 365	114 / 419
210L	2100	111 / 407	109 / 398	124 / 454
250L	2100	111 / 407	109 / 398	123 / 450
250L	2300	122 / 447	119 / 437	135 / 494
250L	2500	133 / 489	130 / 478	147 / 538
			One Pass	
210D	1610	160 / 588	164 / 602	189 / 693
210D	1760	178 / 651	182 / 666	209 / 767
210D	1900	195 / 714	199 / 730	229 / 840
210D	2100	212 / 778	217 / 796	248 / 910
250D	2100	212 / 778	217 / 796	248 / 909
250D	2300	233 / 855	239 / 875	272 / 998
250D	2500	255 / 934	261 / 956	296 / 1087
250M	2100	212 / 778	217 / 796	248 / 909
250M	2300	233 / 855	239 / 875	272 / 998
250M	2500	255 / 934	261 / 956	296 / 1087
250X	2100	212 / 778	217 / 796	248 / 909
250X	2300	233 / 855	239 / 875	272 / 998
250X	2500	255 / 934	261 / 956	296 / 1087

Note: The minimum/maximum condenser water velocity is 3 / 11 ft/sec.

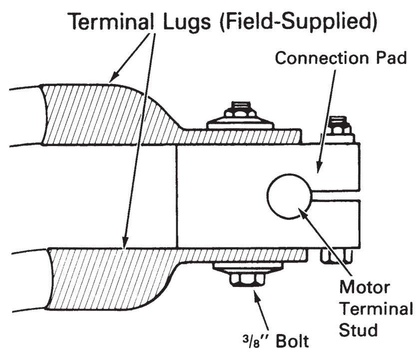
Jobsite Connections

Supply and Motor Lead Wiring and Connections

Copper conductors only should be connected to the compressor motor due to the possibility of galvanic corrosion as a result of moisture if aluminum conductors are used. Copper conductors are recommended for supply leads in the starter panel.

Suggested starter panel line and load side lug sizes (when lugs are provided) are noted in the starter submittals. These submitted lug sizes should be carefully reviewed for compatibility with conductor sizes specified by the electrical engineer or contractor. If they are not compatible, the electrical engineer or contractor should specify the required lug sizes for the particular application. Ground lugs are provided in the motor terminal box and starter panel. The motor terminals are supplied with connection pads which will accommodate bus bars or standard terminal lugs (crimp type recommended). **Terminal lugs are field-supplied.** These connection pads provide additional surface area to minimize improper electrical connections. Also, a 3/8-inch bolt is provided on all connection pads for mounting the lugs. Figure 9 illustrates the connection between the motor connection pads and the terminal lugs.

Figure 13 — Electric Connections



Shipment and Assembly

All style hermetic CenTraVac™ units ship as a factory assembled, factory tested package, ready to rig into place on factory supplied isolation pads.

Tracer™ CH530 Predictive Control Strategies

Today's CenTraVac chillers offer predictive controls that anticipate and compensate for load changes. Other control strategies made possible with the Tracer CH530 controls are:

Feedforward Adaptive Control
Feedforward is an open-loop, predictive control strategy designed to anticipate and compensate for load changes. It uses evaporator entering-water temperature as an indication of load change. This allows the controller to respond faster and maintain stable leaving-water temperatures.

Soft Loading
The chiller controller uses soft loading except during manual operation. Large adjustments due to load or setpoint changes are made gradually, preventing the compressor from cycling unnecessarily. It does this by internally filtering the setpoints to avoid reaching the differential-to-stop or the current limit. Soft loading applies to the leaving chilled-water temperature and current-limit setpoints.

Multi-Objective Limit Arbitration
There are many objectives that the controller must meet, but it cannot satisfy more than one objective at a time. Typically, the controller's primary objective is to maintain the evaporator leaving-water temperature.

Whenever the controller senses that it can no longer meet its primary objective without triggering a protective shutdown, it focuses on the most critical secondary objective. When the secondary objective is no longer critical, the controller reverts to its primary objective.

Fast Restart
The controller allows the CenTraVac to restart while the inlet guide vanes are closing and also during the postlube process. If the chiller shuts down on a nonlatching diagnostic, the diagnostic has 30–60 seconds to clear itself and initiate a fast restart. This includes momentary power losses.

Adaptive Frequency Drive Control
The combination of speed control and inlet guide-vane position is now optimized mathematically and controlled simultaneously. The increased performance of the microprocessor allows the chiller to operate longer at higher efficiency and with greater stability.

Variable-Primary Flow (VPF)
Chilled-water systems that vary the water flow through chiller evaporators have caught the attention of engineers, contractors, building owners, and operators. Varying the water flow reduces the energy consumed by pumps, while requiring no extra energy for the chiller. This strategy can be a significant source of energy savings, depending on the application.

Using the optional variable flow compensation, the Tracer chiller controller reliably accommodates variable evaporator water flow and virtually eliminates its effect on the chilled-water temperature.

Variable Flow Compensation
Variable flow compensation is a new, optional, control feature that includes water pressure-sensor transducers.

Variable flow compensation improves the ability of the chiller to accommodate variable flow, even in combination with an Adaptive Frequency Drive™ (AFD).

VPF with an AFD
Previous controllers sometimes had difficulties with variable water flow in combination with variable-speed drives. Variable flow compensation reacts so quickly that this energy-saving combination is now possible.

34°F Leaving-Water Temperature
Another benefit of Feedforward Adaptive Control is the ability to operate the CenTraVac chiller at low leaving evaporator-water temperatures without the use of glycol.

Colder water is generally used in wide delta-T systems, reducing the pumping energy required and making it less expensive to deliver cooling capacity over long distances. For this reason, 34°F leaving-water temperatures are frequently used in district cooling applications, but can also be used in comfort cooling applications.

Your local Trane office can assist in making chiller two- or three-pass selections using 34°F to 36°F leaving-water temperatures. Special installation procedures may be required for implementing low leaving-water temperatures.

Building Automation and Chiller Plant Control

For a preprogrammable and flexible building automation and chiller plant control, Trane has developed the Tracer Summit™. It can control the operation of the complete installation: chillers, pumps, cooling towers, isolating valves, air handlers and terminal units. Trane can undertake full responsibility for an optimized automation and energy management for the entire chiller plant.

The main functions are:

- **Chiller sequencing:** equalizes the number of running hours of the chillers. Different control strategies are available depending on the configuration of the installation.
- **Control of the auxiliaries:** includes input/output modules to control the operation of the various auxiliary equipments (water pumps, valves, cooling towers, etc.)
- **Time of day scheduling:** allows the end user to define the occupancy period, i.e. time of the day, holiday periods and exception schedules.
- **Optimization of the start/stop time of the installation:** based on the programmed schedule of occupancy and on the historical record of the behavior of the temperatures, calculates the optimal time of start and stop of the installation to get the best compromise between energy savings and comfort of the occupants.
- **Soft loading:** the soft loading function minimizes the number of chillers that are operated to satisfy the building morning pull down, thus preventing an overshoot of the actual capacity required. Unnecessary starts are avoided and the peak current demand is lowered.
- **Communication capabilities:** several communication levels are provided:
  - — local, through a PC workstation keyboard. Summit can be programmed to send messages to local or remote workstations and or a pager in the following cases:
  - — Analog parameter exceeding a programmed value.
  - — Maintenance warning.
  - — Component failure alarm.
  - — Critical alarm messages. In this latter case, the message is displayed until the operator acknowledges the receipt of the information. From the remote station it is also possible to access and modify the chiller plant's control parameters.
- Remote communication through a modem: As an option, a modem can be connected to communicate the plant operation parameters through voice grade phone lines.

The remote terminal is a PC workstation equipped with a modem and software to display the remote plant parameters.

Chiller-Tower Optimization
Tracer Summit™ chiller-tower optimization extends Adaptive Control™ to the rest of the chiller plant. Chiller-tower optimization is a unique control algorithm for managing the chiller and cooling-tower subsystem. It considers the chiller load and real-time ambient conditions, then optimizes the tower setpoint temperature to maximize the efficiency of the subsystem.

Integrated Comfort™ System (ICS)
The onboard Tracer chiller controller is designed to be able to communicate with a wide range of building automation systems. To take full advantage of the capabilities of the chiller, incorporate your chiller into a Tracer Summit building automation system.

But the benefits do not stop at the chiller plant. At Trane, we realize that all energy used in your cooling system is important. That is why we worked closely with other equipment manufacturers to predict the energy required by the entire system. We used this information to create patented control logic for optimizing the HVAC system efficiency.

The building owner's challenge is to tie components and applications expertise into a single reliable system that provides maximum comfort, control and efficiency. Trane's Integrated Comfort™ systems (ICS) are a concept that combines system components, controls and engineering applications expertise into a single, logical and efficient system. These advanced controls are fully commissioned and available on every piece of Trane equipment, from the largest chiller to the smallest VAV box. As a manufacturer, only Trane offers this universe of equipment, controls and factory installation and verification.

Standard Features

Field Connection
The field-connected elements are involved in physically turning the chiller on or off. This involves ensuring that the chiller is not in an emergency or external stop condition, starting the pumps, and verifying that flow has been established. The optional, factory-supplied flow switch or a customer-supplied differential- pressure switch can be used to prove flow.

- External auto stop (enable/disable)
- Emergency stop
- Chilled-water flow contacts
- Condenser-water flow contacts
- Chilled-water pump relay
- Condenser-water pump relay

Heat Exchanger Control
Fundamental internal variables that are necessary to control the chiller are gathered and acted upon by the heat exchanger control function.

Motor Control and Compressor Protection
This includes all functions that start, run, and stop the motor. The starter module provides the interface and control of Y-delta, across-the-line, primary reactor, autotransformer, and solid-state starters. Analog and binary signals are used to interface with the solid state starter. An AFD output signal, included in the AFD option, controls the Adaptive Frequency drive. The motor control also provides protection to both the motor and the compressor.

EarthWise Purge Control
The purge control function provides all the inputs and outputs to control the purge, optimizing both purge and chiller efficiency. The purge controller communicates with DynaView over the IPC3 bus communications link, uploading setpoints and downloading data and diagnostics.

Phase Voltage Sensors – 3 phase
Includes factory-installed potential transformers in the starter for monitoring and displaying phase voltage and provides over/ undervoltage protection. DynaView, TechView and Tracer Summit display the following:

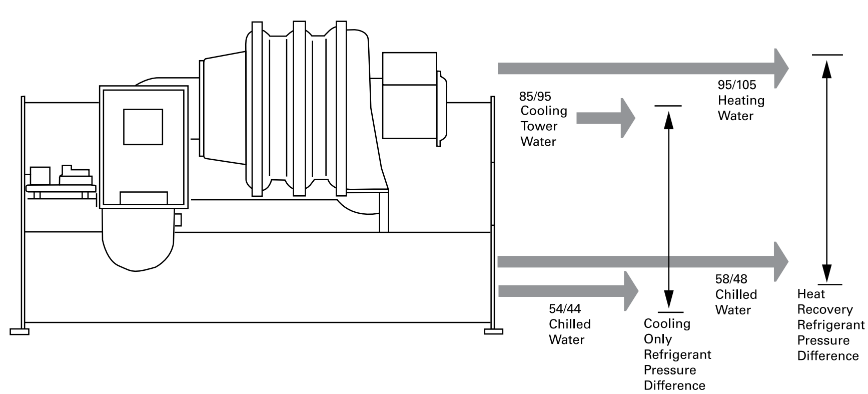
- Compressor phase voltage (a-b, b-c, c-a)
- Kilowatts
- Power factor (uncorrected)

Chilled-Water Reset
Chilled-water reset reduces energy consumption during periods of the year when heating loads are high and cooling loads are reduced. It is based on return chilled-water temperature. Resetting the chilled-water temperature reduces the amount of work that the compressor must do by increasing the evaporator refrigerant pressure. This increased evaporator pressure reduces the pressure differential the compressor must generate while in the heat recovery mode. Chilled-water reset is also used in combination with the hot-water control. By resetting the chilled-water temperature upward, the compressor can generate a higher condenser pressure, resulting in higher leaving hot-water temperatures.

Hot-Water Control
In the hot-water mode, the chiller produces hot water as its primary objective, rather than chilled water. As an option, the Extended Operation package allows an external controller to enable, disable, and modulate this mode. It can be performed with or without a secondary condenser. See also Heat Recovery/Auxiliary Condenser option.

Ice-Making Control
For chillers that have been selected to allow for ice-making operation, the standard control package includes the ice-making mode. As an option, the Extended Operation package allows an external controller to enable, disable, and modulate this mode.

Figure 14 — Chilled Water Reset



Enhanced Protection Package

This optional package includes sensors and transducers that enable the following protection features:

Enhanced Condenser-Limit Control
Includes factory-installed condenser-pressure transducer and interconnecting piping and wiring. Provides enhanced high-pressure cutout avoidance by energizing a relay to initiate head relief. Note: This option is in addition to the standard high refrigerant-pressure safety contact.

Compressor-Discharge Refrigerant-Temperature Protection (optional)
Includes a factory-installed sensor and safety cutout on high compressor-discharge temperature. Allows the chiller controller to monitor compressor discharge temperature, which is displayed at DynaView, TechView, and Tracer Summit. Note: When the chiller is selected with HGBP, this sensor and its associated protection are included.

Individual Sensing of Leaving Oil Set Temperature For Each Bearing
Optional factory-installed sensors allow high-temperature safety cutouts to monitor the leaving bearing-oil temperatures. The chiller controller and Tracer Summit display the temperatures. The high bearing-temperature cutout is fixed at 180°F (82.2°C). If either bearing temperature violates the cutout, a latching diagnostic will be generated.

Extended Operation Package

Select the extended-operation package for chillers that require *external* ice-building control, hot water control, and/or base-loading capabilities. This package also includes a 4-20 mA or 0-10 Vdc analog input for a refrigerant monitor.

- External Ice-building control
- External Ice-building relay
- External base-loading control
- External base-loading relay
- External hot-water control relay
- Refrigerant monitor input

Base-Loading Control
This feature allows an external controller to directly modulate the capacity of the chiller. It is typically used in applications where virtually infinite sources of evaporator load and condenser capacity are available and it is desirable to control the loading of the chiller. Two examples are industrial process applications and cogeneration plants. Industrial process applications might use this feature to impose a specific load on the facility's electrical system. Cogeneration plants might use this feature to balance the system's heating, cooling, and electrical generation.

All chiller safeties and Adaptive Control functions are in full effect when Base Loading is enabled. If the chiller approaches full current, the evaporator temperature drops too low, or the condenser pressure rises too high, the controller's Adaptive Control logic limits the loading of the chiller to prevent the chiller from shutting down on a safety limit. These limits may prevent the chiller from reaching the load requested by the Base Loading signal.

An alternative and less radical approach to Base Loading indirectly controls chiller capacity. Artificially load the chiller by setting the chilled-water setpoint lower than it is capable of achieving. Then, modify the chiller's load by adjusting the current-limit setpoint. This approach provides greater safety and control stability because it leaves the chilled-water temperature-control logic in effect. The chilled-water temperature control responds more quickly to dramatic system changes and limits chiller loading prior to reaching an Adaptive Control limit.

Ice-Making Control
This feature allows an external controller to control the chiller in an ice-storage system. Ice storage is typically used in areas where high electrical-demand charges can be offset by shifting building energy use to off-peak (typically nighttime) hours.

While the standard controller is fully capable of running the chiller in ice-making mode, installation savings and additional energy savings can be realized by using the Chiller Plant Control module of the Tracer building automation system. Chiller Plant Control anticipates how much ice needs to be made at night and operates the system accordingly. The controls are integrated with the chiller—two wires and preprogrammed software reduce field-installation cost and complex custom programming.

The CenTraVac chiller is uniquely suited for low-temperature applications like ice storage, because it provides multiple stages of compression. This allows the chiller to produce ice efficiently, while experiencing less stress than a single-stage compression chiller.

Hot-Water Control
This feature allows an external controller to enable/disable and modulate the hot-water control mode. Occasionally, CenTraVac chillers are used to provide heating as a primary mission. In this case the external controller or operator would select a hot-water temperature setpoint and the chiller capacity would be modulated to maintain the setpoint. Heating is the primary mission and cooling is a waste product or a secondary mission. This technique provides application flexibility, especially in multiple-chiller plants in conjunction with undersized heating plants.

The chiller needs only one condenser for hot-water control, whereas Heat Recovery uses a secondary condenser.

Refrigerant Monitor
The Extended Operation package allows for a refrigerant monitor to send a 4-20 mA signal to the DynaView display. It can be calibrated to correspond to either 0-100 ppm or 0-1,000 ppm concentration levels. The concentration level is displayed at DynaView, but the chiller will not take any action based on the input from the refrigerant monitor.

Alternatively, a refrigerant monitor can be connected to Tracer Summit, which has the ability to increase ventilation in the equipment room in response to high refrigerant concentrations.

Tracer™ Chiller Controller

The chiller controller uses proportional-integral-derivative (PID) control for all limits—there is no dead band. This removes oscillation above and below setpoints and extends the capabilities of the chiller.

Some of the standard protection features of the chiller controller are described in this section. There are additional protection features not listed here.

High Condenser-Pressure Protection
The chiller controller's condenser limit keeps the condenser pressure under a specified maximum pressure. The chiller runs all the way up to 100 percent of the setpoint before reducing capacity using its adaptive control mode.

Starter-Contactor Failure Protection
The chiller will protect itself from a starter failure that prevents the compressor motor from disconnecting from the line to the limits of its capabilities.

The controller starts and stops the chiller through the starter. If the starter malfunctions and does not disconnect the compressor motor from the line when requested, the controller will recognize the fault and attempt to protect the chiller by operating the evaporator-and condenser-water pumps and attempting to unload the compressor.

Loss of Water-Flow Protection
DynaView has an input that will accept a contact closure from a proof-of-flow device such as a flow switch or pressure switch. Customer wiring diagrams also suggest that the flow switch be wired in series with the cooling-water (condenser-water) pump starter's auxiliary contacts. When this input does not prove flow within a fixed time during the transition from Stop to Auto modes of the chiller, or if the flow is lost while the chiller is in the Auto mode of operation, the chiller will be inhibited from running by a nonlatching diagnostic.

Evaporator Limit Protection
Evaporator Limit is a control algorithm that prevents the chiller tripping on its low refrigerant-temperature cutout. The machine may run up to the limit but not trip. Under these conditions the intended chilled-water setpoint may not be met, but the chiller will do as much as it can. The chiller will deliver as much cold water as possible even under adverse conditions.

Low Evaporator-Water Temperature
Low evaporator-water temperature protection, also known as Freeze Stat protection, avoids water freezing in the evaporator by immediately shutting down the chiller and attempting to operate the chilled-water pump. This protection is somewhat redundant with the Evaporator Limit protection, and prevents freezing in the event of extreme errors in the evaporator- refrigerant temperature sensor.

The cutout setting should be based on the percentage of antifreeze used in the customer's water loop. The chiller's operation and maintenance documentation provides the necessary information for percent antifreeze and suggests leaving-water temperature-cutout settings for a given chilled-water temperature setpoint.

High-Vacuum Lockout Protection
The controller inhibits a compressor start with a latching diagnostic whenever the evaporator pressure is less than or equal to 3.1 psia for R123. This protects the motor by locking out chiller operation while the unit is in a high vacuum, to prevent starting when the evaporator is in a high-vacuum state.

Oil-Temperature Protection
Low oil temperature when the oil pump and/or compressor are running may be an indication of refrigerant diluting the oil. If the oil temperature is at or below the low oil-temperature setpoint, the compressor is shut down on a latching diagnostic and cannot be started. The diagnostic is reported at the user interface. The oil heater is energized in an attempt to raise the oil temperature above the low oil-temperature setpoint.

High oil-temperature protection is used to avoid overheating the oil and the bearings.

Low Differential Oil-Pressure Protection
Oil pressure is indicative of oil flow and active oil-pump operation. A significant drop in oil pressure indicates a failure of the oil pump, oil leakage, or other blockage in the oil-circuit.

The differential pressure during oil pump, compressor prelube mode should not fall below 12 psid. A failure on this parameter generates a shutdown diagnostic within 2 seconds of the differential pressure falling below 2/3 of the low differential oil pressure cutout. When the compressor is running, the diagnostic is issued when the differential pressure falls below the cutout setpoint for more than (cutout x 3) seconds.

Excessive Purge Detection
Pump-out activity is indicative of the amount of air leaking into the chiller refrigerant system. The operator should be informed when the air-leakage rate changes. Through this setpoint, the operator can indicate the expected leakage rate, and can be notified though a diagnostic if the rate is higher than expected.

Occasionally, when a service technician performs a mechanical repair on the chiller, an unusually high pump-out rate is expected for a certain period of time following the procedure. The service excessive pump-out override allows the technician to specify a time period for the purge system to rid the chiller of air in the system. This temporarily suspends excessive purge detection.

Phase-Unbalance Protection
Phase-unbalance protection is based on an average of the three phase-current inputs. The ultimate phase-unbalance trip point is 30 percent. In addition, the RLA of the motor is derated by resetting the active current-limit setpoint based on the current unbalance. The RLA derate protection can be disabled in the field-startup menu.

The following derates apply when the phase-unbalance limit is enabled:

10% unbalance = 100% RLA derate
15% unbalance = 90% RLA derate
20% unbalance = 85% RLA derate
25% unbalance = 80% RLA derate
30% unbalance = Shutdown

Phase-Loss Protection
The controller will shut down the chiller if any of the three phase currents feeding the motor drop below 10 percent RLA. The shutdown will result in a latching phase-loss diagnostic. The time to trip is 1 second at minimum, 3 seconds maximum.

Phase Reversal/Rotation Protection
The controller detects reverse phase rotation and provides a latching diagnostic when it is detected. The time to trip is 0.7 seconds. Phase-rotation protection can be disabled in TechView.

Momentary Power Loss and Distribution Fault Protection
Three-phase momentary power loss (MPL) detection gives the chiller improved performance through many different power anomalies. MPLs of 2.5 cycles or longer will be detected and cause the unit to shut down. The unit will be disconnected from the line within 6 line cycles of detection. If enabled, MPL protection will be active any time the compressor is running. MPL is not active on reduced-voltage starters from the initial start signal through transition. The MPL diagnostic is an automatic reset diagnostic. MPL protection can be disabled in TechView.

An MPL has occurred when the motor no longer consumes power. An MPL may be caused by any drop or sag in the voltage that results in a change in the direction of power flow. Different operating conditions, motor loads, motor size, inlet guide vane (IGV) position, etc. may result in different levels at which this may occur. It is difficult to define an exact voltage sag or voltage level at which a particular motor will no longer consume power, but we are able to make some general statements concerning MPL protection:

The chiller will remain running under the following conditions:

- Line-voltage sag of 1.5 line cycles or less for any voltage magnitude sag
- Control-voltage sags of less than 3 line cycles for any magnitude sag
- Control-voltage sags of 40 percent or less for any amount of time
- Second-order or lower harmonic content on the line

The chiller may shut down under the following conditions:

- Line-voltage sags of 1.5 or more line cycles for voltage dips of 30 percent or more
- Control-voltage sags of 3 or more line cycles for voltage dips of 40 percent or more
- Third-order or higher harmonic content on the line

Controls

Standard Protections

Current Overload Protection
The control panel will monitor the current drawn by each line of the motor and shut the chiller off when the highest of the three line currents exceeds the trip curve. A manual reset diagnostic describing the failure will be displayed. The current overload protection does not prohibit the chiller from reaching its full-load amperage.

The chiller protects itself from damage due to current overload during starting and running modes, but is allowed to reach full-load amps.

High Motor-Winding Temperature Protection
This function monitors the motor temperature and terminates chiller operation when the temperature is excessive. The controller monitors each of the three winding-temperature sensors any time the controller is powered up, and displays each of the temperatures at the service menu. Immediately prior to start, and while running, the controller will generate a latching diagnostic if the winding temperature exceeds 265 ± 5°F (129.4 ± 2.8°C).

Surge Detection Protection
Surge detection is based on current fluctuations in one of three phases. The default detection criterion is two occurrences of RMS current change of 30 percent within 0.8 seconds in 60 + 10 percent seconds. With the Tracer chiller controller, the detection criterion is adjustable.

Overvoltage and Undervoltage Protection
The unit will be shut down with an automatic reset if the line voltage is below or above 10 percent of nominal.

Must trip = 15 percent of nominal.

Time to trip = minimum of 1 minute, 10 seconds and maximum of 5 minutes, 20 seconds. Overvoltage and undervoltage protection can be disabled using TechView.

Power Factor and kW Measurement
Three-phase measurement of kW and unadjusted power factor yields higher accuracy during power imbalance conditions than with UCP2.

Short-Cycling Protection
Two selections exist, one based on motor-winding temperature and the other based on a start-to-start time.

Based on Motor-Winding Temperature:

If all three motor-winding temperatures are less than the 'Restart Inhibit Temperature' setpoint, the chiller will be allowed to proceed with prestart when there is need to cool. If at least one of the three motor-winding temperatures is greater than or equal to the setpoint, but less than 265°F, the chiller will enter the restart-inhibit mode. The chiller will remain in this mode until all three motor-winding temperatures are less than the setpoint. After these temperatures drop below the setpoint, they will not be checked again in this sequence. If at least one of the three motor-winding temperatures is 265°F or higher, a High Motor Winding Temp diagnostic will be called.

Based On Time:

This method uses a straight start-to-start timer to determine when to allow the next start. A time-based restart inhibit-function is used if the Restart Inhibit Type is set to 'Time' or if the motor-winding temperatures are determined to be invalid.

A 'Restart Inhibit Start-to-Start Time' setpoint is used to set the desired start-to-start time. There is no 'free' start on a power up at DynaView. The real-time clock is used to determine when the next start will be allowed, based on the previous start.

When the start is inhibited by the restart-inhibit function, the time remaining is displayed along with the restart-inhibit mode.

Variable Flow Compensation

This option includes transducers for the differential evaporator-and condenser-water pressures (psid). Flow switches or some other means to prove flow are still required and must be field connected. One type of sensor handles all pressure ranges up to 300 psig.

The following data will be shown at the DynaView and TechView displays and at Tracer Summit.

- Evaporator and condenser differential water pressures (psid)
- Evaporator and condenser gpm
- Evaporator tons

How It Works

The Tracer chiller controller uses a patented, variable, water-flow compensation algorithm to maintain stable, precise capacity control. Variable flow compensation is a new optional control feature for CTV chillers.

It will automatically adjust capacity control to:

- Maintain control stability at low flow.
- Reject variable-flow disturbance.

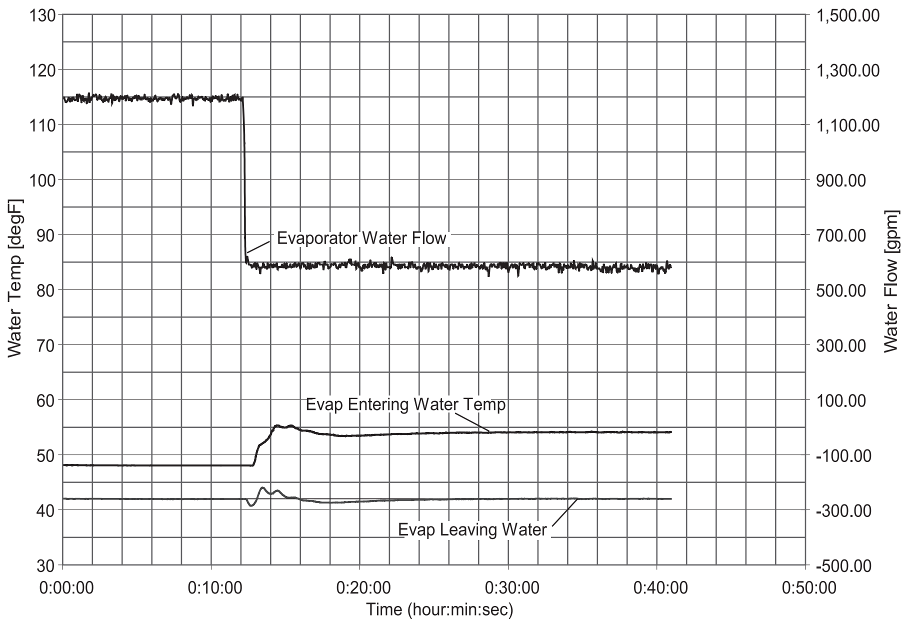
If the water-pressure transducer fails and the flow switch continues to prove flow, water-flow compensation will be disabled and the design delta T will be used.

For applications designed to operate with variable-primary (VPF) water-flow, variable flow compensation allows the chiller to respond quickly to accelerating or decelerating water. By automatically adjusting the control gain, large changes in the water-flow rate can be tolerated.

Data shown on Figure 15 demonstrates water-temperature control with flow compensation enabled. The chilled-water temperature remains stable, even when the water-flow rate drops 50 percent in 30 seconds. In contrast, Figure 16 demonstrates water-temperature control without flow compensation.

Another benefit is disturbance rejection. Figure 17 shows the test results from step changes in water flow with increasing magnitudes. The leaving chilled-water temperature remains largely unaffected. Even the most severe change—dropping water flow 66 percent in 30 seconds— caused only a small, 1.5°F variation in chilled-water temperature. It is unlikely that a chiller application would be making water-flow changes of this magnitude. The results demonstrate that the chiller is more than capable of supporting variable water-flow applications.

Figure 15 — Capacity Control with Variable Flow Compensation



Variable Flow Stability

Figure 16 — Capacity Control without Variable Flow Compensation

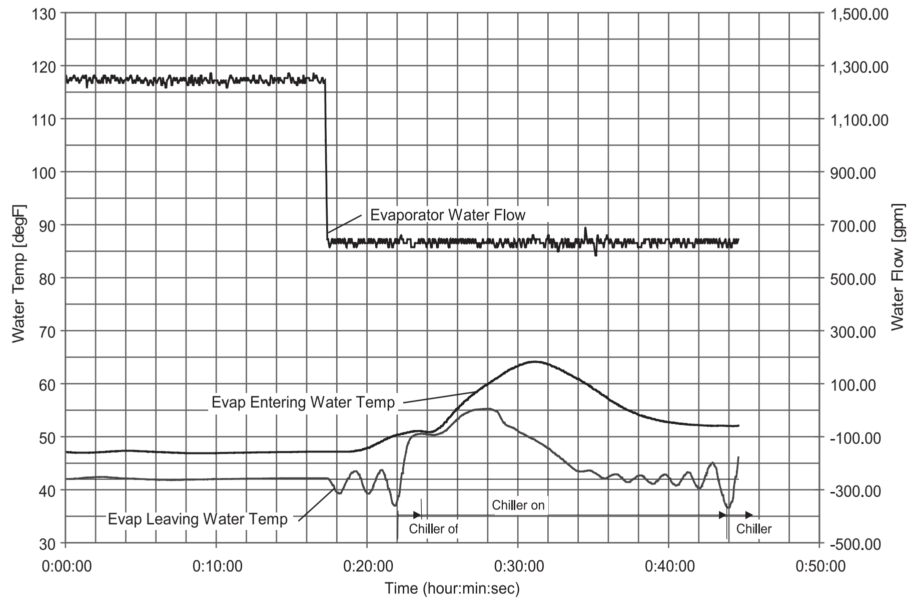
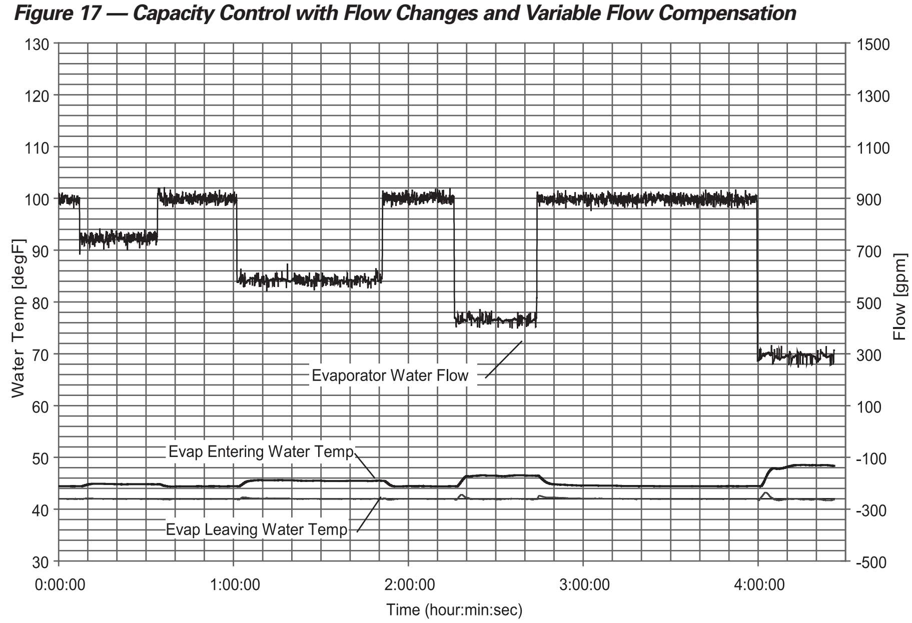


Figure 17 — Capacity Control with Flow Changes and Variable Flow Compensation



Weights

60 Hz Compressor (IP & SI Units)

The weight information provided here should be used for general information purposes only. Trane does not recommend using this weight information for considerations relative to chiller handling. The large number of variances between chiller selections drives variances in chiller weights that are not recognized in this table.

Table 5 – Weights 60 Hz Compressors

					Without				With Starters			
					Operating Weights		Shipping Weights		Operating Weights		Shipping Weights	
MODL	NTON	CPK	EVSZ	CDSZ	lbs	kg	lbs	kg	lbs	kg	lbs	kg
	350 - 485	453	050L	050L	21152	9595	18617	8445	22234	10085	19699	8935
	350 - 485	453	050S	050L	19814	8988	17668	8014	20896	9478	18750	8505
	350 - 485	453	050S	050S	18925	8584	16937	7683	20007	9075	18019	8173
	350 - 485	453	080L	080L	30751	13949	26866	12186	31833	14439	27948	12677
	350 - 485	453	080S	080L	28589	12968	25254	11455	29671	13459	26336	11946
	350 - 485	453	080S	080S	26876	12191	23787	10790	27958	12682	24869	11281
	555 - 640	588	050L	050L	21620	9807	19085	8657	23094	10475	20559	9326
	555 - 640	588	050S	050L	20282	9200	18136	8226	21756	9869	19610	8895
C	555 - 640	588	050S	050S	19393	8797	17405	7895	20867	9465	18879	8564
V	555 - 640	588	080L	080L	31219	14161	27334	12399	32693	14830	28808	13067
H	555 - 640	588	080S	080L	29057	13180	25722	11667	30531	13849	27196	12336
F	555 - 640	588	080S	080S	27344	12403	24255	11002	28818	13072	25729	11671
	650 - 910	957	080L	080L	32688	14827	28803	13065	34249	15535	30364	13773
	650 - 910	957	080S	080L	30526	13847	27191	12334	32087	14555	28752	13042
	650 - 910	957	080S	080S	28813	13070	25724	11668	30374	13778	27285	12376
	650 - 910	957	142L	142L	42739	19386	36476	16546	44300	20094	38037	17254
	650 - 910	957	142M	142L	41548	18846	35653	16172	43109	19554	37214	16880
	1060 - 1280	1228	142E	142L	44713	20282	38063	17265	46130	20925	39480	17908
	1060 - 1280	1228	142L	142L	43436	19703	37173	16862	44853	20345	38590	17504
	1060 - 1280	1228	142M	142L	42245	19162	36350	16488	43662	19805	37767	17131
	1060 - 1280	1228	210L	210L	52882	23987	44876	20356	54299	24630	46293	20999
	1470	1340	210L	210L	56217	25500	48211	21869	57299	25991	49293	22359
	1470 - 1720	1340	250E	250L	68393	31023	57807	26221	69475	31514	58889	26712
	230 - 320	287	032L	032L	16691	7571	15145	6870	17773	8062	16227	7361
	230 - 320	287	032S	032L	15795	7165	14484	6570	16877	7655	15566	7061
	230 - 320	287	032S	032S	14960	6786	13730	6228	16042	7277	14812	6719
C	230 - 320	287	050L	050L	20650	9367	18081	8202	21732	9858	19163	8692
V	230 - 320	287	050S	050L	19312	8760	17132	7771	20394	9251	18214	8262
H	230 - 320	287	050S	050S	18278	8291	16248	7370	19360	8782	17330	7861
E	360 - 500	453	050L	050L	22187	10064	19618	8899	23269	10555	20700	9390
	360 - 500	453	050S	050L	20849	9457	18669	8468	21931	9948	19751	8959
	360 - 500	453	050S	050S	19815	8988	17785	8067	20897	9479	18867	8558
	360 - 500	453	080L	080L	30758	13952	26806	12159	31840	14443	27888	12650
	360 - 500	453	080S	080L	28595	12971	25194	11428	29677	13461	26276	11919
	360 - 500	453	080S	080S	27155	12318	24016	10894	28237	12808	25098	11384
C	1500 - 2000	745	210D	210D	82345	37352	70434	31949	84211	38198	72300	32795
D	2100 - 2500	1062	250D	250D	91786	41634	77908	35339	92900	42139	79022	35844
H	3000	1340	250M	250M	115613	52442	98544	44700	N/A	N/A	N/A	N/A
F	3500	1340	250X	250X	119662	54279	100297	45495	N/A	N/A	N/A	N/A

These values represent chiller weights that include the following:

- Heaviest possible bundle and heaviest possible motor voltage combination for the applicable family of chillers
- Applicable compressor
- TECU .028" tubes
- 150 psig non-marine waterboxes
- Chillers-with-starter values include the weight of the heaviest possible starter
- Operating weights include the heaviest possible refrigerant charge weight

Weights

50 Hz Compressor (IP & SI Units)

The weight information provided here should be used for general information purposes only. Trane does not recommend using this weight information for considerations relative to chiller handling. The large number of variances between chiller selections drives variances in chiller weights that are not recognized in this table.

Table 6 – Weights 50 Hz Compressors

					Without				With Starters			
					Operating Weights		Shipping Weights		Operating Weights		Shipping Weights	
MODL	NTON	CPK	EVSZ	CDSZ	lbs	kg	lbs	kg	lbs	kg	lbs	kg
	480 - 565	489	050L	050L	23384	10607	20815	9442	24466	11098	21897	9932
	480 - 565	489	050S	050L	22046	10000	19866	9011	23128	10491	20948	9502
	480 - 565	489	050S	050S	21323	9672	19324	8765	22405	10163	20406	9256
	480 - 565	489	080L	080L	31955	14495	28003	12702	33037	14986	29085	13193
C	480 - 565	489	080S	080L	29792	13514	26391	11971	30874	14004	27473	12462
V	480 - 565	489	080S	080S	29154	13224	26065	11823	30236	13715	27147	12314
H	670 - 780	621	080L	080L	33266	15089	29314	13297	34348	15580	30396	13788
G	670 - 780	621	080S	080L	31103	14108	27702	12566	32185	14599	28784	13056
	670 - 780	621	080S	080S	30465	13819	27376	12418	31547	14310	28458	12909
	670 - 780	621	142L	142L	44705	20278	38442	17437	45787	20769	39524	17928
	670 - 780	621	142M	142L	43514	19738	37619	17064	44596	20229	38701	17555
	920 - 1067	621	142L	142L	45545	20659	39282	17818	46627	21150	40364	18309
	920 - 1067	621	142M	142L	44354	20119	38459	17445	45436	20610	39541	17936
	920 - 1067	621	210L	210L	57319	26000	49375	22397	58401	26491	50457	22887
	190 - 270	242	032L	032L	16719	7584	15173	6882	17801	8075	16255	7373
	190 - 270	242	032S	032L	15823	7177	14512	6583	16905	7668	15594	7073
	190 - 270	242	032S	032S	14988	6799	13758	6241	16070	7289	14840	6731
C	190 - 270	242	050L	050L	20678	9380	18109	8214	21760	9870	19191	8705
V	190 - 270	242	050S	050L	19340	8773	17160	7784	20422	9263	18242	8275
H	190 - 270	242	050S	050S	18306	8304	16276	7383	19388	8794	17358	7874
E	300 - 420	379	050L	050L	21569	9784	19000	8618	22651	10274	20082	9109
	300 - 420	379	050S	050L	20231	9177	18051	8188	21313	9668	19133	8679
	300 - 420	379	050S	050S	19197	8708	17167	7787	20279	9199	18249	8278
	300 - 420	379	080L	080L	30140	13672	26188	11879	31222	14162	27270	12370
	300 - 420	379	080S	080L	27977	12690	24576	11148	29059	13181	25658	11638
	300 - 420	379	080S	080S	26537	12037	23398	10613	27619	12528	24480	11104
CD	1250 - 1750	621	210D	210D	86267	39131	74805	33932	88431	40112	76969	34913
HG	2150	621	250D	250D	97424	44192	83035	37665	97862	44390	83473	37863

These values represent chiller weights that include the following:

- Heaviest possible bundle and heaviest possible motor voltage combination for the applicable family of chillers
- TECU .028″ tubes
- Applicable compressor
- 150 psig non-marine waterboxes
- Chillers-with-starter values include the weight of the heaviest possible starter
- Chillers-without-starter values do not include a weight-add for the starter
- Operating weights include the heaviest possible refrigerant charge weight

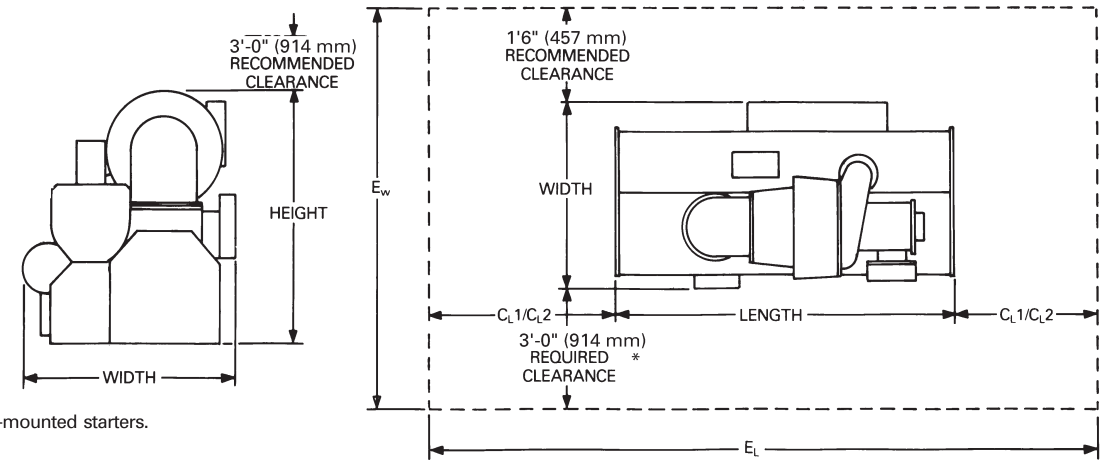
Single Compressor CenTraVac Chillers

Table 7 — CenTraVac Water Connection Pipe Size

Water Passes	Shell Size 032	050	080	142	210	250
EVAPORATOR	Nominal Pipe Size (Inches)					
1 PASS	8	10	12	16	16	16
2 PASS	6	8	10	12	14	14
3 PASS	5	6	8	10	12	12
CONDENSER 2 PASS	6	8	10	12	14	14
EVAPORATOR	Metric Pipe Size (Millimeters)					
1 PASS	DN200	DN250	DN300	DN400	DN400	DN400
2 PASS	DN150	DN200	DN250	DN300	DN350	DN350
3 PASS	DN125	DN150	DN200	DN250	DN300	DN300
CONDENSER 2 PASS	DN150	DN200	DN250	DN300	DN350	DN350

Single Compressor CenTraVac Chillers

Figure 18 for Table 8 and 9 — Space Envelope for 60 and 50 Hz Compressor Chillers



*Without unit-mounted starters.

Table 8 for Figure 18 — Physical Dimensions 50 Hz Compressor Chillers (IP and SI Units)

				IP UNITS								
				Envelope		Clearance		Unit Dimensions				
	COMP	Shell Size	Shell Arrange-ment	EL	W/O Unit Mounted Starters EW	With Unit Mounted Starters EW	Tube Pull CL1	CL2	Length	Height	W/O Unit Mounted Starters Width	With Unit Mounted Starters Width
	190-270	320	SS	26' 5″	10' 6 1/4″	11' 7 1/2″	11' 9″	3' 5″	11' 3″	7' 9 3/4″	5′ 9 1/4″	6' 7 1/2″
	190-270	320	SL & LL	33' 11 1/4″	10' 6 1/4″	11' 7 1/2″	15' 6″	3' 5″	15' 0 1/4″	7' 9 3/4″	5″ 9 1/4″	6' 7 1/2″
	190-270	500	SS	26' 6 3/8″	11' 4 5/8″	12' 9 7/8″	11' 9″	3' 6 3/8″	11' 3″	8' 2 1/4″	6' 7 5/8″	7' 9 7/8″
C	190-270	500	SL & LL	34' 0 5/8″	11' 4 5/8″	12' 9 7/8″	15' 6″	3' 6 3/8″	15' 0 1/4″	8' 2 1/4″	6' 7 5/8″	7' 9 7/8″
V	300-420	500	SS	26' 6 3/8″	11' 4 5/8″	12' 8 1/2″	11' 9″	3' 6 3/8″	11' 3″	8' 2 1/2″	6' 7 5/8″	7' 8 1/2″
H	300-420	500	SL & LL	34' 0 5/8″	11' 4 5/8″	12' 8 1/2″	15' 6″	3' 6 3/8″	15' 0 1/4″	8' 2 1/2″	6' 7 5/8″	7' 8 1/2″
E	300-420	800	SS	27' 4 1/4″	12' 5 1/4″	13' 9 1/4″	11' 9″	4' 4 1/4″	11' 3″	9' 6 3/8″	7' 11 1/4″	8' 7 5/8″
	300-420	800	SL & LL	34' 10 1/2″	12' 5 1/4″	13' 9 1/4″	15' 6″	4' 4 1/4″	15' 0 1/4″	9' 6 3/8″	7' 11 1/4″	8' 7 5/8″
	480-565	500	SS	26' 6 3/8″	11' 4 5/8″	13' 7 5/8″	11' 9″	3' 6 3/8″	11' 3″	8' 7 1/4″	6' 7 5/8″	7' 8 3/4″
	480-565	500	SL & LL	34' 0 5/8″	11' 4 5/8″	13' 7 5/8″	15' 6″	3' 6 3/8″	15' 0 1/4″	8' 7 1/4″	6' 7 5/8″	7' 8 3/4″
	480-565	800	SS	27' 4 1/4″	12' 5 1/4″	13' 1 5/8″	11' 9″	4' 4 1/4″	11' 3″	9' 8″	7' 11 1/4″	8' 7 5/8″
C	480-565	800	SL & LL	34' 10 1/2″	12' 5 1/4″	13' 1 5/8″	15' 6″	4 4 1/4″	15' 0 1/4″	9' 8″	7' 11 1/4″	8' 7 5/8″
V	670-780	800	SS	27' 4 1/4″	12' 10″	13' 10	11' 9″	4' 4 1/4″	11' 3″	9' 6 3/4″	8' 4″	9' 1 3/4″
H	670-780	800	SL & LL	34' 10 1/2″	12' 10″	13' 10	15' 6″	4' 4 1/4″	15' 0 1/4″	9' 6 3/4″	8' 4″	9' 1 3/4″
G	670-780	1420	ML & LL	35' 5 1/4″	14' 5 3/4″	14' 4 1/2″	15' 6″	4' 11″	15' 0 1/4″	10' 1 1/8″	9' 11 3/4″	10' 3 7/8″
	920-1067	1420	ML & LL	35' 5 1/4″	14' 5 3/4″	14' 4 1/2″	15' 6″	4' 11″	15' 0 1/4″	10' 1 1/8″	9' 11 3/4″	10' 3 7/8″
	920-1067	2100	LL	35' 5 1/4″	15 3 3/4″	15' 8 3/8″	15' 6″	4' 11″	15' 0 1/4″	11' 0 7/8″	10' 9 3/4″	10' 10″
				SI UNITS (mm)								
	190-270	320	SS	8052	3207	3543	3581	1041	3429	2380	1759	2019
	190-270	320	SL & LL	10344	3207	3543	4724	1041	4578	2380	1759	2019
	190-270	500	SS	8087	3470	3909	3581	1076	3429	2494	2022	2384
C	190-270	500	SL & LL	10379	3470	3909	4724	1076	4578	2494	2022	2384
V	300-420	500	SS	8087	3470	3874	3581	1076	3429	2502	2022	2350
H	300-420	500	SL & LL	10379	3470	3874	4724	1076	4578	2502	2022	2350
E	300-420	800	SS	8338	3867	4198	3581	1327	3429	2905	2419	2632
	300-420	800	SL & LL	10630	3867	4198	4724	1327	4578	2905	2419	2632
	480-565	500	SS	8087	3470	4156	3581	1076	3429	2624	2022	2356
	480-565	500	SL & LL	10379	3470	4156	3581	1076	4578	2624	2022	2356
	480-565	800	SS	8338	3867	4003	4724	1327	3429	2946	2419	2632
C	480-565	800	SL & LL	10630	3867	4003	4724	1327	4578	2946	2419	2632
V	670-780	800	SS	8338	3912	4216	3581	1327	3429	2915	2540	2788
H	670-780	800	SL & LL	10630	3912	4216	4724	1327	4578	2915	2540	2788
G	670-780	1420	ML & LL	10754	4413	4381	4724	1499	4578	3077	3042	3146
	920-1067	1420	ML & LL	10754	4413	4381	4724	1499	4578	3077	3042	3146
	920-1067	2100	LL	10801	4667	4667	4724	1499	4578	3375	3296	3302

CL1 CAN BE AT EITHER END OF MACHINE AND IS REQUIRED FOR TUBE PULL CLEARANCE.
CL2 IS ALWAYS AT THE OPPOSITE END OF MACHINE FROM CL1 AND IS REQUIRED FOR SERVICE CLEARANCE.

Single Compressor CenTraVac Chillers

Table 9 for Figure 18 — Physical Dimensions 60 Hz Compressor Chillers (IP and SI Units)

				IP UNITS							
				Envelope		Clearance		Unit Dimensions			
				W/O Unit Mounted Starters	With Unit Mounted Starters*	Tube Pull				W/O Unit Mounted Starters	With Unit Mounted Starters
	COMP	Shell Size	Shell Arrange-ment	EL	EW	EW	CL1	CL2	Length	Height	Width	Width
	230-320	320	SS	26' 5″	10' 6 1/4″	11' 7 1/2″	11' 9″	3' 5″	11' 3″	7' 9 3/4″	5' 9 1/4″	6' 7 1/2″
	230-320	320	SL & LL	33' 11 1/4″	10' 6 1/4″	11' 7 1/2″	15' 6″	3' 5″	15' 0 1/4″	7' 9 3/4″	5″ 9 1/4″	6' 7 1/2″
	230-320	500	SS	26' 6 3/8″	11' 4 5/8″	12' 9 7/8″	11' 9″	3' 6 3/8″	11' 3″	8' 2 1/4″	6' 7 5/8″	7' 9 7/8″
C	230-320	500	SL & LL	34' 0 5/8″	11' 4 5/8″	12' 9 7/8″	15' 6″	3' 6 3/8″	15' 0 1/4″	8' 2 1/4″	6' 7 5/8″	7' 9 7/8″
V	360-500	500	SS	26' 6 3/8″	11' 4 5/8″	12' 8 1/2″	11' 9″	3' 6 3/8″	11' 3″	8' 2 1/2″	6' 7 5/8″	7' 8 1/2″
H	360-500	500	SL & LL	34' 0 5/8″	11' 4 5/8″	12' 8 1/2″	15' 6″	3' 6 3/8″	15' 0 1/4″	8' 2 1/2″	6' 7 5/8″	7' 8 1/2″
E	360-500	800	SS	27' 4 1/4″	12' 5 1/4″	13' 9 1/4″	11' 9″	4' 4 1/4″	11' 3″	9' 6 3/8″	7' 11 1/4″	8' 7 5/8″
	360-500	800	SL & LL	34' 10 1/2″	12' 5 1/4″	13' 9 1/4″	15' 6″	4' 4 1/4″	15' 0 1/4″	9' 6 3/8″	7' 11 1/4″	8' 7 5/8″
	350-485	500	SS	26' 6 3/8″	11' 4 5/8″	13' 7 5/8″	11' 9″	3' 6 3/8″	11' 3″	8' 4″	6' 7 5/8″	7' 8 1/2″
	350-485	500	SL & LL	34' 0 5/8″	11' 4 5/8″	13' 7 5/8″	15' 6″	3' 6 3/8″	15' 0 1/4″	8' 4″	6' 7 5/8″	7' 8 3/4″
	350-485	800	SS	27' 4 1/4″	12' 5 1/4″	13' 9 1/4″	11' 9″	4' 4 1/4″	11' 3″	9' 6 1/2″	7' 11 1/4″	8' 7 5/8″
	350-485	800	SL & LL	34' 10 1/2″	12' 5 1/4″	13' 9 1/4″	15' 6″	4' 4 1/4″	15' 0 1/4″	9' 6 1/2″	7' 11 1/4″	8' 7 5/8″
	555 & 640	500	SS	26' 6 3/8″	11' 4 5/8″	13' 7 5/8″	11' 9″	3' 6 3/8″	11' 3″	8' 7 1/4″	6' 7 5/8″	7' 8 3/4″
C	555 & 640	500	SL & LL	34' 0 5/8″	11' 4 5/8″	13' 7 5/8″	15' 6″	3' 6 3/8″	15' 0 1/4″	8' 7 1/4″	6' 7 5/8″	7' 8 3/4″
V	555 & 640	800	SS	27' 4 1/4″	12' 5 1/4″	13' 1 5/8″	11' 9″	4' 4 1/4″	11' 3″	9' 8″	7' 11 1/4″	8' 7 5/8″
H	555 & 640	800	SL & LL	34' 10 1/2″	12' 5 1/4″	13' 1 5/8″	15' 6″	4' 4 1/4″	15' 0 1/4″	9' 8″	7' 11 1/4″	8' 7 5/8″
F	650-910	800	SS	27' 4 1/4″	12' 10″	13' 10	11' 9″	4' 4 1/4″	11' 3″	9' 6 3/4″	8' 4″	9' 1 3/4″
	650-910	800	SL & LL	34' 10 1/2″	12' 10″	13' 10	15' 6″	4' 4 1/4″	15' 0 1/4″	9' 6 3/4″	8' 4″	9' 1 3/4″
	650-910	1420	ML & LL	35' 5 1/4″	14' 5 3/4″	14' 4 1/2″	15' 6″	4' 11″	15' 0 1/4″	10' 1 1/8″	9' 11 3/4″	10' 3 7/8″
	1060-1280	1420	ML &LL	35' 5 1/4″	14' 5 3/4″	14' 4 1/2″	15' 6″	4' 11″	15' 0 1/4″	10' 1 1/8″	9' 11 3/4″	10' 3 7/8″
	1060-1280	1420	EL	39' 2 7/8″	14' 5 3/4″	14' 4 1/2″	17' 5″	4' 11″	16' 10 3/4″	10' 1 1/8″	9' 11 3/4″	10' 3 7/8″
	1060-1280	2100	LL	35' 5 1/4″	15' 3 3/4″	15' 8 3/8″	15' 6″	4' 11″	15' 0 1/4″	11' 0 7/8″	10' 9 3/4″	10' 10″
	1060-1280	2500	EL	39' 5 7/8″	16' 7″	18' 2 5/8″	17' 5″	5' 2 1/8″	16' 10 3/4″	11' 4 7/8″	11' 11 1/2″	11' 11 1/2″
	1470-1720	2100	LL	35' 5 1/4″	15' 3 3/4″	NA	15' 6″	4' 11″	15' 0 1/4″	11' 5″	10' 9 3/4″	10' 10″
	1470-1720	2500	EL	39' 5 7/8″	16' 7″	NA	17' 5″	5' 2 1/8″	16' 10 3/4″	11' 9 1/8″	11' 11 1/2″	11' 11 1/2″
				SI UNITS (mm)								
	230-320	320	SS	8052	3207	3543	3581	1041	3429	2380	1759	2019
	230-320	320	SL & LL	10344	3207	3543	4724	1041	4578	2380	1759	2019
	230-320	500	SS	8087	3470	3909	3581	1076	3429	2494	2022	2384
C	230-320	500	SL & LL	10379	3470	3909	4724	1076	4578	2494	2022	2384
V	360-500	500	SS	8087	3470	3874	3581	1076	3429	2502	2022	2350
H	360-500	500	SL & LL	10379	3470	3874	4724	1076	4578	2502	2022	2350
E	360-500	800	SS	8338	3867	4198	3581	1327	3429	2905	2419	2632
	360-500	800	SL & LL	10630	3867	4198	4724	1327	4578	2905	2419	2632
	350-485	500	SS	8087	3470	4156	3581	1076	3429	2540	2022	2350
	350-485	500	SL & LL	10379	3470	4156	4724	1076	4578	2540	2022	2350
	350-485	800	SS	8338	3867	4198	3581	1327	3429	2908	2419	2632
	350-485	800	SL & LL	10630	3867	4198	4724	1327	4578	2908	2419	2632
	555 & 640	500	SS	8087	3470	4156	3581	1076	3429	2624	2022	2356
C	555 & 640	500	SL & LL	10379	3470	4156	4724	1076	4578	2624	2022	2356
V	555 & 640	800	SS	8338	3867	4003	3581	1327	3429	2946	2419	2632
H	555 & 640	800	SL & LL	10630	3867	4003	4724	1327	4578	2946	2419	2632
F	650-910	800	SS	8338	3912	4216	3581	1327	3429	2915	2540	2788
	650-910	800	SL & LL	10630	3912	4216	4724	1327	4578	2915	2540	2788
	650-910	1420	ML & LL	10754	4413	4381	4724	1499	4578	3077	3042	3146
	1060-1280	1420	ML &LL	10754	4413	4381	4724	1499	4578	3077	3042	3146
	1060-1280	1420	EL	11909	4413	4381	5309	1499	5150	3077	3042	3146
	1060-1280	2100	LL	10801	4667	4667	4724	1499	4578	3375	3296	3302
	1060-1280	2500	EL	11069	5055	5553	5309	1578	5150	3477	3645	3645
	1470-1720	2100	LL	10801	4667	NA	4724	1499	4578	3479	3296	3302
	1470-1720	2500	EL	11069	5055	NA	5309	1578	5150	3585	3645	3645

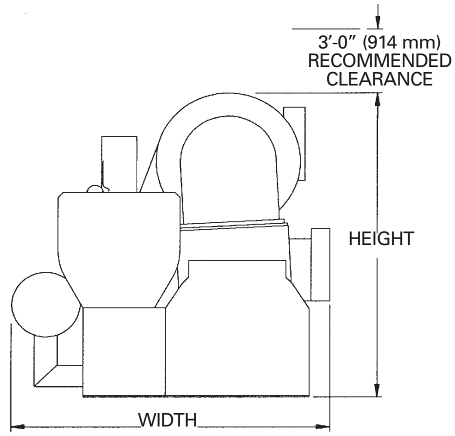
CL1 CAN BE AT EITHER END OF MACHINE AND IS REQUIRED FOR TUBE PULL CLEARANCE.
CL2 IS ALWAYS AT THE OPPOSITE END OF MACHINE FROM CL1 AND IS REQUIRED FOR SERVICE CLEARANCE.
*Dimensions for low-voltage unit-mounted starters. Medium-voltage starters are also available for unit mounting.

Physical Dimensions — 50 & 60 Hz (IP Units)

Dual Compressor CenTraVac Chillers

CenTraVac™ Water Connection Pipe Sizes

	Shell Size		
Water Passes	250D, 210D	250M	250X
EVAPORATOR	Nominal Pipe Size (Inches)		
1 Pass	16	18	18
CONDENSER			
1 Pass	16	20	20
EVAPORATOR	Nominal Pipe Size (mm)		
1 Pass	DN400	458	458
CONDENSER			
1 Pass	DN400	508	508



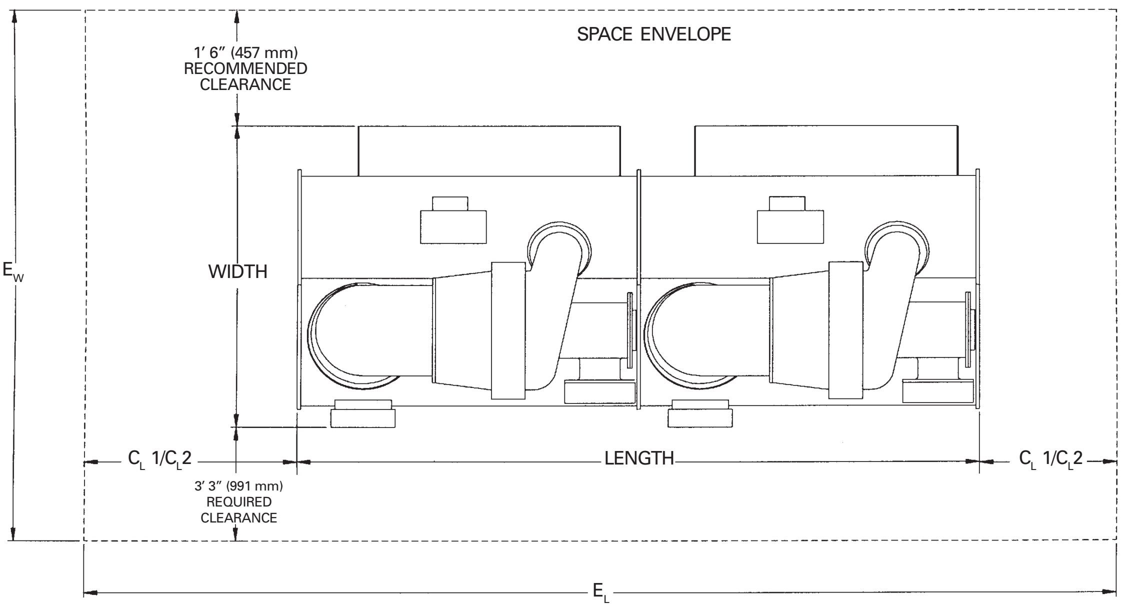


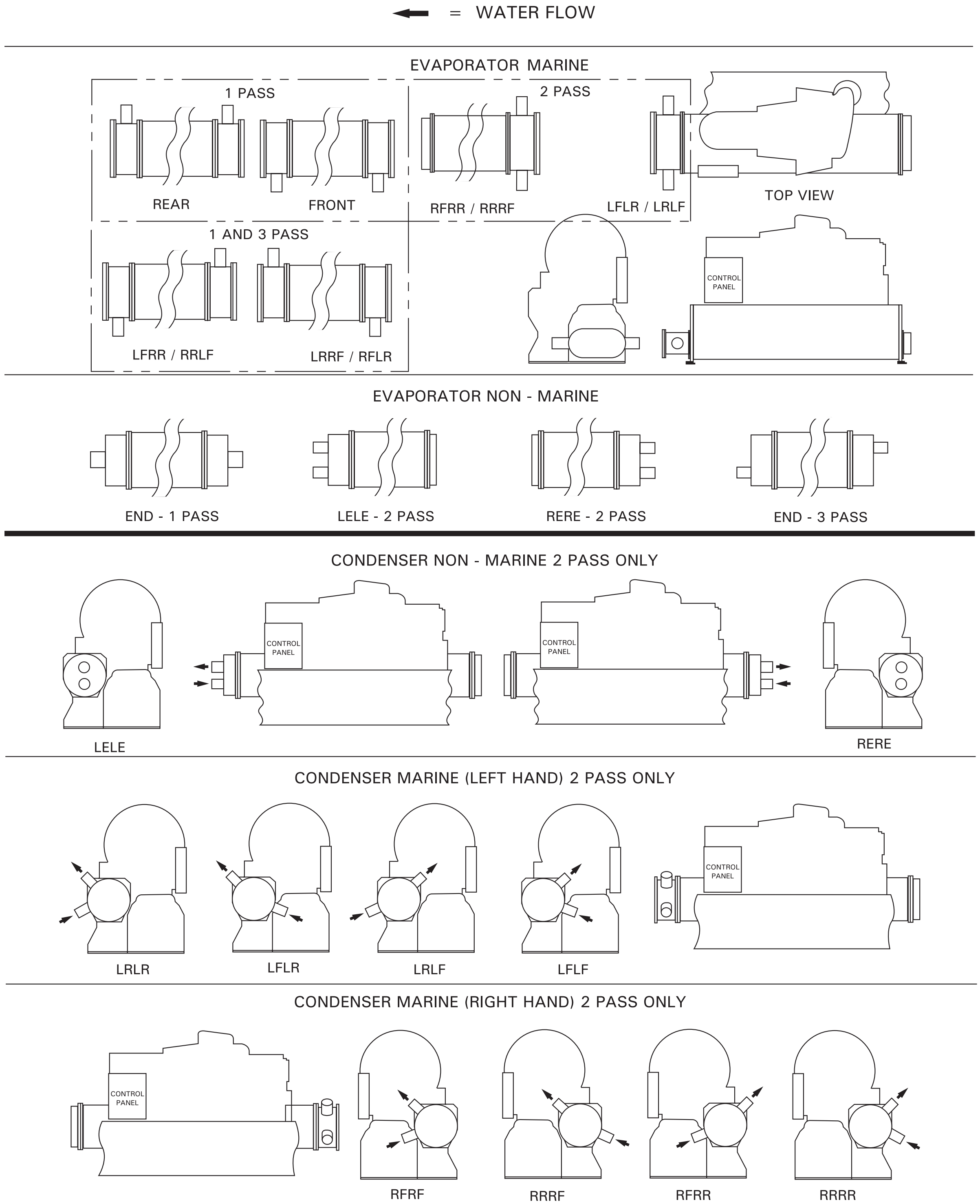
Table 10 — Physical Dimensions Dual 50 and 60 Hz Compressor Units (IP and SI Units)

				Envelope			Clearance		Unit Dimensions		
				IP Units							
Type	NTON	Shell Size	Shell Arrange-ment	EL	W/O Unit Mounted Starters EW	With Unit Mounted Starters EW	Tube Pull CL1	CL2	Length	Height	W/O Unit Mounted Starters Width	With Unit Mounted Starters Width
CDHF	3500	250X	XX	67' 6"	16' 3"	N/A	30' 6"	7' 0"	30' 0"	11' 9 3/8"	11' 5 1/4"	N/A
CDHF	3000	250M	MM	59' 6"	16' 3"	N/A	26' 6"	7' 0"	26' 0"	11' 9 3/8"	11' 5 1/4"	N/A
CDHF	2100-2500	250D	DD	50' 6"	16' 9"	16'9"	22' 0"	7' 0"	21' 6"	11'4 7/8"	11' 10 1/2"	11' 10 1/2"
CDHG	2150	250D	DD	50' 6"	16' 9"	16' 9"	22' 0"	7' 0"	21' 6"	11' 4 7/8"	11' 10 1/2"	11' 10 1/2"
CDHF	1500-2000	210D	DD	50' 6"	15' 9"	15' 11"	22' 0"	7' 0"	21' 6"	11' 0 3/4"	10' 11 1/2"	11' 1 5/8"
CDHG	1250-1750	210D	DD	50' 6"	15' 9"	15' 11"	22' 0"	7' 0"	21' 6"	11' 0 3/4"	10' 11 1/2"	11' 1 5/8"
				SI Units								
CDHF	3500	250X	XX	20574	4953	N/A	9297	2134	9144	3591	3487	N/A
CDHF	3000	250M	MM	18136	4953	N/A	8078	2134	7925	3591	3487	N/A
CDHF	2100-2500	250D	DD	15392	5105	5105	6706	2134	6553	3477	3620	3620
CDHG	2150	250D	DD	15392	5105	5105	6706	2134	6553	3477	3620	3620
CDHF	1500-2000	210D	DD	15392	4801	4851	6706	2134	6553	3372	3340	3395
CDHG	1250-1750	210D	DD	15392	4801	4851	6706	2134	6553	3372	3340	3395

CL1 CAN BE AT EITHER END OF MACHINE AND IS REQUIRED FOR TUBE PULL CLEARANCE.
CL2 IS ALWAYS AT THE OPPOSITE END OF MACHINE FROM CL1 AND IS REQUIRED FOR SERVICE CLEARANCE.

Physical Dimensions

Waterbox Connection Arrangement



These graphics are intended to help you visualize the possible connections/combinations that may be available for your unit. You must contact your local Trane office who can configure your selection as an as-built drawing to confirm it is available and to provide appropriate dimensions.

Table 11 — Waterbox Lengths – IP Units (inches) and SI Units (mm)

Evaporator								Condenser				
				Length		Return Length			Length		Return Length	
Shell	PSIG	Type	Passes	IP	SI	IP	SI	Passes	IP	SI	IP	SI
320	150	Marine	1 2 3	16.12	409	6.94	176	2	16.674	424	6.125	156
320	150	NonMarine	1 2 3	12.94	329	6.94	176	2	9.25 cast	235 cast	6.125	156
320	300	Marine	1 2 3	16.12	409	6.94	176	2	17	432	8	203
320	300	NonMarine	1 2 3	12.94	329	6.94	176	2	13.28/20.28	337/515	8	203
500	150	Marine	1 2 3	18.5	470	6.73	171	2	16.31	414	7.875	200
500	150	NonMarine	1 2 3	12.73	323	6.73	171	2	10.5 cast	267 cast	7.875	200
500	300	Marine	1 2 3	19	483	6.73	171	2	18.363	466	7.6	193
500	300	NonMarine	1 2 3	12.73	323	6.73	171	2	12.86/20.46	327/520	7.6	193
800	150	Marine	1 2 3	23.225 21.225 19.225	590 539 488	7.21	183	2	23.75	603	8.32	211
800	150	NonMarine	1 2 3	13.19	335	7.21	183	2	14.2	361	8.32	211
800	300	Marine	1 2 3	25 23 21	635 584 533	7.96	202	2	28.14	871	8.93	227
800	300	NonMarine	1 2 3	13.96	355	7.96	202	2	14.4/23.27	366/591	8.93	227
1420	150	Marine	1 2 3	28.25 25 23	718 635 584	9.33	237	2	28.25	718	9.25	235
1420	150	NonMarine	1 2 3	15.41	391	9.33	237	2	16	406	9.25	235
1420	300	Marine	1 2 3	31.056 27.8 25.8	789 706 655	9.84	250	2	33.16	842	10.06	256
1420	300	NonMarine	1 2 3	15.59	396	9.84	250	2	15.79	401	10.06	256
2100	150	Marine	1 2 3	N/A 27.25 25.25	N/A 692 641	N/A 8.88	N/A 226	2	29.632	753	9.382	238
2100	150	NonMarine	1 2 3	15.88	403	8.88	226	2	16.38	416	9.382	238
2100	300	Marine	1 2 3	N/A 29.64 29.64	N/A 753 753	9.84	250	2	35	889	10.71	272
2100	300	NonMarine	1 2 3	16.84	428	9.84	250	2	17.71	450	10.71	272
2500	150	Marine	1 2 3	N/A 30 N/A	N/A 762 N/A	11.75	298	2	32	813	10.75	273
2500	150	NonMarine	1 2 3	18.75	476	11.75	298	2	17.75	451	10.75	273
2500	300	Marine	1 2 3	N/A N/A N/A	N/A N/A N/A	N/A	N/A	2	38.3	973	11.75	298
2500	300	NonMarine	1 2 3	20.25	514	13.25	337	2	18.75	476	11.75	298

Table 12 — Waterbox Lengths - IP and SI Units

Evaporator							Condenser			
			No. of	Length		Return	No. of	Length		Return
Shell	PSIG	Type	Passes	IP	SI	Length	Passes	IP	SI	Length
210D	150	Marine	1	28.25	718	N/A	1	31.88	810	N/A
210D	300			31.62	803	N/A		38.88	988	N/A
210D	150	NonMarine	1	15.88	403	N/A	1	16.38	416	N/A
210D	300			16.88	429	N/A		17.75	451	N/A
250D	150	Marine	1	30.25	768	N/A	1	36.25	921	N/A
250D	300			34.25	870	N/A		38.38	975	N/A
250D	150	NonMarine	1	18.75	476	N/A	1	17.75	451	N/A
250D	300			20.25	514	N/A		18.75	476	N/A
250M	150	Marine	1	30.25	769	N/A	1	36.25	921	N/A
250M	300			34.25	870	N/A		45.25	1150	N/A
250M	150	NonMarine	1	18.75	477	N/A	1	17.75	451	N/A
250M	300			20.25	515	N/A		18.75	477	N/A
250X	150	Marine	1	30.25	769	N/A	1	36.25	921	N/A
250X	300			34.25	870	N/A		45.25	1150	N/A
250X	150	NonMarine	1	18.75	477	N/A	1	17.75	451	N/A
250X	300			20.25	515	N/A		18.75	477	N/A

Marine Waterbox Arrangement Tables

Evaporator Waterbox Arrangement

EVWA	Inlet	Outlet
LFRF	LH Front	RH Front
RFLF	RH Front	LH Front
LRRR	LH Rear	RH Rear
RRLR	RH Rear	LH Rear
LFRR	LH Front	RH Rear
RFLR	RH Front	LH Rear
LRRF	LH Rear	RH Front
RRLF	RH Rear	LH Front

Data based on looking at unit on control panel side

Condenser Waterbox Arrangement

CDWA	Inlet	Outlet
LFRF	LH Front	RH Front
RFLF	RH Front	LH Front
LRRR	LH Rear	RH Rear
RRLR	RH Rear	LH Rear
LTRT	LH Top	RH Top
RTLT	RH Top	LH Top
LBRB	LH Bottom	RH Bottom
RBLB	RH Bottom	LH Bottom
LFRR	LH Front	RH Rear
LFRT	LH Front	RH Top
LFRB	LH Front	RH Bottom
RFLR	RH Front	LH Rear
RFLT	RH Front	LH Top
RFLB	RH Front	LH Bottom
LRRF	LH Rear	RH Front
LRRT	LH Rear	RH Top
LRRB	LH Rear	RH Bottom
RRLF	RH Rear	LH Front
RRLT	RH Rear	LH Top
RRLB	RH Rear	LH Bottom
LTRF	LH Top	RH Front
LTRR	LH Top	RH Rear
LTRB	LH Top	RH Bottom
RTLF	RH Top	LH Front
RTLR	RH Top	LH Rear
RTLB	RH Top	LH Bottom
LBRF	LH Bottom	RH Front
LBRR	LH Bottom	RH Rear
LBRT	LH Bottom	RH Top
RBLF	RH Bottom	LH Front
RBLR	RH Bottom	LH Rear
RBLT	RH Bottom	LH Top

Data based on looking at unit on control panel side

Mechanical Specifications

Compressor

Guide Vanes
Fully modulating variable inlet guide vanes provide capacity control. The guide vanes are controlled by an externally mounted electric vane operator in response to refrigeration load on the evaporator.

Impellers
Fully shrouded impellers are high strength aluminum alloy and directly connected to the motor rotor shaft operating at 3,600 rpm (60 hertz), 3,000 rpm (50 hertz). Impellers are dynamically balanced and over-speed tested at 4,500 rpm; the motor-compressor assembly is balanced to a maximum vibration of .15 inch/second at 3600 rpm as measured on the motor housing.

Compressor Casing
Separate volute casings of refrigerant-tight, close-grained cast iron are used on the centrifugal compressor; each incorporating a parallel wall diffuser surrounded by a collection scroll. The diffuser passages are machined to ensure high efficiency. All casings are proof-tested and leak-tested.

Motor
Compressor motors are hermetically sealed two-pole, low-slip squirrel cage, induction-type. They are built in accordance with Trane specifications and guaranteed by the manufacturer for continuous operation at the nameplate rating. A load-limit system provides protection against operation in excess of this rating. The rotor shaft is of heat-treated carbon steel and designed such that the first critical speed is well above the operating speed. The control circuit prevents motor energization unless positive oil pressure is established. Impellers are keyed directly to the motor shaft and locked in position. Nonferrous, labyrinth-type seals minimize recirculation and gas leakage between the stages of the compressor.
200- through 600-volt, three-phase, 60-hertz and 380 through 415 volt three-phase 50 hertz motors are supplied with six terminal posts for full-voltage (across-the-line) or reduced-voltage (star-delta, autotransformer or solid-state) starting. For low-voltage, full-voltage starting — connecting links are furnished to convert the motor to a 3-lead motor.

2,300- through 4,160-volt, three-phase, 60-hertz and 3300 through 6600 volt three phase 50 hertz motors are supplied with three terminal posts for full-voltage (across-the-line) or reduced-voltage (primary reactor or autotransformer) starting. Motor terminal pads are supplied. A removable sheet metal terminal box encloses the terminal board area.

Motor Cooling
Cooling is accomplished by liquid refrigerant pumped through the motor with a patented refrigerant pump. The refrigerant circulates uniformly over the stator windings and between the rotor and stator. The windings of all motors are specifically insulated for operation within a refrigerant atmosphere.

Lubrication
A direct-drive system, positive-displacement oil pump driven by a low voltage 3/4 horsepower, 120/60/1 or 120/50/1 motor is submerged in the oil sump to assure a positive oil supply to the two compressor bearings at all times. A low watt-density heater maintains the oil temperature which minimizes its affinity for refrigerant. Oil cooling is provided by refrigerant.

Mechanical Specifications

Evaporator

Shell and Waterboxes
The evaporator shell is formed of carbon steel plate and incorporates a carbon rupture disc in accordance with the ANSI/ASHRAE 15 Safety Code. A refrigerant temperature coupling is provided for customer use or for use with a low limit controller.

For all units, pass arrangements are available at 150 psig or 300 psig water side working pressures, with grooved connections. Flanged connections are also available. Marine-type waterboxes are available.

Tube Sheets
A thick carbon steel tube sheet is welded to each end of the shell and is drilled and reamed to accommodate the tubes. Three annular grooves are machined into each tube hole to provide a positive liquid and vapor seal between the refrigerant and water side of the shell after tube rolling. Intermediate tube support sheets are positioned along the length of the shell to avoid contact and relative motion between adjacent tubes.

Tubes
Individually replaceable externally finned seamless copper tubing, either internally enhanced (one-inch nominal diameter) or (three-quarter inch nominal diameter) is utilized as the evaporator heat transfer surface. Tubes are mechanically expanded into the tube sheets (and affixed to the intermediate support sheets with the clips) to provide a leak-free seal and eliminate tube contact and abrasion due to relative motion.

Eliminators
Multiple layers of metal mesh screen form the eliminators and are installed over the tube bundle along the entire length of the evaporator to prevent liquid refrigerant carryover into the compressor.

Refrigerant Distribution
A refrigerant distribution compartment in the base of the evaporator assures uniform wetting of the heat transfer surface over the entire length of the shell and under varying loads. High velocity refrigerant spray impingement on the tubes is prevented through this design.

Refrigerant Flow Control
A multiple orifice flow control system maintains the correct pressure differential between the condenser, economizer and evaporator over the entire range of loading. This patented system contains no moving parts.

Shell Tests
The refrigerant side of the evaporator shell, complete with tubes, but without waterbox covers, is proof-tested at 45 psig, vacuum leak-tested and pressure leak-tested. The water side of the shell, with waterboxes in place, is hydrostatically tested at one and one-half times the design working pressure, but not less than 225 psig. (These tests are not to be repeated at installation).

Condenser/Heat Recovery Condenser

Shell and Waterboxes
The condenser shell is formed of carbon steel plate designed and constructed in accordance with ANSI/ASHRAE 15 Safety Code. For all units, all pass arrangements are available at 150 psig or 300 psig water side working pressures with grooved connections. Flanged connections are also available. Marine-type waterboxes are available.

Tube Sheets
A thick carbon steel tube sheet is welded to each end of the shell and is drilled and reamed to accommodate the tubes. Three annular grooves are machined into each tube hole to provide a positive liquid and vapor seal between the refrigerant and water sides of the shell after tube rolling. Intermediate tube support sheets are positioned along the length of the shell to avoid contact and relative motion between adjacent tubes.

Tubes
Individually replaceable externally finned seamless copper tubing, either internally enhanced (one-inch nominal diameter) or (three-quarter inch nominal diameter), is utilized as the condenser heat transfer surface.

Refrigerant Gas Distribution
A baffle between the tube bundle and the condenser shell distributes the hot gas longitudinally throughout the condenser downward over the tube bundle preventing direct impingement of high velocity compressor discharge gas upon the tubes.

Shell Tests
The refrigerant side of the condenser shell with tubes, but without waterbox covers, is proof-tested at 45 psig, vacuum leak-tested and pressure leak- tested. The water side of the shell with waterboxes in place is hydrostatically tested at one and a half times the design working pressure, but not less than 225 psig. (These tests are not to be repeated at installation).

Mechanical Specifications

Economizer

The CVHE/CVHG style CenTraVac™ two-stage economizer (single-stage economizer on CVHF style units) is a series of interstage pressure chambers which utilize a multiple orifice system to maintain the correct pressure differential between the condenser, economizer and evaporator over the entire range of loading. This patented system contains no moving parts. CDHG Duplex units use a two-stage economizer per circuit. CDHF Duplex units use a single-stage economizer per circuit.

Purge System

The purge is 25 ¾" high, 27 ½" wide and 21 ¾" deep. It is suitable for use with refrigerants R123, 11, and 113.

115 VAC, 50/60 Hz, 1-Phase
10.3 total unit amps
12.3 minimum circuit ampacity
175 watt carbon tank heater
335 psig design pressure high side
175 psig low side

The purge uses an R404A refrigeration circuit with a ¼ hp condensing unit (fan, compressor, expansion valve), and a compressor suction temperature sensor. The purge tank has a fusible plug, evaporator coil, normally-closed float switch, and the following connections: 1/4" liquid return with filter-drier and moisture indicator, 5/8" vapor line. The expansion valve automatically controls the purge suction pressure to 34 psia.

The pump-out system consists of a pump-out compressor, pump-out solenoid valve and an exhaust solenoid valve.

The carbon bed tank incorporates a temperature sensor and a regenerative cycle, a 175-watt resistive heater, 150 psi pressure relief valve, and a temperature sensor. The carbon bed tank automatically collects and scrubs refrigerant molecules from the noncondensable gas and drives any collected refrigerant vapor back into the chiller. This design keeps the purge efficiency at peak levels throughout its life without the maintenance required on other purges.

The purge controller interfaces with the following intelligent devices on an IPC3 communications link: liquid-level switch, dual relay output, quad relay output, dual triac output, suction temperature sensor and carbon temperature sensor. 50 Hz applications have a separate voltage correction transformer.

The purge controller communicates with the Tracer chiller controller and display, mounted on the front of the chiller control panel. Descriptive text indicates purge operating mode, status, set points, purge operating data reports, diagnostics, and alarms. Operating modes Stop, On, Auto and Adaptive operate the purge refrigeration circuit and accumulate noncondensables with or without the chiller running.

Chiller Controller

The microcomputer control panel is factory installed and tested on the CenTraVac™ unit. All controls necessary for the safe and reliable operation of the chiller are provided including oil management, purge operation, and interface to the starter. The control system is powered by a control power transformer included in the starter panel. The microcomputer control system processes the leaving evaporator fluid temperature sensor signal to satisfy the system requirements across the entire load range.

The microprocessor controller is compatible with reduced voltage or full voltage electromechanical starters, variable speed drives, or solid state starters. Depending on the applicability, the drives may be factory-mounted or remote mounted.

The controller will load and unload the chiller via control of the stepper- motor/actuator which drives the inlet guide vanes open or closed. The load range can be limited either by a current limiter or by an inlet guide vane limit (whichever controls the lower limit). It will also control the evaporator and condenser pumps to insure proper chiller operation.

Approximately 200 diagnostic checks are made and displayed when a fault is detected. The display indicates the fault, the type of reset required, the time and date the diagnostic occurred, the mode in which the machine was operating at the time of the diagnostic, and a help message. A diagnostic history displays the last 10 diagnostics with the time and date of their occurrence.

Mechanical Specifications

The panel features machine protection shutdown requiring **manual** reset for:

- low evaporator refrigerant temperature
- high condenser refrigerant pressure
- low differential oil pressure
- low oil flow
- low oil temperature
- excessive loss of communication
- critical sensor or detection circuit faults
- free-cooling valve closure failure (free-cooling applications only)
- extended compressor surge
- actuator drive circuit fault

The display also provides reports that are organized into six groupings: Evaporator , Condenser, Compressor, Motor, Purge, and the ASHRAE Chiller Log. Each report contains data that is accessed by scrolling through the menu items.
Each grouping will have a heading which describes the type of data in that grouping. This data includes:

- All water temperatures and setpoints
- Current chiller operating mode
- Last 10 diagnostics
- Control source (i.e. local panel, external source, remote BAS)
- Current limit setpoint
- Water flows (optional)
- Water pressure drops (optional)
- Outdoor air temperature (optional)
- Saturated refrigerant temperatures and pressures
- Purge suction temperature
- Evaporator refrigerant liquid level
- Condenser liquid refrigerant temperature
- Compressor starts and hours running
- Phase currents
- Phase voltages
- Watts and power factor (optional)
- Oil temperature and flow
- Motor winding temperatures
- Bearing temperatures (optional)
- Refrigerant detection external to chiller in ppm (optional)

The controller is capable of receiving signals from a variety of control sources (which are not mutually exclusive — i.e. any combination of control sources can coexist simultaneously) and of being programmed at the keypad as to which control source has priority. Control sources can be:

- The local operator interface (standard)
- The remote operator interface (optional)
- A 4-20 mA or 2-10 vdc signal from an external source (interface optional, control source not supplied by chiller manufacturer)
- Tracer™ Summit building automation system (interface optional)
- Process computer (interface optional, control source not supplied by chiller manufacturer)
- Generic BAS (interface optional, control source not supplied by chiller manufacturer)

The control source with priority will then determine the active setpoints via the signal that is sent to the control panel.

Isolation Pads

Isolation pads are supplied with each CenTraVac™ chiller for placement under all support points. They are constructed of molded neoprene.

Refrigerant and Oil Charge

A full charge of refrigerant and oil is supplied with each unit. The oil ships in the unit's oil sump and the refrigerant ships directly to the jobsite from refrigerant suppliers.

Thermometer Wells and Sight Glasses

In addition to the thermowells provided for use with the standard unit safety controls, a well is provided for measurement of the liquid refrigerant condensing temperature and a coupling for the evaporating temperatures. Sight glasses are provided for monitoring oil charge level, oil flow, compressor rotation and purge condenser drum.

Insulation

Factory applied insulation is available on all units. All low temperature surfaces are covered with 3/4-inch Armaflex II or equal (thermal conductivity = 0.28 Btu/hr-ft^2), including the evaporator, waterboxes and suction elbow. The economizer and motor cooling lines are insulated with 3/8" and 1/2" insulation respectively.

Refrigerant Pumpout/ Reclaim Connections

Connections are factory provided as standard to facilitate refrigerant reclaim/ removal required during maintenance or overhaul in accordance with ANSI/ ASHRAE 15.

Painting

All painted CenTraVac surfaces are coated with two coats of air-dry beige primer-finisher prior to shipment.

Unit Mounted Starter Options

Low-voltage (200 - 600 V) unit-mounted starters can either be star-delta or solid-state in a NEMA 1 enclosure.

Medium-voltage starters (2300 - 6600 V) are available to unit mount on most sizes in full-voltage, primary reactor, or auto transformer.

Mechanical Specifications

Trane Adaptive Frequency™ Drive (AFD)

The Trane AFD is a closed-loop, liquid-cooled, microprocessor-based PWM design. The AFD is both voltage- and current-regulated. The output power devices are IGBT transistors.

The AFD is factory-mounted on the chiller and ships completely assembled, wired and tested. Patented Trane AFD control logic is specifically designed to interface with the centrifugal water chiller controls. AFD control adapts to the operating ranges and specific characteristics of the chiller and chiller efficiency is optimized by coordinating compressor motor speed and compressor inlet guide vane position. The chilled-water control and AFD control work together to maintain the chilled-water setpoint, improve efficiency and avoid surge. If a surge is detected, AFD surge avoidance logic makes adjustments to move away from and avoid surge at similar conditions in the future.

Standard Design Features for All Trane AFDs

- NEMA 1 ventilated enclosure with a hinged, locking door is tested to a short circuit withstand rating of 65,000 amps. It includes a padlockable door-mounted circuit breaker/shunt trip with AIC rating of 65,000 amps. The entire package is UL/CUL listed.
- Simple modular construction.
- The drive is rated for 480/60/3 input power, +/-10%, with a drive overload capability of 100% continuous to 150% for five seconds.
- Motor thermal overload protection 102% continuous, 140% for 1.5 seconds, 108% for 60 seconds.
- Minimum efficiency of 97% at rated load and 60 hertz.
- Soft start, linear acceleration, coast to stop.
- Adjustable frequency from 38 to 60 hertz.
- All control circuit voltages are physically and electrically isolated from power circuit voltage.
- 150% instantaneous torque available for improved surge control.
- Output line-to-line and line-to-ground short circuit protection.
- Line dip ride through.
- AFD can be started without a motor connected.

Chiller Unit Controller Features for all Trane AFDs

The chiller unit controller capabilities provide for the control/configuration interface to, and the retrieval/display of AFD-related data. AFD standard design features controlled through the chiller controller include:

- Current limited to 100%
- Output speed reference via IPC3 communication bus from the chiller controller to the AFD
- Motor overload protection
- Motor overtemperature protection
- Automatic restart after a power outage or power dip
- Loss of follower signal – in the event of loss of input speed signal the AFD will default to 38 hertz or hold speed based on last reference received.
- Phase loss, reversal, imbalance protection
- Overvoltage, undervoltage protection
- Digitally displayed on the chiller controller: output speed in hertz, output speed in rpm, input line voltage, input line kW, output/load amps, average current in % RLA, load power factor, fault, AFD transistor temperature

Environmental ratings:

- 32F to 104 (0C to 40) operating ambient temperature
- Altitude to 3300 feet (1000m), amperage derate of 1% per every 300 feet above 3300 feet
- Humidity, 95% non-condensing

Refrigerant-Cooled Trane AFD Design features

- Integrated active rectification control of the building AC power assures low line-generated harmonics back to the users power grid. This Trane AFD has 5% or less current harmonic distortion (TDD) at the AFD.
- Active input rectifier will regulate a unity displacement power factor of .99 or better.
- Full motor voltage is applied regardless of the input voltage.

Water-Cooled Trane AFD Design features

- DC bus filter choke to limit harmonic distortion
- Input displacement power factor will exceed .96 regardless of speed and load.
- Input Line Reactor Option (water-cooled AFD only)

Field-installed option is located on the input side of the AFD to reduce harmonic distortion and help meet IEEE 519 guidelines. NEMA 1 enclosure, 5% impedance.

Standard Conversion Table

To Convert From:	To:	Multiply By:
Length		
Feet (ft)	meters (m)	.30481
Inches (In)	millimeters (mm)	25.4
Area		
Square Feet (ft^2)	square meters (m^2)	.093
Square Inches (In^2)	square millimeters (mm^2)	645.2
Volume		
Cubic Feet (ft^3)	Cubic meters (m^3)	.0283
Cubic Inches (In^3)	Cubic mm (mm^3)	16387
Gallons (gal)	litres (l)	3.785
Gallons (gal)	cubic meters (m^3)	.003785
Flow		
Cubic feet/min (cfm)	cubic meters/second (m^3/s)	.000472
Cubic feet/min (cfm)	cubic meters/hr (m^3/hr)	1.69884
Gallons/minute (GPM)	cubic meters/hr (m^3/hr)	.2271
Gallons/minute (GPM)	litres/second (l/s)	.06308
Velocity		
Feet per minute (ft/m)	meters per second (m/s)	.00508
Feet per second (ft/s)	meters per second (m/s)	.3048

To Convert From:	To:	Multiply By:
Energy and Power and Capacity		
British Thermal Units (BTUH)	Kilowatt (kW)	.000293
British Thermal Units (BTU)	KCalorie (Kcal)	.252
Tons (refrig. effect)	Kilowatt (refrig. effect)	3.516
Tons (refrig. effect)	Kilocalories per hour (Kcal/hr)	3024
Horsepower	Kilowatt (kW)	.7457
Pressure		
Feet of water (ftH_2O)	Pascals (PA)	2990
Inches of water (inH_2O)	Pascals (PA)	249
Pounds per square inch (PSI)	Pascals (PA)	6895
PSI	Bar or KG/CM^2	6.895×10^{-2}
Weight		
Ounces (oz)	Kilograms (kg)	.02835
Pounds (lbs)	Kilograms (Kg)	.4536
Fouling factors for heat exchangers		
.00075 ft^2 °F hr/BTU	= .132 m^2 ° K/kW	
.00025 ft^2 °F hr/BTU	= .044 m^2 ° K/kW	

Temperature — Centrigrade (°C) Versus Fahrenheit (°F)

Note: The center columns of numbers, referred to as BASE TEMP., is the temperature in either degrees Fahrenheit (°F) or Centigrade (°C), whichever is desired to convert into the other. If degrees Centigrade is given, read degrees Fahrenheit to the right. If degrees Fahrenheit is given, read degrees Centigrade to the left.

Temperature		
°C	C or F	°F
−40.0	**−40**	−40.0
−39.4	**−39**	−38.2
−38.9	**−38**	−36.4
−38.3	**−37**	−34.6
−37.8	**−36**	−32.8
−37.2	**−35**	−31.0
−36.7	**−34**	−29.2
−36.1	**−33**	−27.4
−35.6	**−32**	−25.6
−35.0	**−31**	−23.8
−34.4	**−30**	−22.0
−33.9	**−29**	−20.2
−33.3	**−28**	−18.4
−32.8	**−27**	−16.6
−32.2	**−26**	−14.8
−31.7	**−25**	−13.0
−31.1	**−24**	−11.2
−30.6	**−23**	−9.4
−30.0	**−22**	−7.6
−29.4	**−21**	−5.8
−28.9	**−20**	−4.0
−28.3	**−19**	−2.2
−27.8	**−18**	−0.4
−27.2	**−17**	+1.4
−26.7	**−16**	+3.2
−26.1	**−15**	+5.0
−25.6	**−14**	+6.8
−25.0	**−13**	+8.6
−24.4	**−12**	+10.4
−23.9	**−11**	+12.2
−23.3	**−10**	+14.0
−22.8	**−9**	+15.8
−22.2	**−8**	+17.6
−21.7	**−7**	+19.4
−21.1	**−6**	+21.2
−20.6	**−5**	+23.0
−20.0	**−4**	+24.8
−19.4	**−3**	+26.6
−18.9	**−2**	+28.4
−18.3	**−1**	+30.2
−17.8	**0**	+32.0
−17.2	**+1**	+33.8
−16.7	**+2**	+35.6
−16.1	**+3**	+37.4
−15.6	**+4**	+39.2

Temperature		
°C	C or F	°F
−15.0	**+5**	+41.0
−14.4	**+6**	+42.8
−13.9	**+7**	+44.6
−13.3	**+8**	+46.4
−12.8	**+9**	+48.2
−12.2	**+10**	+50.0
−11.7	**+11**	+51.8
−11.1	**+12**	+53.6
−10.6	**+13**	+55.4
−10.0	**+14**	+57.2
−9.4	**+15**	+59.0
−8.9	**+16**	+60.8
−8.3	**+17**	+62.6
−7.8	**+18**	+64.4
−7.2	**+19**	+66.2
−6.7	**+20**	+68.0
−6.1	**+21**	+69.8
−5.5	**+22**	+71.6
−5.0	**+23**	+73.4
−4.4	**+24**	+75.2
−3.9	**+25**	+77.0
−3.3	**+26**	+78.8
−2.8	**+27**	+80.6
−2.2	**+28**	+82.4
−1.7	**+29**	+84.2
−1.1	**+30**	+86.0
−0.6	**+31**	+87.8
.0	**+32**	+89.6
+0.6	**+33**	+91.4
+1.1	**+34**	+93.2
+1.7	**+35**	+95.0
+2.2	**+36**	+96.8
+2.8	**+37**	+98.6
+3.3	**+38**	+100.4
+3.9	**+39**	+102.2
+4.4	**+40**	+104.0
+5.0	**+41**	+105.8
+5.5	**+42**	+107.6
+6.1	**+43**	+109.4
+6.7	**+44**	+111.2
+7.2	**+45**	+113.0
+7.8	**+46**	+114.8
+8.3	**+47**	+116.6
+8.9	**+48**	+118.4
+9.4	**+49**	+120.2

Temperature		
°C	C or F	°F
+10.0	**+50**	+122.0
+10.6	**+51**	+123.8
+11.1	**+52**	+125.6
+11.7	**+53**	+127.4
+12.2	**+54**	+129.2
+12.8	**+55**	+131.0
+13.3	**+56**	+132.8
+13.9	**+57**	+134.6
+14.4	**+58**	+136.4
+15.0	**+59**	+138.2
+15.6	**+60**	+140.0
+16.1	**+61**	+141.8
+16.7	**+62**	+143.6
+17.2	**+63**	+145.4
+17.8	**+64**	+147.2
+18.3	**+65**	+149.0
+18.9	**+66**	+150.8
+19.4	**+67**	+152.6
+20.0	**+68**	+154.4
+20.6	**+69**	+156.2
+21.1	**+70**	+158.0
+21.7	**+71**	+159.8
+22.2	**+72**	+161.6
+22.8	**+73**	+163.4
+23.3	**+74**	+165.2
+23.9	**+75**	+167.0
+24.4	**+76**	+168.8
+25.0	**+77**	+170.6
+25.6	**+78**	+172.4
+26.1	**+79**	+174.2
+26.7	**+80**	+176.0
+27.2	**+81**	+177.8
+27.8	**+82**	+179.6
+28.3	**+83**	+181.4
+28.9	**+84**	+183.2
+29.4	**+85**	+185.0
+30.0	**+86**	+186.8
+30.6	**+87**	+188.6
+31.1	**+88**	+190.4
+31.7	**+89**	+192.2
+32.2	**+90**	+194.0
+32.8	**+91**	+195.8
+33.3	**+92**	+197.6
+33.9	**+93**	+199.4
+34.4	**+94**	+201.2

Temperature		
°C	C or F	°F
+35.0	**+95**	+203.0
+35.6	**+96**	+204.8
+36.1	**+97**	+206.6
+36.7	**+98**	+208.4
+37.2	**+99**	+210.2
+37.8	**+100**	+212.0
+38.3	**+101**	+213.8
+38.9	**+102**	+215.6
+39.4	**+103**	+217.4
+40.0	**+104**	+219.2
+40.6	**+105**	+221.0
+41.1	**+106**	+222.8
+41.7	**+107**	+224.6
+42.2	**+108**	+226.4
+42.8	**+109**	+228.2
+43.3	**+110**	+230.0
+43.9	**+111**	+231.8
+44.4	**+112**	+233.6
+45.0	**+113**	+235.4
+45.6	**+114**	+237.2
+46.1	**+115**	+239.0
+46.7	**+116**	+240.8
+47.2	**+117**	+242.6
+47.8	**+118**	+244.4
+48.3	**+119**	+246.2
+48.9	**+120**	+248.0
+49.4	**+121**	+249.8
+50.0	**+122**	+251.6
+50.6	**+123**	+253.4
+51.1	**+124**	+255.2
+51.7	**+125**	+257.0
+52.2	**+126**	+258.8
+52.8	**+127**	+260.6
+53.3	**+128**	+262.4
+53.9	**+129**	+264.2
+54.4	**+130**	+266.0
+55.0	**+131**	+267.8
+55.6	**+132**	+269.6
+56.1	**+133**	+271.4
+56.7	**+134**	+273.2
+57.2	**+135**	+275.0
+57.8	**+136**	+276.8
+58.3	**+137**	+278.6
+58.9	**+138**	+280.4
+59.4	**+139**	+282.2

Temperature		
°C	C or F	°F
+60.0	**+140**	+284.0
+60.6	**+141**	+285.8
+61.1	**+142**	+287.6
+61.7	**+143**	+289.4
+62.2	**+144**	+291.2
+62.8	**+145**	+293.0
+63.3	**+146**	+294.8
+63.9	**+147**	+296.6
+64.4	**+148**	+298.4
+65.0	**+149**	+300.2
+65.6	**+150**	+302.0
+66.1	**+151**	+303.8
+66.7	**+152**	+305.6
+67.2	**+153**	+307.4
+67.8	**+154**	+309.2
+68.3	**+155**	+311.0
+68.9	**+156**	+312.8
+69.4	**+157**	+314.6
+70.0	**+158**	+316.4
+70.6	**+159**	+318.2
+71.1	**+160**	+320.0
+71.7	**+161**	+321.8
+72.2	**+162**	+323.6
+72.8	**+163**	+325.4
+73.3	**+164**	+327.2
+73.9	**+165**	+329.0
+74.4	**+166**	+330.8
+75.0	**+167**	+332.6
+75.6	**+168**	+334.4
+76.1	**+169**	+336.2
+76.7	**+170**	+338.0
+77.2	**+171**	+339.8
+77.8	**+172**	+341.6
+78.3	**+173**	+343.4
+78.9	**+174**	+345.2
+79.4	**+175**	+347.0
+80.0	**+176**	+348.8
+80.6	**+177**	+350.6
+81.1	**+178**	+352.4
+81.7	**+179**	+354.2
+82.2	**+180**	+356.0
+82.8	**+181**	+357.8
+83.3	**+182**	+359.6
+83.9	**+183**	+361.4
+84.4	**+184**	+363.2

FOR INTERPOLATION IN THE ABOVE TABLE USE:

BASE TEMPERATURE (°F or °C):	1	2	3	4	5	6	7	8	9	10
DEGREES CENTIGRADE:	0.56	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5.00	5.56
DEGREES FAHRENHEIT:	1.8	3.6	5.4	7.2	9.0	10.8	12.6	14.4	16.2	18.0

Trane is a participant in the Green Seal Program

Literature Order Number	CTV-PRC007-EN
File Number	PL-RF-CTV-000-PRC007-EN--1002
Supersedes	CTV-PRC007-EN-0402
Stocking Location	La Crosse

Trane
A business of American Standard Companies
www.trane.com

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

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