



Product Catalog

EarthWise™ CenTraVac™ Water-Cooled Liquid Chillers 300–2500 Tons, 50 and 60 Hz

CVHE-Three-Stage Single Compressor CenTraVac-50 and 60 Hz



CVHG-Three-Stage Single Compressor CenTraVac-50 Hz



CVHF-Two-Stage Single Compressor CenTraVac-60 Hz



CDHG-Dual Compressor CenTraVac-50 Hz





World's Most Efficient Lowest Emissions Chiller

Standard of Excellence—Trane found that the straightest path to reliability is simplicity. Trane's 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—no gear boxes, couplings, extra shafts, or shaft seals. This also reduces wear and drag on parts, resulting in more sustainable, reliable and efficient operation.

Economically and Environmentally Sound—Trane's EarthWise CenTraVac has a proven track record as the world's most efficient, lowest emissions chiller. Selectable at an unmatched efficiency level of .48 kW/ton, at standard ARI conditions. With an efficiency level of 16 to 25% better than competitive chillers.

Feedforward Adaptive Control—CenTraVac™ chiller control algorithms shorten chiller response time for energy-saving variable pumping strategies. Feedforward is a control strategy designed to anticipate and compensate for load changes via entering water temperatures and flow rates. The controller includes unit mounted control panel, main processor, and operator interface. Control capabilities include:

- Adaptive frequency drive control (AFD)
- Variable primary flow (VPF)
- VPF with AFD
- Soft loading and Fast restart
- 34°F (1.1°C) leaving water temperature
- Variable flow compensation

EarthWise™ System Design—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 systems (ICS) control technology assures the EarthWise System delivers optimal, reliable performance.

Smaller equipment and duckwork means supplying less airflow at colder temperatures and permits a quieter operation. This also reduces relative humidity in the building, improving indoor air quality.

Compared to conventional designs, an EarthWise chilled water system reduces the total cost of ownership by cutting installation and operational costs. For more information, visit: http://www.trane.com/Commercial/HvacSystems/1_3_EarthWise.aspx?i=865

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Introduction

Unmatched Local Expertise

The performance and reliability of a CenTraVac chiller is backed by a local team of engineers. These engineers can help answer your questions or solve your problems regarding system design application, installation, or evaluation 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 that Trane can custom build a unit to specific job requirements. Design parameters such as shell type, compressor, 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 Business Unit. The system 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.

Certified ARI Performance

Trane centrifugal chillers are rated within the scope of the ARI program and 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.

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

- Free cooling
- Heat recovery
- Low temperature applications, including ice storage
- Auxiliary condenser
- Glycol and brines
- 60 Hz chillers above 2000 tons and/or 5000 volts
- 50 Hz chillers above 1500 tons and/or 5000 volts

Note: 50/60 Hz chillers above 2500 tons and/or 5000 volts effective July 2008.

District Cooling

Trane Adaptive Control™ algorithms and multistage design allow all CenTraVac™ chillers to operate at low leaving water temperatures without the use of glycol or other freeze inhibitors. This reduces the cost of delivering cooling capacity over long distances. Pre-engineered thermal storage systems using Trane chillers extend the chillers 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 to reduce NOx emissions. With turbine inlet cooling, plants can delay or even avoid the need for additional turbines because more capacity is obtainable 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 environmental 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 at ARI conditions

	Low Pressure	Medium/High Pressure
Evaporator	<ul style="list-style-type: none"> • Always at negative pressure • Air leaks inward at low rate • Refrigerant lost: (# air leak in) x purge efficiency^(a) • No refrigerant loss into equipment room (vented to the relief line via purge) 	<ul style="list-style-type: none"> • Always at positive pressure • Refrigerant leaks outward at moderate rate • Refrigerant loss is into equipment room
Condenser	<ul style="list-style-type: none"> • Usually at negative pressure during inactivity (air leaks inward) • At slightly positive pressure during operation • Refrigerant leaks outward at very low rate during operation 	<ul style="list-style-type: none"> • Always at high positive pressure • Refrigerant leaks outward at very high rate
Monitoring of leak rate	<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • Only ways to monitor leak rate on high pressure chiller are: <ul style="list-style-type: none"> • 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.
Typical Pressures (38°F evap.) (100°F cond.)	HCFC-123 Evap: -9.2 psig (-18.1 in. Hg) Cond: 6.1 psig	HFC-134a Evap: 33.1 psig Cond: 124.1 psig

(a)Trane EarthWise purge efficiency does not exceed 0.02 lb-refrigerant/lb-air

Standard and Optional Features

Standard Features

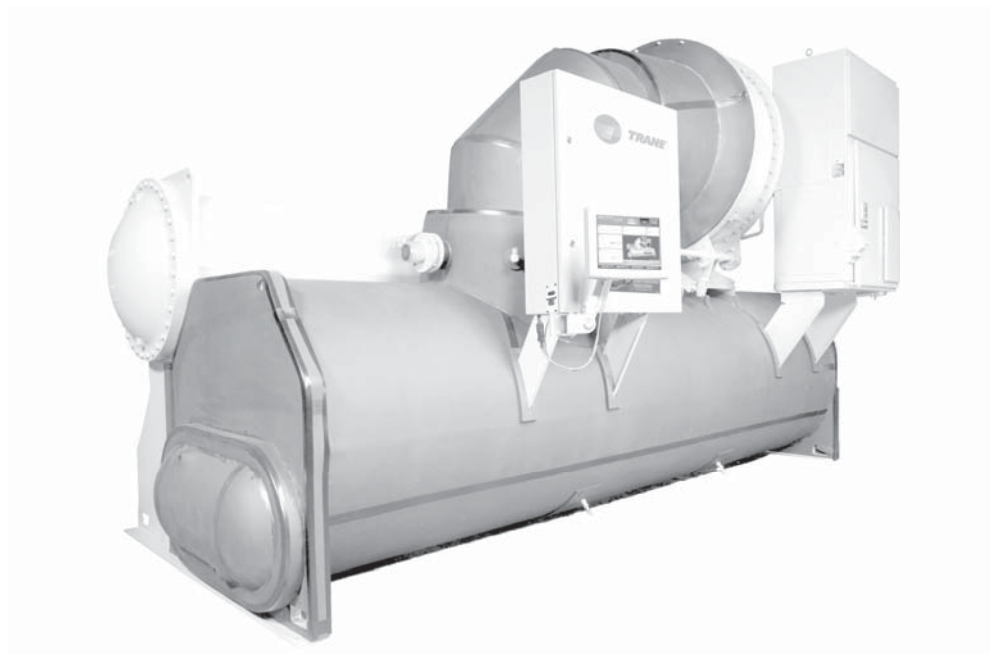
The following features are provided as standard with all Trane CenTraVac™ chillers:

- Isolation pads.
- Tracer™ chiller control strategies.
- Purge capability when chiller is off.
- Two-stage or single-stage economizer.
- Prewired instrument and control panel.
- Phase voltage sensors (3-phase).
- Startup and operator instruction service.
- High efficiency purge system with automatic regeneration capability.
- Low-pressure operation that minimizes the chance for outward refrigerant leaks.
- Minimum 5 year leak-tight warranty based on service documentation of leak rates 0.5 percent per year of the chiller's refrigerant charge. Extendable to the lifetime of the chiller with a Trane service contract.
- 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.
- Oil heater.
- Oil and refrigerant charge.
- Ability to meet or exceed ASHRAE 90.1-2004.
- Complies with ASHRAE Standard 147.
- Motor control and compressor protection.
- Hot water control and ice-making control.
- Wiring and conduit for purge and oil system interconnection to the main control panel.
- On-line tolerance for quick changes in refrigerant loop conditions, variable pumping strategies, and other atypical operating requirements.
- Entering condenser water temperature down to 50°F (10°C) maintaining 3 psid differential pressure.
- Designed to be rugged and simple yet amazingly quiet, the CenTraVac is directly driven at low speed with a motor shaft that is supported by two aircraft-turbine-rated bearings. The design includes industrial-grade components and only one primary moving part. Likewise, the design purposely excludes speed-increasing gears and lightweight parts that, while accessible, have a higher failure rate.

Optional Features

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

- Spring isolators
- Refrigerant monitor
- Industrial paint option
- Chiller break apart (disassembly)
- Three-pass or one-pass evaporator
- High-pressure (300 psig) water side construction
- Medium-voltage (over 600 volts) compressor motor
- Energy saving free cooling, heat recovery
- Leaving water temperature down to 34°F (1.1°C) without glycol
- Chilled-water reset based upon outside air temperature
- Special tubing: smooth bore, CuNi, and various tube wall thicknesses
- UL label
- Variable-speed drives
- Enhanced condenser limit control
- Factory-applied thermal insulation
- Building automation system (BAS) interface
- Industrial packaging of controls and electrical wiring
- Marine waterboxes for evaporators and condensers
- Proof of predicted performance and sound pressures
- Extended operation control for external ice-building, base loading, and providing hot-water
- Complete line of compressor motor starters—factory installed and prewired if unit-mounted



Factory Testing for Assured Performance

CenTraVac™ chillers that fall within ARI Std 550/590 requirements bare the ARI seal. All other CenTraVac chillers, and the selection software itself, are rated in accordance to the standard and fulfill identical performance requirements. 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 chiller 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 is accordance with standrd provided by the 3rd party.

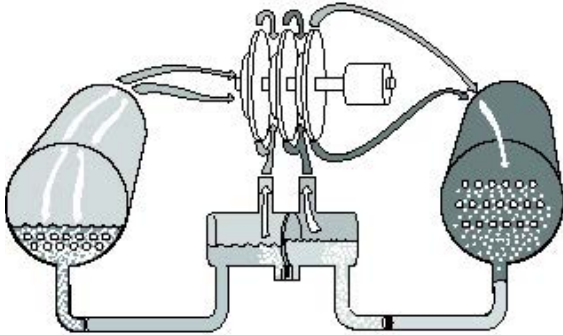
Trane offers two levels of CenTraVac™ performance testing:

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

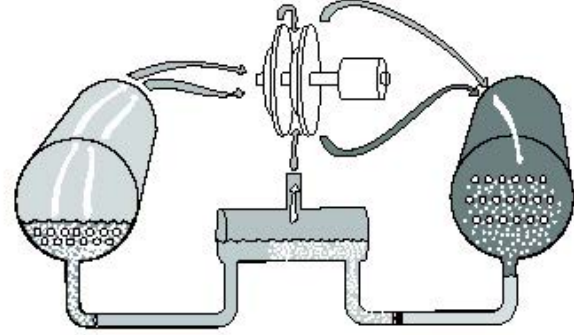


During customer witnessed performance tests of Trane CenTraVac chillers, a nickel can be balanced on the edge of the compressor-motor assembly. This demonstrates the extremely low vibrations generated by the unit while operating at full- and part-load conditions.

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 motor life over open designs.

Design Simplicity

Impellers are keyed directly to the motor shaft for high reliability, 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 primary rotating component—the rotor and impeller assembly—the Trane low speed, direct-drive design operates exceptionally quiet. The smoothly rotating CenTraVac compressor is inherently quieter than gear-driven compressors. 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.

Refrigeration Cycle

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 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 the use of moveable 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, significantly increasing chiller efficiency. This improvement in efficiency is not possible in single-stage chillers because 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, significantly increasing chiller efficiency. This improvement in efficiency is not possible in single-stage chillers because all compression is done by one impeller.

Refrigerant/Oil Pump Motor

The oil pump motor is a 120 volt, 50/60 hertz, $\frac{3}{4}$ hp, 1-phase motor with protective fusing and panel mounted contactor.

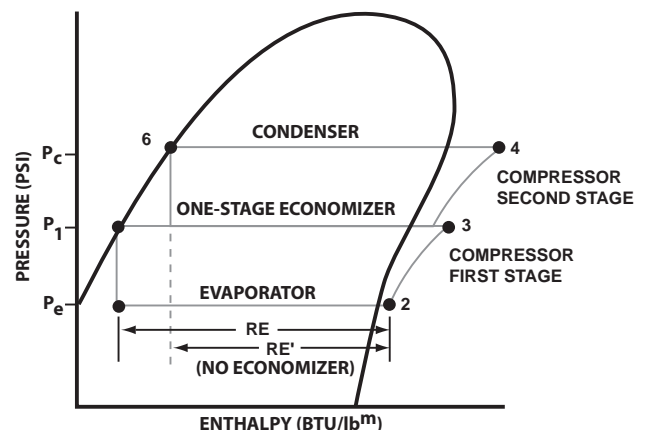
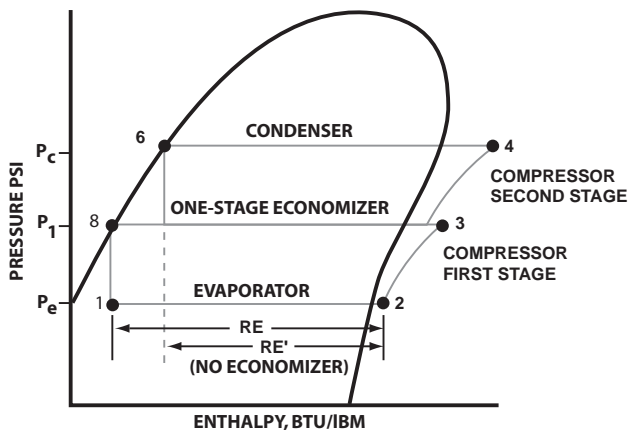
EarthWise Purge System

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 pound 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 Diagrams

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

Evaporator—A liquid-gas refrigerant mixture enters the evaporator (point 1). Liquid refrigerant is vaporized (point 2) as it absorbs heat from the system cooling load. The vaporized refrigerant then flows into the compressor's 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 (point 3).

Refrigeration Cycle

Compressor Second Stage—Refrigerant gas leaving the first-stage compressor is mixed with cooler refrigerant gas from the low pressure side of the two- or single-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 (point 4).

Compressor Third Stage—For CenTraVac™ chillers with three-stage compression, the refrigerant gas leaving the compressor's 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 (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 (point 6).

For three-stage CenTraVac chillers with the patented two-stage economizer and refrigerant orifice system, liquid refrigerant leaving the condenser (Figure 1, 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 (P1). Preflashing some liquid refrigerant cools the remaining liquid (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 (point 8).

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

For two-stage CenTraVac chillers with economizer and refrigerant orifice system, liquid refrigerant leaving the condenser (Figure 2, point 6) flows through the first orifice system and enters the economizer. The purpose of the orifice and economizer is to preflash a small amount of refrigerant at an intermediate pressure (P1) between the evaporator and condenser. Preflashing some liquid refrigerant cools the remaining liquid (point 8).

Another benefit of flashing refrigerant is to increase the total evaporator refrigeration effect from RE1 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 percent energy savings, compared to chillers with no economizer. To complete the operating cycle, liquid refrigerant leaving the economizer (point 8) flows through a second orifice system. Here, refrigerant pressure and temperature are reduced to evaporator conditions (point 1).



Unit Options

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 size must be greater than, or equal to, the compressor motor current draw.

Low Voltage (200 to 600 volts)

- Solid-state starters
- Wye (star)-delta closed transition
- Adaptive Frequency Drive

Medium-Voltage Starters (2,300–6,600 V)

- Full voltage
- Flanged disconnect
- Primary reactor, closed transition

Starters

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.
- Starter enclosures capable of being padlocked.
- 120 volt, 60 hertz, 1-phase fused pilot and safety circuits.
- Control power transformer (4 kVA) producing 120 volt, 50 or 60 hertz, single-phase.
- 3-phase incoming line terminals.
- 6 output load terminals (3 for medium-voltage) factory connected to the motor.
- Automatic closed-transition transfer from wye to delta on any two-step starter (unit-mounted).
- One pilot relay to initiate start sequence from CenTraVac™ control circuit signal.

Optional Features

- Ground fault protection.
- Digital metering devices.
- Surge protector/lighting arrestor.
- Standard, high interrupt, and higher interrupt circuit breakers that are mechanically interlocked to disconnect line power when the starter door is open.
- Special NEMA enclosures.
- Analog ammeters and voltmeters.
- Special function pilot lights.
- Current limiting circuit breakers incorporating fuse links that disconnect line power in the event the interrupting capacity is exceeded.

Factory-Installed Starters:

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

Figure 3. Typical equipment room layout—conventional remote Wye-Delta starter

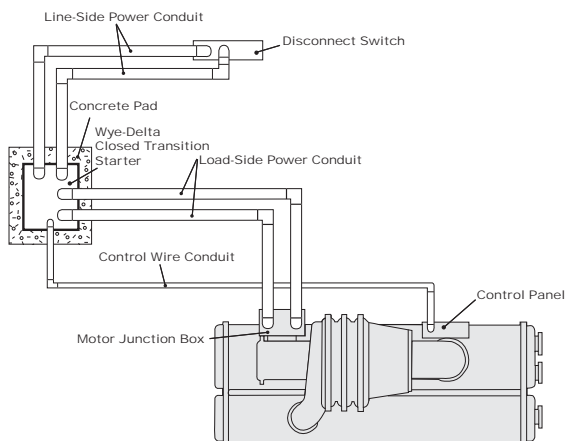
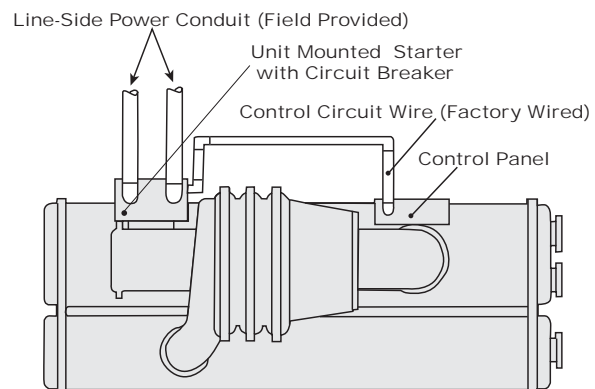


Figure 4. Typical equipment room layout—unit-mounted Wye-Delta starter



Starters

Wye (Star)-Delta Starters

One type of low-voltage starter that can be unit-mounted is a wye (star)-delta, closed-transition, reduced-voltage starter as shown in Figures 3 and 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 33 percent the full-voltage torque rating, which 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 the motor from losing phase to the line current during this period. With the completion of transition, the motor windings are connected in the delta configuration with full line voltage.

Standard Motor Protection

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 detections is provided:

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

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.

Silicon Controlled Rectifiers (SCR)

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 motors 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 otherwise is 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. The SCRs are then turned off, and the current flow stops.

Adaptive Frequency Drive

Adaptive Frequency Drive Benefits

Trane Adaptive Frequency™ Drives (AFDs) 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. A frequency drive can be used to significantly reduce power consumption by reducing motor speed at low-load and low-lift conditions. Trane patented AFD Adaptive Control™ logic safely allows inlet guide vane and speed control combinations that optimize part-load performance.

Application

Certain system characteristics favor installation of an AFD because of energy cost savings and shorter payback. These systems include: condenser water temperature relief, chilled-water reset, and utilities with high kWh and low kW demand rates.

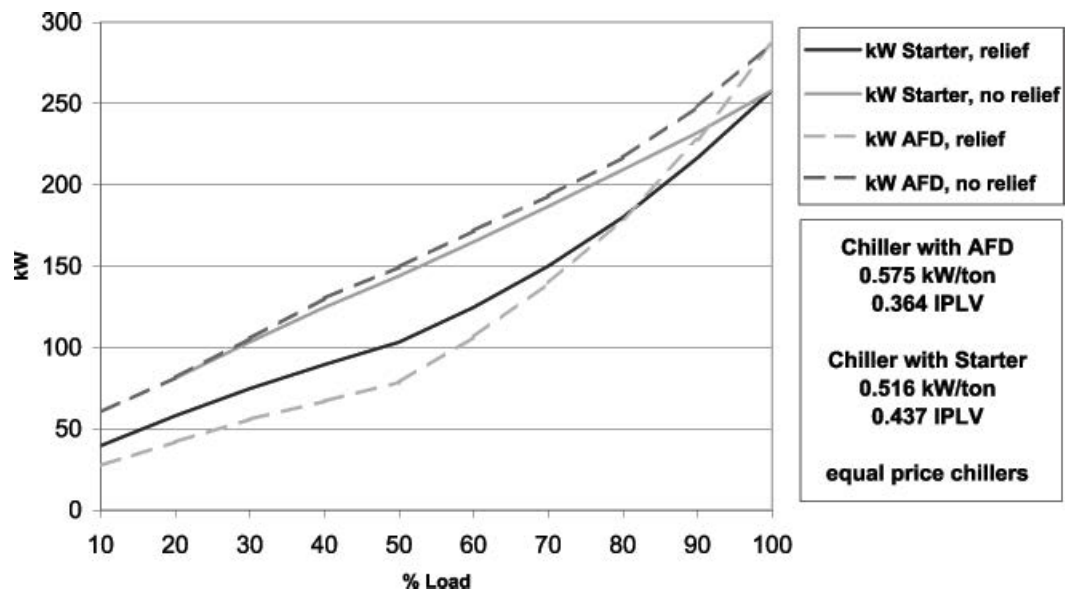
Condenser Water Temperature Relief or Chilled-Water Reset

Compressor lift reduction is required for a chiller application, both to provide stable chiller significant operating hours with compressor lift reduction is required to achieve greater energy savings. Intelligent control to reduce condenser water temperature, or chilled-water reset strategies, are key to AFD savings in chiller applications.

High Operating Hours with Relief

Figure 5 is based on a CVHF485, 500-ton load at 42/54, 3 gpmc/ton demonstrates the energy savings of an AFD chiller with condenser water relief. Figure 5 shows that the more operating hours the machine has, the more energy the AFD saves and the payback time is reduced.

Figure 5. CVHF485 energy demand with/without AFD



High kW Demand 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 and part-lift conditions throughout the year. The greater the kWh charge, and the smaller demand or distribution charges, the shorter the payback.

Adaptive Frequency Drive

Operation

The Trane AFD controls the speed of the chiller compressor by regulating the output voltage in proportion to the output frequency as required by 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 three basic power sections:

- **Rectifier** — An IGBT active rectifier takes incoming AC power and converts it to a fixed DC voltage. This rectifier significantly reduces the amount of ripple on the DC bus.
- **DC bus** — Uses capacitors to store DC power from the rectifier until it's needed by the inverter.
- **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.

All Trane CenTraVac™ Chillers with AFDs use integrated active rectification control. TDD (total demand distortion) measured at the drive is limited to 5% or less.

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 (IGV) position is optimized mathematically and controlled simultaneously. The microprocessor performance allows the chiller to operate longer at higher efficiency 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 evaporator leaving water-temperature control to reach setpoint or for a 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 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, inlet vanes and speed will modulate simultaneously to control both surge margin and chiller capacity.

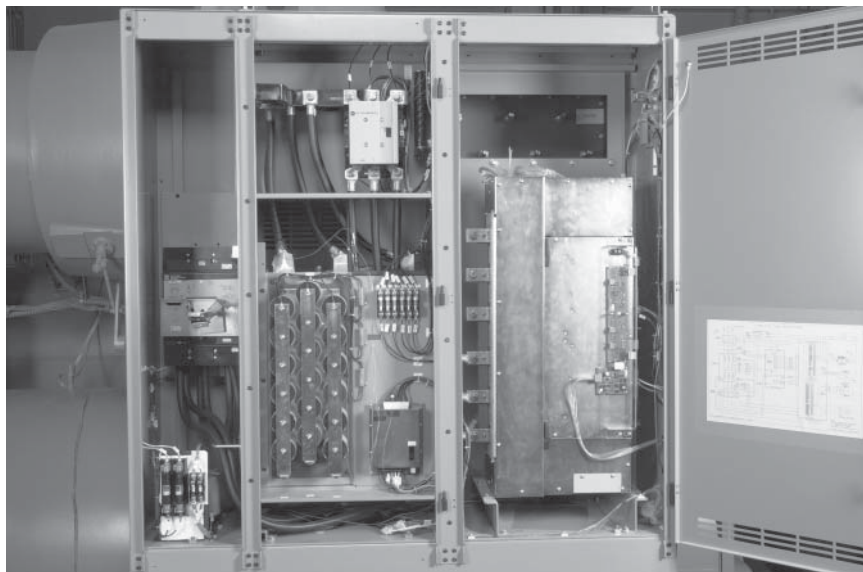


Mathematically optimizes inlet guide vanes and speed

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 and the elapsed time since the last optimization was done. After the new boundary is established, speed control will make adjustments to follow the boundary as conditions change.

*Adaptive Frequency Drive***Instability is not an issue**

- **Short chilled-water loop**—Feedforward control cancels out the effect of short water loops.
- **Rapid changes in load**—Feedforward control improves chilled-water temperature response.
- **Variable water flow designs**—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.
- **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 a Tracer chiller controller will maintain excellent water-temperature control at the best efficiency.
- **Waiting for leaving temperature to exceed threshold**— The Tracer chiller controller responds to the surge boundary based on the current differential operating pressure and not the entering/leaving water temperatures, making instantaneous corrections to speed and vane settings as conditions change.



Factory-Installed AMPGARD Medium-Voltage Starters

The AMPGARD™ medium-voltage starter family by Cutler-Hammer™, built to Trane specifications, is available as a factory-installed option for use with CenTraVac™ chillers. Trane 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 site.

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.

Advantages of 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 are 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 inrush current, motor voltage, and motor current draw, for compatibility with the rest of the power system.

Across-the-Line (Full Voltage)

An across-the-line starter is the smallest medium-voltage starter option. These starters draw the highest inrush current at startup (100% of LRA), and 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 inrush current. 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-voltage starter types such as primary reactor and autotransformer are also available to unit-mount on the CenTraVac chiller.

Primary Reactor

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

Medium-Voltage Starters

Autotransformer

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

Standard Features

- UL approved
- Unit-mounted or remote-mounted
- Non-load-break isolation switch and current limiting fuses
- Voltage range of 2300–6600 volts
- Factory installed (unit-mounted only)
- Types: Across-the-line (full voltage), primary reactor, autotransformer
- Phase voltage sensors for kW, volts/phase protection, under/overvoltage
- Cutler-Hammer™ AMPGARD™, designed and built to Trane specifications

Optional Features

- Ground fault protection
- Factory-installed power factor correction capacitors sized specific to the motor, factory-wired and mounted inside the starter

DMP, Differential Motor Protection (SMP option)

DMP replaces the zero-sequence ground fault protection. Instead, it uses a flux-summation selfcompensating differential protection scheme for more quickly and more precisely removing line power during a fault.

DMP is available only for 1062 kW and larger motor sizes up to 5000 volts.

CVAC, Customer-Supplied Vacuum Circuit Breaker

- Three-pole disconnect
- Relays for vacuum circuit-breaker starter type
- Industrial terminal block
- Secondary 120 to 30 volt PT's (for medium-voltage units)

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.

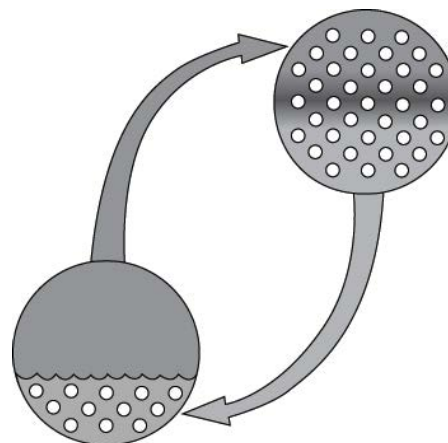
Free Cooling

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 most 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°F to 55°F (10°C to 12.8°C), the unit control panel starts the free cooling cycle automatically.

Free Cooling Schematic



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 factory installed and requires no additional 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.

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 (7.2°C) wet bulb or more than 4000 degree-days per year are well suited to free cooling operation. A cooling tower 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 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 high cost electricity in most areas of the country, this heating penalty can be very significant.

Free Cooling

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.

Free cooling is 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 from the storage tank into the evaporator, flooding the tube bundle. Since the refrigerant temperature and pressure are 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 option consists of the following factory-installed or supplied components:

- Additional refrigerant charge required for the free cooling cycle
- Manual free cooling controls on the unit control panel
- A refrigerant gas line, including an electrically actuated shutoff valve, installed between the evaporator and condenser
- A liquid-refrigerant storage vessel adjacent to the economizer
- A valved-liquid return line, including an electrically activated shutoff valve, between the condenser sump and evaporator

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

Figure 6. Compressor operation schematic

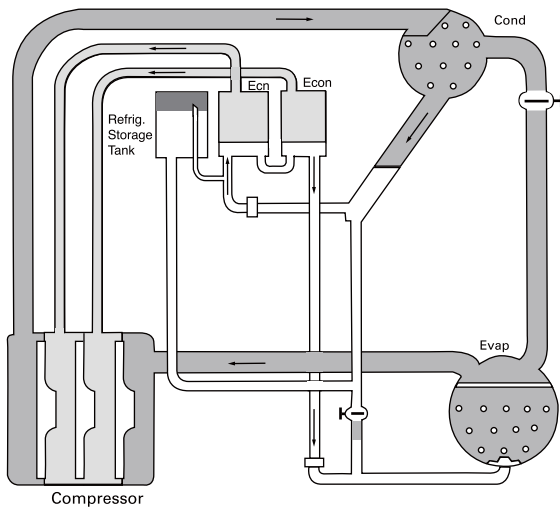
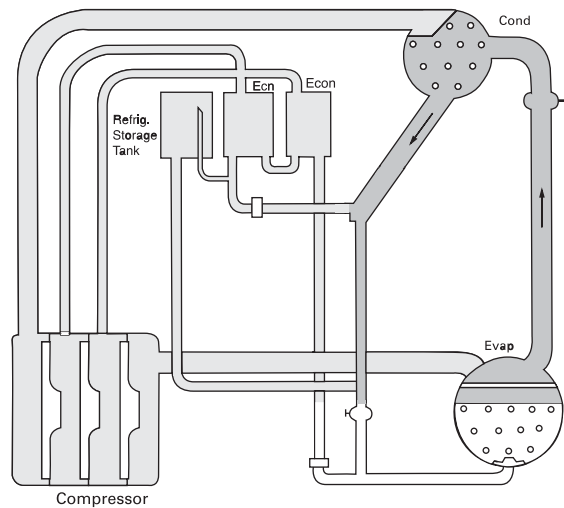


Figure 7. Free cooling operation schematic



System Options

Heat Recovery

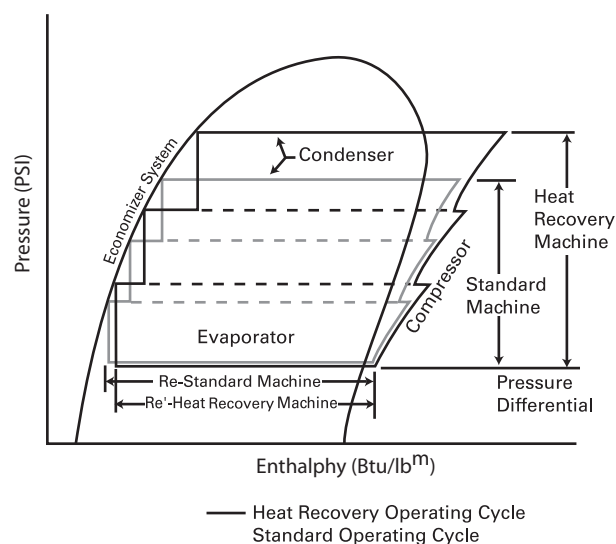
Use of the Heat Recovery CenTraVac™ can significantly reduce the energy operating costs of many buildings by using heat which normally would be rejected to the atmosphere. Typical uses for this heat are perimeter zone heating, reheat air conditioning systems, and preheating domestic hot water. Any building 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 (29.4°C to 35°C) 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 8, 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

Figure 8. Typical operating cycles



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 .54 to .57 kW/ton 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. A heat recovery machine's operating efficiency is 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, which is shown in Figure 9. This means the impeller diameters are determined by the heat recovery operating conditions.

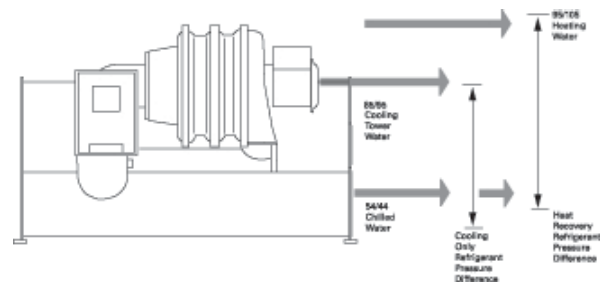
The multistage compressor and advanced impeller design on the CenTraVac™ chiller reduce this costly energy penalty. The higher lift and stability the multistage compressor allows a closer match of impeller size for both the cooling only and heat recovery operating conditions. In addition, the computer designed impellers and crossover are designed to reduce losses as the kinetic energy of the refrigerant gas is converted to static pressure.

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 by 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°F to 120°F (35°C to 48.9°C) hot water depending upon the operating conditions. 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.



Heat Recovery

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

Heating Water Temperatures and Control

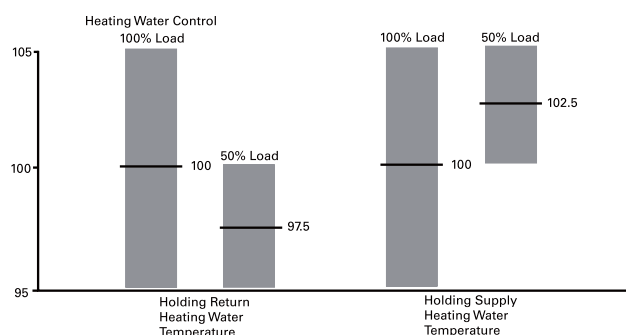
It is always desirable to use as low a heating water temperature as the application allows. Experience has shown that a design heating water temperature of 105°F to 110°F (40.5°C to 43.3°C) can satisfy most heating requirements. Lower heating water temperatures increase the chiller operating efficiency 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 (-12.2°C) 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 compressors capability to handle the pressure difference decreases. Therefore, the chiller's capability to unload without the use of hot gas bypass is reduced.

Hot gas bypass artificially increases the load on the compressor by diverting refrigerant gas from the condenser back to the compressor. Although hot gas bypass increases the units 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



Ice Storage Provides Reduced Electrical Demand

An ice storage system uses a dual-duty 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 for 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°F to 24°F (-5.6°C to -4.4°C) glycol solution. 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 the 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 20°F to 25°F (-5.6°C to -4.4°C) glycol solution 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.

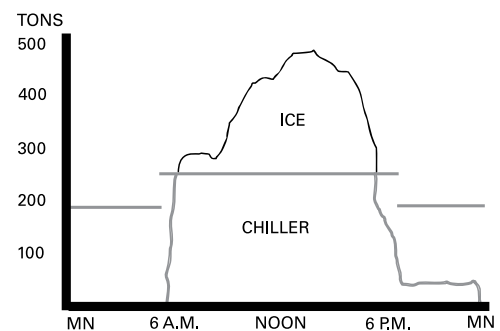
Ice Storage

When cooling is required, ice chilled glycol solution 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.

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

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

Figure 11. Ice storage demand cost savings



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 the system's most efficient setting and starts the chiller.

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, 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 Control

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.

Most chillers are designed to entering tower temperatures around 85°F (29.5°C), but Trane CenTraVac chillers can operate at reduced lift down to a 3 psid 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 (12.8°C) dependent on a variety of factors such as load, leaving evaporator temperature and component combinations. Startup below this differential is possible as long as the 3 psid minimum pressure differential is achieved within a given amount of time.

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.

Water Flow

Today's technology challenges ARIs traditional design of 3 gpm/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 of the water pumps
- Pump energy (30 to 35% reduction)
- Size and cost for condenser lines and valves
- Size and cost of the cooling tower
- 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 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 4,000 VA divided by the unit design voltage.

As an example, calculate the minimum circuit ampacity of a machine that has a design RLA of 350 amps with 460 volt power:

$$\begin{aligned}\text{Minimum Circuit Ampacity} &= (125\% \times 350\text{Amps}) + \frac{4000\text{VA}}{460\text{V}} \\ &= 437.5 \text{ A} + 8.7 \text{ A} \\ &= 446.2 \text{ A}\end{aligned}$$

After the minimum circuit ampacity has been determined, the electrical engineer or contractor will refer to the appropriate NEC conductor sizing table to determine the exact conductors required. A typical table for 75°F (23.9°C) conductors is listed on the Trane submittal. The selection of conductors is based on a number of job site 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).

Additional electrical information is available in an engineering bulletin, CTV-PRB004-EN, "Starters and Electrical Components for CenTraVac™ Chillers."

Selection Procedure

Selection

The CenTraVac™ centrifugal chiller product line provides more than 200,000 individual unit selections over a capacity range of 170 through 3950 cooling 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.

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 that most closely meets the job requirements. All selections are made 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 fluid 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 multiple 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.

Roughing-in Dimensions

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 with its support feet is superimposed on this drawing.

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.

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™, The Trane 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 for single-chiller installations. Although these values are not necessarily a precise indicator of actual energy use, they do provide a basis for comparison.



Performance Data

Table 2. Minimum and maximum evaporator flow rates (gpm)

Shell Size EVSZ	Bundle Size EVBS	One Pass						Two Pass						Three Pass					
		IMCU		TECU		IECU		IMCU		TECU		IECU		IMCU		TECU		IECU	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
050S/L	390	310	2276	473	2604	311	2255	155	1137	237	1302	160	1125	102	752	156	885	102	741
050S/L	480	370	2714	578	3180	370	2689	185	1355	289	1590	191	1342	122	896	190	1081	122	883
050S/L	580	448	3282	691	3802	448	3253	224	1640	345	1901	231	1623	147	1084	228	1292	147	1068
050S/L	700	543	3983	812	4470	544	3947	272	1989	406	2235	280	1969	178	1316	268	1520	179	1296
050S/L	860	656	4814	-	-	657	4771	328	2405	-	-	338	2380	216	1590	-	-	216	1567
080S/L	740	585	4289	-	-	585	4250	292	2142	-	-	301	2121	192	1417	-	-	192	1396
080S/L	880	686	5033	959	5277	687	4987	343	2514	479	2638	354	2489	226	1662	316	1794	226	1638
080S/L	1050	841	6171	1097	6037	842	6115	421	3082	548	3019	433	3051	277	2038	362	2052	277	2009
080S/L	1210	979	7178	1227	6752	980	7113	489	3585	613	3376	504	3549	322	2371	404	2295	322	2336
080S/L	1400	1146	8403	1411	7766	1147	8327	573	4197	705	3883	590	4155	377	2776	465	2640	377	2735
142M/L	890	693	5080	964	5297	692	5069	347	2540	482	2648	346	2534	231	1693	321	1765	231	1689
142M/L	980	770	5645	1079	5930	769	5632	385	2822	540	2965	384	2816	257	1881	360	1976	256	1877
142M/L	1080	868	6361	1200	6598	866	6347	434	3180	600	3299	433	3173	290	2120	400	2199	289	2115
142M/L/E	1220	963	7056	1349	7416	961	7040	482	3528	675	3708	480	3520	321	2351	450	2472	320	2346
142M/L/E	1420	1120	8206	1502	8256	1116	8188	560	4103	751	4128	559	4094	373	2735	501	2752	373	2729
210L	1610	1232	9031	1470	8083	1229	9011	616	4515	735	4041	615	4506	411	3010	490	2694	410	3003
210L	1760	1383	10139	1642	9029	1380	10117	692	5069	821	4514	690	5058	461	3379	548	3009	460	3372
210L	1900	1528	11203	1824	10030	1525	11178	764	5601	912	5014	763	5589	510	3734	608	3343	509	3726
210L	2100	1623	11898	2010	11055	1619	11871	812	5948	1005	5527	810	8935	541	3965	670	3685	540	3957
250E	2280	1587	11637	1935	10642	1590	11663	793	5819	967	5321	795	5832						Not applicable
250E	2300	1750	12832	2174	11953	1762	12917	875	6415	1087	5976	881	6458	584	4277	725	3984	588	4306
250E	2480	1757	12882	2127	11699	1761	12911	878	6441	1064	5850	880	6456						Not applicable
250E	2500	1916	14047	2394	13162	1929	14141	958	7023	1197	6581	965	7070	639	4682	798	4387	643	4713
210D/M	1610	1216	8913	1421	7814	1224	8973												
210D/M	1850	1388	10175	1680	9239	1397	10243												
210D/M	2100	1557	11414	1935	10641	1567	11490												

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, and may be limited by other factors such as glycol. Confirm actual minimum and maximum flows for each selection before operating near flow boundaries. In the above table, 0.025" wall tubes were used for M, L, S, and E bundles and 0.028" wall tubes were used for D, M, and X bundles.

Evaporator Flow Rates

Minimum and maximum evaporator flow rates (liter/second)

Shell Size EVSZ	Bundle Size EVBS	One Pass						Two Pass						Three Pass					
		IMCU		TECU		IECU		IMCU		TECU		IECU		IMCU		TECU		IECU	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
050S/L	390	20	144	30	164	20	142	10	72	15	82	10	71	6	47	10	56	6	47
050S/L	480	23	171	36	201	23	170	12	86	18	100	12	85	8	57	12	68	8	56
050S/L	580	28	207	44	240	28	205	14	103	22	120	15	102	9	68	14	82	9	67
050S/L	700	34	251	51	282	34	249	17	126	26	141	18	124	11	83	17	96	11	82
050S/L	860	41	304	-	-	41	301	21	152	-	-	21	150	14	100	-	-	14	99
080S/L	740	37	271	-	-	37	268	18	135	-	-	19	134	12	89	-	-	12	88
080S/L	880	43	318	60	333	43	315	22	159	30	166	22	157	14	105	20	113	14	103
080S/L	1050	53	389	69	381	53	386	27	194	35	190	27	193	17	129	23	129	17	127
080S/L	1210	62	453	77	426	62	449	31	226	39	213	32	224	20	150	26	145	20	147
080S/L	1400	72	530	89	490	72	525	36	265	45	245	37	262	24	175	29	167	24	173
142M/L	890	44	320	61	334	44	320	22	160	30	167	22	160	15	107	20	111	15	107
142M/L	980	49	356	68	374	49	355	24	178	34	187	24	178	16	119	23	125	16	118
142M/L	1080	55	401	76	416	55	400	27	201	38	208	7	200	18	134	25	139	18	133
142M/L/E	1220	61	445	85	468	61	444	30	223	43	234	30	222	20	148	28	156	20	148
142M/L/E	1420	71	518	95	521	70	517	35	259	47	260	35	258	24	173	32	174	24	172
210L	1610	78	570	93	510	78	569	39	285	46	25	39	284	26	190	31	170	26	189
210L	1760	87	640	104	570	87	638	44	320	52	285	44	319	29	213	35	190	29	213
210L	1900	96	707	115	633	96	705	48	353	58	316	48	353	32	236	38	211	32	235
210L	2100	102	751	127	697	102	749	51	375	63	349	51	564	34	250	42	232	34	250
250E	2280	100	934	122	671	100	736	50	367	61	336	50	368						Not applicable
250E	2300	110	810	137	754	111	815	55	405	69	377	56	407	37	270	46	251	37	272
250E	2480	111	813	134	738	111	815	55	406	67	369	56	407						Not applicable
250E	2500	121	886	151	830	122	892	60	443	76	415	61	446	40	295	50	277	41	297
210D/M	1610	77	562	90	493	77	566												
210D/M	1850	88	642	106	583	88	646												Not Applicable
210D/M	2100	98	720	122	671	99	725												

Note: The minimum evaporator water velocity is .457 m/s for IECU tubes and .610 m/s for all other tubes. For a variable evaporator water flow system, the minimum LPS is generally not applicable at full load, and may be limited by other factors such as glycol. Confirm actual minimum and maximum flows for each selection before operating near flow boundaries. In the above table, 0.025" wall tubes were used for M, L, S, and E bundles and 0.028" wall tubes were used for D, M, and X bundles.



Performance Data

Condenser Flow Rates

Table 3. Minimum and maximum condenser flow rates (gpm)

Shell Size EVSZ	Bundle Size EVBS	Two Pass							
		SBCU		TECU		IECU		IMCU	
		Min	Max	Min	Max	Min	Max	Min	Max
050S	360	336	1233	328	1201	347	1269	345	1263
050S/L	400	378	1388	369	1351	391	1430	389	1423
050S/L	450	26	1563	416	1522	440	1611	438	1604
050S/L	500	473	1733	461	1688	489	1792	787	1784
080S	500	473	1733	461	1688	489	1792	487	1784
080S	560	529	1940	516	1889	547	2004	545	1995
080S/L	630	595	2182	580	2126	613	2246	610	2235
080S/L	710	691	2466	656	2402	687	2518	584	2506
080S/L	800	756	2770	736	2698	772	2830	769	2821
142L	890	853	3125	834	3055	874	3203	870	3190
142L	980	949	3476	927	3398	973	3565	968	3549
142L	1080	1060	3884	1036	3796	1088	3988	1083	3970
142L	1220	1185	4343	1158	4245	1215	4452	1209	4431
142L	1420	1335	4895	1305	4785	1404	5147	1398	5123
210L	1610	1331	4879	1301	4769	1492	5469	1301	4769
210L	1760	1473	5400	1440	5279	1651	6053	1644	6025
210L	1900	1615	5921	1579	5788	1808	6627	1800	6597
210L	2100	1760	6452	1721	6307	1959	7181	1950	7148
250L	2100	1760	6452	1721	6307	1956	7171	1947	7138
250L	2300	1935	7092	1891	6932	2149	7876	2139	7840
250L	2500	2103	7747	2066	7573	2338	8571	2327	8532
		One Pass							
210D/M	1610	2662	9758	2602	9539	2984	10938	2970	10888
210D/M	1760	2946	10800	2880	10558	3302	12107	3287	12051
210D/M	1900	3231	11873	3158	11576	2616	13255	3599	13194
210D/M	2100	3520	12906	3441	12615	3918	14363	3900	14297

Note: The minimum condenser water velocity is 3 ft/sec and the maximum is 11 ft/sec, and may be limited by other factors such as glycol. Confirm actual minimum and maximum flows for each selection before operating near flow boundaries. Table values based on 0.028" wall tubes.

Condenser Flow Rates

Minimum and maximum condenser flow rates (liter/second)

Shell Size EVSZ	Bundle Size EVBS	Two Pass							
		SBCU		TECU		IECU		IMCU	
		Min	Max	Min	Max	Min	Max	Min	Max
050S	360	21	78	21	76	22	80	22	80
050S/L	400	24	88	23	85	25	90	25	90
050S/L	450	27	99	26	96	28	102	28	101
050S/L	500	30	109	29	106	31	113	31	113
080S	500	30	109	29	106	31	113	31	113
080S	560	33	122	33	119	35	126	34	126
080S/L	630	38	138	37	134	39	142	38	141
080S/L	710	44	156	41	152	43	159	37	158
080S/L	800	48	175	46	170	49	179	49	178
142L	890	54	197	53	193	55	202	55	201
142L	980	60	219	58	214	61	225	61	224
142L	1080	67	245	65	239	69	252	68	250
142L	1220	75	274	73	268	77	281	76	280
142L	1420	84	309	82	302	89	325	88	323
210L	1610	84	308	82	301	94	345	82	301
210L	1760	93	341	91	333	104	382	104	380
210L	1900	102	374	100	365	114	418	114	416
210L	2100	111	407	109	398	124	453	123	451
250L	2100	111	407	109	398	123	452	123	450
250L	2300	122	447	119	437	136	497	135	495
250L	2500	133	489	130	478	148	541	147	538
		One Pass							
210D/M	1610	168	616	164	602	188	690	187	687
210D/M	1760	186	681	182	666	208	764	207	760
210D/M	1900	204	747	199	730	165	836	227	832
210D/M	2100	222	814	217	796	247	906	246	902

Note: The minimum condenser water velocity is 0.914 m/s, and the maximum is 3.35 m/s, and may be limited by other factors such as glycol. Confirm actual minimum and maximum flows for each selection before operating near flow boundaries. Table values based on 0.028" wall tubes.

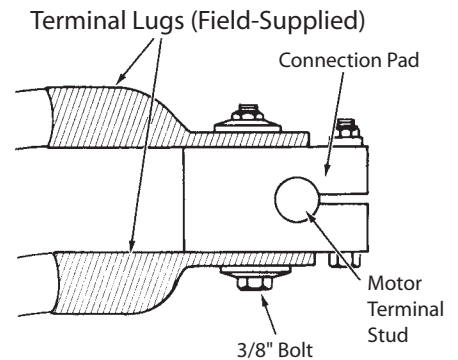
Job Site Connections

Supply and Motor Lead Wiring and Connections

Copper conductors should only 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.

Figure 12. Electric connections



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 12, illustrates the connection between the motor connection pads and the terminal lugs.

Shipment and Assembly

All CenTraVac™ chillers ship as a factory assembled, factory tested package, ready to rig into place on factory supplied isolation pads. A full oil charge is shipped in the oil sump, and a 5 psig (34.5 kPa) dry nitrogen charge prevents condensation and confirms a leak-free seal before installation.

Controls

Tracer AdaptiView Controller

Today's CenTraVac™ chillers offer predictive controls that anticipate and compensate for load changes. Other control strategies made possible with the Tracer AdaptiView™ 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 chiller to restart 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 having limited affect on the chiller energy consumption. 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 differential-pressure-sensor transducers.

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.

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

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, low 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 (1.1°C to 2.2°C) leaving water temperatures. Special installation procedures may be required.

Standard Features

Tracer AdaptiView Control Operator Interface

Tracer AdaptiView™ control is the unit-mounted operator interface with a touch-sensitive 12.1" display. The display presents information through an intuitive navigation system. Alternate languages are also available for the control panel display.

Tracer AdaptiView™ control receives information from and communicates information to the other devices on the chiller's communications link. Tracer AdaptiView™ control performs the Leaving Chilled-Water Temperature and Limit Control algorithms.

Tracer AdaptiView™ control can be connected to the service tool using a standard USB type B cable. The connection is located on the side of the control panel, along with a power outlet for a laptop PC power supply.



- Data graphs
- Mode overrides
- Status (all subsystems) with animated graphics
- Auto/Stop commands
- 50 diagnostics
- ASHRAE chiller log
- Setpoint adjustment (daily user points)

Tracer TU Interface

The Tracer chiller controller adds a level of sophistication better served by a PC application to improve service technician effectiveness and minimize chiller downtime. Tracer AdaptiView™ control is intended to serve only typical daily tasks. The portable PC-based service-tool software, Tracer TU™, supports service and maintenance tasks.

Tracer TU serves 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.

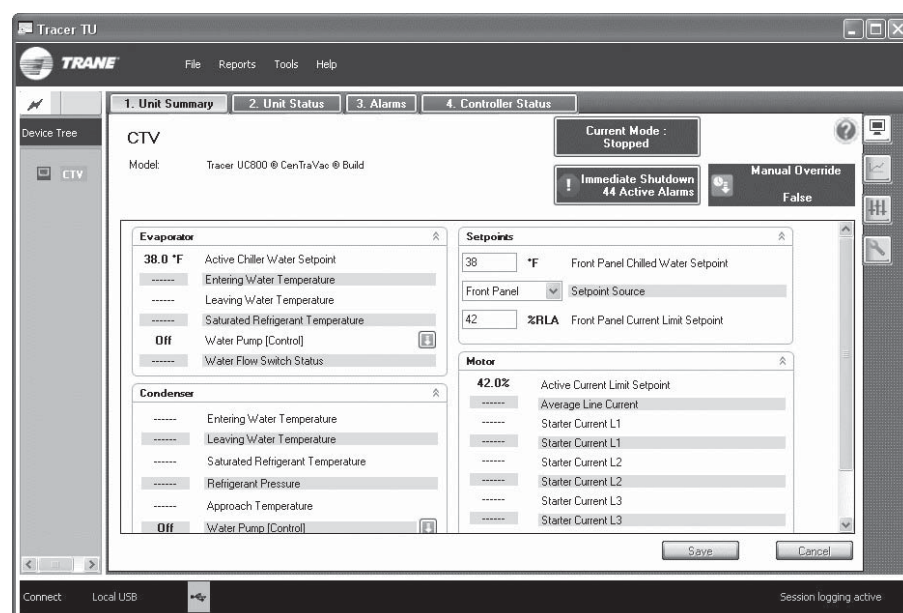
The panel bus is easy to troubleshoot using LED sensor verification. Only the defective device is replaced. Tracer TU can communicate with individual devices or groups of devices.

All chiller status, machine configuration settings, customizable limits, and up to 100 active or historic diagnostics are displayed through the service-tool software interface.

LEDs and their respective Tracer TU indicators visually confirm the availability of each connected sensor, relay, and actuator. Tracer TU is designed to run on a customer's laptop, connected to the AdaptiView control panel with a USB cable.

Hardware requirements for Tracer TU

- CD-ROM
- 1024 x 768 resolution
- Windows® XP Pro or Vista
- An available USB port (USB 2.0)
- 1 GB RAM
- Ethernet 10/100 Lan card
- Pentium IV or higher processor



Standard Features

Field Connection

The field-connected items are important for turning the chiller on or off. This includes an emergency or external stop, pump relays, and verifying that flow has been established. The optional, factory-supplied flow switch or differential-pressure switch can be used to prove flow.

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

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 wye-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 regulates the purge to optimize both purge and chiller efficiency. The purge controller communicates with Tracer AdaptiView™ control over the machine bus communications link, uploading setpoints and downloading data and diagnostics.

Potential/Current Transformers—3-phase

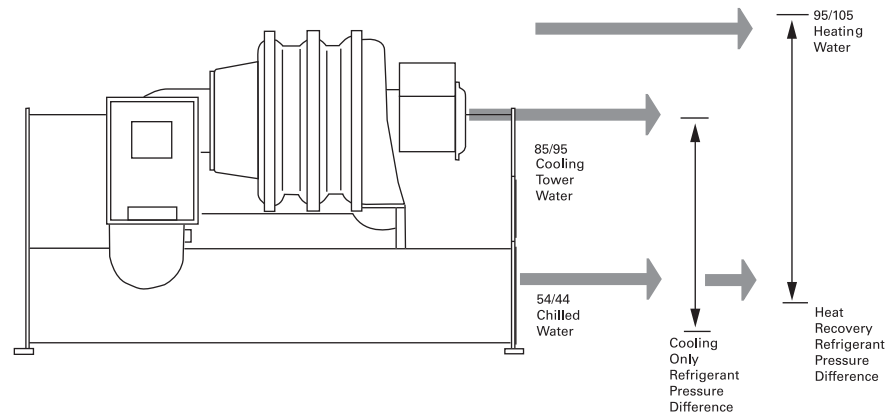
Includes factory-installed potential/current transformers in the starter for monitoring and displaying phase voltage and amperage, and provides over/undervoltage protection. Tracer AdaptiView™ control, Tracer TU, and Tracer Summit display the following:

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

Chilled-Water Reset

Chilled-water reset reduces chiller 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.

Figure 13. Chilled-water reset



Hot-Water Control

In the hot-water mode, the chiller produces hot water as its primary objective, rather than chilled water—similar to the heat-pump operation. A leaving condenser water setpoint is maintained while the leaving evaporator temperature is allowed to modulate with the load. As an option, the Extended Operation package allows an external controller to enable, disable, and modulate this mode. The hot-water mode is performed without a secondary condenser. For additional information, see the Heat Recovery/Auxiliary Condenser option

Ice-Making Control

For chillers that have been selected 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.

Standard Features

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 2-10 Vdc analog input for a refrigerant monitor.

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

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 the chiller capacity. Artificially load the chiller by setting the chilled-water setpoint lower than it is capable of achieving. Then, modify the chillers 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 operation. 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 function and cooling is a waste product or a secondary function. 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 Tracer AdaptiView™ control 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 the Tracer AdaptiView™ control, 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.

Optional Features

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.

How It Works

The Tracer chiller controller uses a patented, variable, water-flow compensation algorithm to maintain stable, precise capacity control.

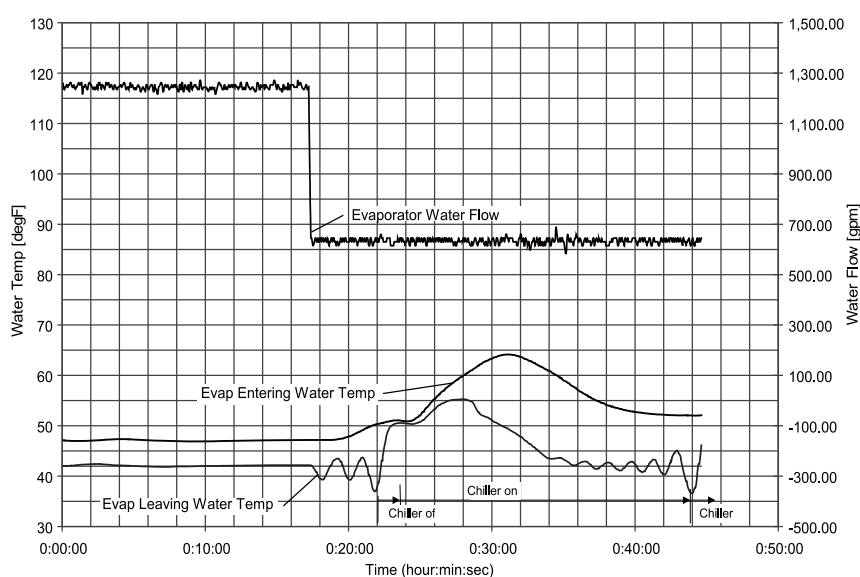
If the water-pressure transducer fails and the flow switch continues to prove flow, water-flow compensation will be disabled and the design delta-T will be used.

For applications designed to operate with variable-primary water flow, variable-flow compensation allows the chiller to respond quickly to changes in chilled-water flow rate. By automatically adjusting the control gain, large changes in the water-flow rate are accommodated.

Data shown on Figure 14 demonstrates water-temperature control without flow compensation. In contrast, 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.

Another benefit is disturbance rejection. Figure 16 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 (-16.9°C) variation in chilled-water temperature. It is unlikely that a chiller application would make water flow changes of this magnitude. The results demonstrate that the chiller is more than capable of supporting variable water flow applications.

Figure 14. Capacity control without variable-flow compensation



Variable-Flow Stability

Figure 15. Capacity control with variable-flow compensation

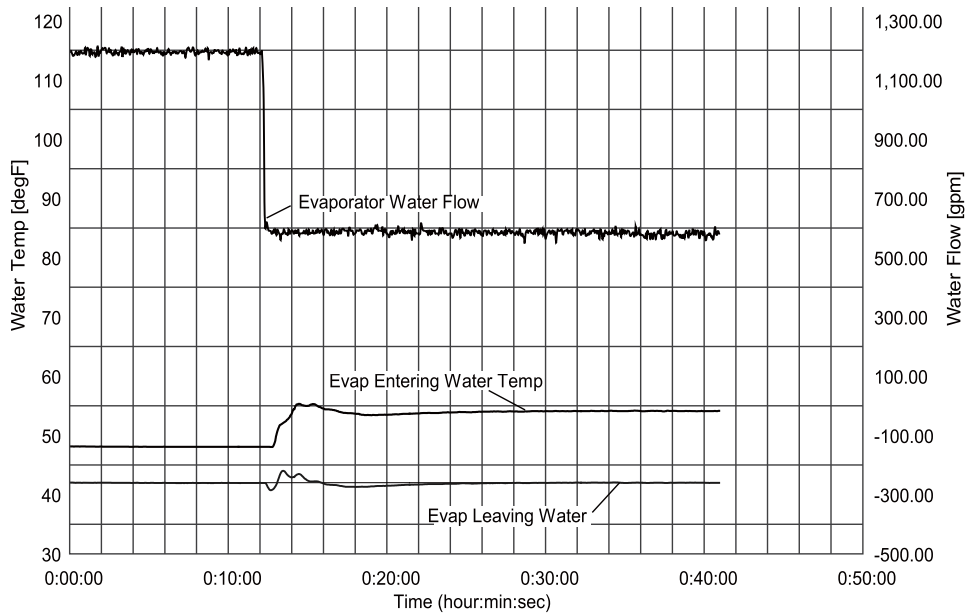
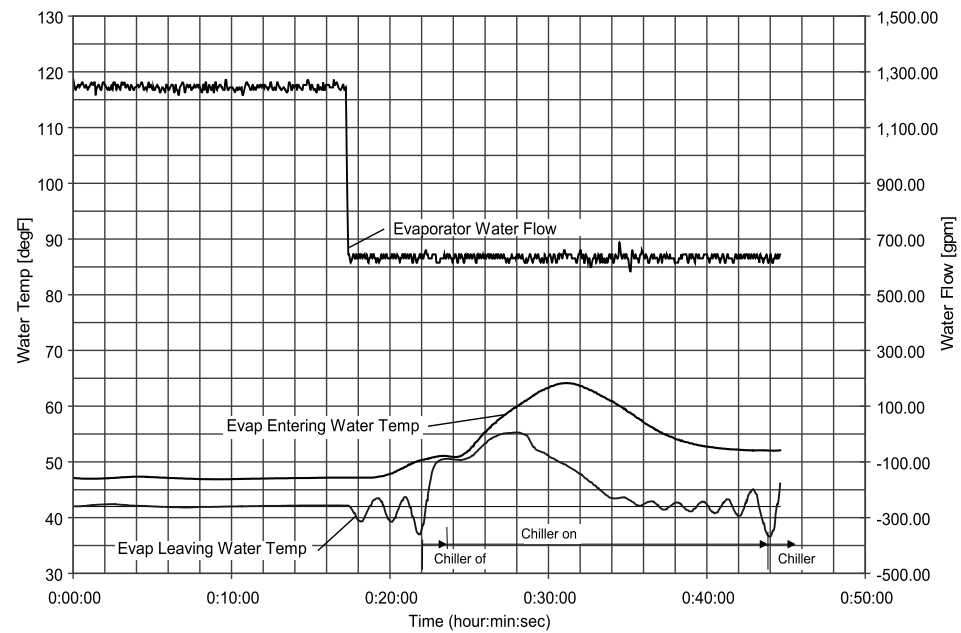


Figure 16. Capacity control with flow changes and variable-flow compensation



The following data will be shown at the Tracer AdaptiView™ control, TracerTU displays and at Tracer Summit:

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

It will automatically adjust capacity control to:

- Minimize variable-flow disturbance
- Maintain control stability at low flow

Interoperability

LonTalk Communications Interface (LCI-C)

The optional LonTalk™ Communications Interface for Chillers (LCI-C) is available factory or field installed. It is an integrated communication board that enables the chiller controller to communicate over a LonTalk network. The LCI-C is capable of controlling and monitoring chiller setpoints, operating modes, alarms, and status. The Trane LCI-C provides additional points beyond the standard LonMark™ defined chiller profile to extend interoperability and support a broader range of system applications. These added points are referred to as open extensions. The LCI-C is certified to the LonMark Chiller Controller Functional Profile 8040 version 1.0, and follows LonTalk FTT-10A free topology communications.

Native BACnet Communications

Tracer AdaptiView™ control can be configured for BACnet communications at the factory or in the field. This enables the chiller controller to communicate on a BACnet MS/TP network. Chiller setpoints, operating modes, alarms, and status can be monitored and controlled through BACnet.

Tracer AdaptiView controls conform to the BACnet B-ASC profile as defined by ASHRAE 135-2004.

Modbus Communications

Tracer AdaptiView control can be configured for Modbus communications at the factory or in the field. This enables the chiller controller to communicate as a slave device on a Modbus network. Chiller setpoint, operating modes, alarms, and status can be monitored and controlled by a Modbus master device.

Building Automation and Chiller Plant Control

Trane Tracer Summit™ building automation systems include pre-engineered and flexible control for chiller plants. 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 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, for example: time of the day, holiday periods and exception schedules.

- **Optimization of the installation start/stop time:** based on the programmed schedule of occupancy and the historical temperature records. Tracer Summit calculates the optimal start/stop time 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 a large chilled-water-loop pull down, thus preventing an overshoot of the actual capacity required. Unnecessary starts are avoided and the peak current demand is lowered.
- **Communication capabilities:** local, through a PC workstation keyboard. Tracer Summit™ can be programmed to send messages to other 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 plants 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.

A 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 entire subsystem. This real-time optimization may vary tower temperatures between 50°F–90°F (10°C–32.2°C) depending upon current outdoor conditions, chiller loading, and ancillary efficiencies.

Interoperability

Integrated Comfort System (ICS)

The onboard Tracer chiller controller is designed to be able to communicate with a wide range of building automation systems. In order to take full advantage of chiller's capabilities, 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 the 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 HVAC system efficiency.

The building owners challenge is to tie components and applications expertise into a single reliable system that provides maximum comfort, control, and efficiency. Trane 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 Protections

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, contact your local Trane office for additional protection information.

High Condenser-Pressure Protection

The chiller will protect itself from a starter failure that prevents disconnecting the compressor motor from the incoming line power.

The chiller controller's condenser limit keeps the condenser pressure under a specified maximum pressure. The chiller will run up to 100 percent of this setpoint before the adaptive control mode reduces capacity.

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

Tracer AdaptiView™ control 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 and condenser-water pump starter 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 from 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.

Protections

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 chillers 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 (21.4 kPa). This protects the motor by locking out chiller operation while the unit is in a high vacuum—preventing startup without a refrigerant change during commissioning.

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 a blockage in the oil circuit.

During compressor prelube the differential pressure should not fall below 12 psid. A shutdown diagnostic will occur within 2 seconds of the differential pressure falling below two-thirds of the low differential oil-pressure cutout.

When the compressor is running the shutdown diagnostic will occur when the differential pressure falls below the differential oil-pressure cutout for more than (cutout x 3) seconds. This allows for a relatively high cutout to be violated longer before triggering shutdown, as compared to a low cutout.

Excessive Purge Detection

Pump-out activity is indicative of the amount of air leaking into the chiller refrigerant system. The operator is informed when the air-leakage rate changes. Through this setpoint the operator can specify an expected leakage rate, and can be notified through 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 available
15% unbalance = 90% RLA available
20% unbalance = 85% RLA available
25% unbalance = 80% RLA available
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

Protections

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 during startup to avoid nuisance trips. The MPL diagnostic is an automatic reset diagnostic.

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 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:

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

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

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 temperature at the service menu. Immediately prior to start, and while running, the controller will generate a latching diagnostic if the winding temperature exceeds 265°F (129.4°C) for 0.5–2 seconds.

Surge Detection Protection

Surge detection is based on current fluctuations in one of three phases. The default detection criterion is two occurrences of root-mean square (RMS) current change of 30 percent within 0.8 seconds in 60 ± 10 percent seconds. The detection criterion is adjustable with the Tracer chiller controller.

Overvoltage and Undervoltage Protection

While some components of the chiller are impervious to dramatically different voltages, the compressor-motor is not. The control panel monitors all three line-to-line voltages for the chiller, and bases the over and undervoltage diagnostics on the average of the three voltages. The default protection resets the unit if the line voltage is below or above $\pm 10\%$ of nominal for 60 seconds.

Power Factor and kW Measurement

Three-phase measurement of kW and unadjusted power factor yields higher accuracy during power imbalance conditions.

Short-Cycling Protection

This function mimics heat dissipation from a motor start using two setpoints: Restart Inhibit Free Starts and Restart Inhibit Start-to-Start Timer. This allows the CenTraVac™ to inhibit too many starts in a defined amount of time while still allowing for fast restarts. The default for CenTraVac is 3 Free Starts and a 20 minute Start-to-Start Timer. The control panel generates a warning when the chiller is inhibited from starting by this protection.

Restart Inhibit Free Starts: This setting will allow a maximum number of rapid restarts equal to its value. If the number of free starts is set to 1, this will allow only one start within the time period set by the Start-to-Start Time setting. The next start will be allowed only after the start-to-start timer has expired. If the number of free starts is programmed to 3, the control will allow three starts in rapid succession, but thereafter, it would hold off on a compressor start until the Start-to-Start timer expired.

Restart Inhibit Start-to-Start Time Setting: This setting defines the shortest chiller cycle period possible after the free starts have been used. If the number of free starts is programmed to 1, and the Start-to-Start Time setting is programmed to 10 minutes, the compressor will be allowed one start every 10 minutes. The start-to-start time is the time from when the motor was directed to energize to when the next prestart is issued.

Protections

Enhanced Protection Option

This optional package (included with the industrial package) includes sensors and transducers that enable the following protection features:

Enhanced Condenser-Limit Control

Includes factory-installed condenser-pressure transducer and all necessary interconnecting piping and wiring. Enhanced condenser-limit control provides 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 Tracer AdaptiView™ control, Tracer TU™, and Tracer Summit™.

Note: When the chiller is selected with HGBP, this sensor and its associated protection are included as standard.

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 these 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.



Weights

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 rigging and placement. The large number of variances between chiller selections drives variances in chiller weights that are not recognized in this table. Use the weights from the selection program for better accuracy.

Table 4. Weights 60 Hz compressors

Model	Weight without Starter								Weight with Starters			
	NTON	CPKW	EVSZ	CDSZ	Operating		Shipping		Operating		Shipping	
					lb	kg	lb	kg	lb	kg	lb	kg
CVHE (60Hz)	360-500	453	050S	050S	20812	9440	18700	8482	23037	10449	20925	9491
	360-500	453	050S	050L	21748	9865	19475	8834	23973	10874	21700	9843
	360-500	453	050L	050L	23275	10557	20447	9275	25500	11567	22672	10284
	360-500	453	050S	080S	23540	10678	20910	9485	25765	11687	23135	10494
	360-500	453	050L	080L	26586	12059	23193	10520	28811	13068	25418	11529
	360-500	453	080S	080S	28529	12941	25002	11341	30754	13950	27227	12350
	360-500	453	080S	080L	30098	13652	26313	11935	32323	14661	28538	12945
	360-500	453	080L	080L	32186	14599	27893	12652	34411	15609	30118	13661
CVHF	350-570	588	050S	050S	19319	8763	17207	7805	22260	10097	20148	9139
	350-570	588	050S	050L	20255	9188	17982	8156	23196	10522	20923	9491
	350-570	588	050L	050L	21682	9835	18954	8597	24623	11169	21895	9931
	350-570	588	050S	080S	21997	9978	19417	8807	24938	11312	22358	10141
	350-570	588	050L	080L	24993	11337	21700	9843	27934	12671	24641	11177
	350-570	588	080S	080S	27010	12252	23483	10652	29951	13586	26424	11986
	350-570	588	080S	080L	28579	12963	24794	11246	31520	14297	27735	12580
	350-570	588	080L	080L	30667	13910	26374	11963	33608	15244	29315	13297
	650-910	957	080S	080S	29385	13329	25858	11729	32275	14640	28748	13040
	650-910	957	080S	080L	30954	14040	27169	12324	33844	15351	30059	13635
	650-910	957	080L	080L	33042	14988	28749	13040	35932	16298	31639	14351
	650-910	957	080L	142L	38292	17369	32204	14607	41182	18680	35094	15918
	650-910	957	142M	142L	39210	17785	33278	15095	41525	18835	35437	16074
	650-910	957	142L	142L	40451	18348	34101	15468	42100	19096	36168	16406
	1070-1300	1228	080L	142L	40819	18515	34731	15754	43341	19659	36991	16779
	1070-1300	1228	142M	142L	41511	18829	35579	16138	43150	19573	37218	16882
	1070-1300	1228	142L	142L	42752	19392	36402	16512	44391	20135	38041	17255
	1070-1300	1228	142E	142L	43986	19952	37292	16915	45625	20695	38931	17659
	1070-1300	1228	210L	210L	51651	23428	43440	19704	53290	24172	45079	20447
	1070-1300	1228	250E	250L	60905	27626	50350	22838	62544	28369	51989	23582
1470	1340	210L	210L	54232	24599	46021	20875	55871	25343	47660	21618	
1470-1720	1340	250E	250L	63486	28797	52931	24009	65125	29540	54570	24753	

- These values represent chiller weights do not include the following:
- TECU .028" tubes
 - 150 psig non-marine waterboxes
 - INDP (Industrial Control Panel), add 50 lb (23kg)
 - CPTR (Control Panel Transformer) option, add 130 lb (50 kg)
 - SMP (Supplemental Motor Protection) option, add 500 lb (230 kg)
 - Operating weights include the heaviest possible refrigerant charge weight
 - Chillers with starter values include the weight of the heaviest possible starter
 - Heaviest possible bundle and heaviest possible motor voltage combination for the applicable family of chillers

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 rigging and placement. The large number of variances between chiller selections drives variances in chiller weights that are not recognized in this table. Use the weights from the selection program for better accuracy.

Table 5. Weights 50 Hz compressors

Model	Weight without Starter								Weight with Starters			
	Operating				Shipping				Operating		Shipping	
	NTON	CPKW	EVSZ	CDSZ	lb	kg	lb	kg	lb	kg	lb	kg
CVHE (50Hz)	300-420	379	050S	050S	20195	9160	18083	8202	21834	9904	19722	8946
	300-420	379	050S	050L	21131	9585	18858	8554	22770	10328	20497	9297
	300-420	379	050L	050L	22658	10277	19830	8995	24297	11021	21469	9738
	300-420	379	080S	080S	27912	12661	24385	11061	29551	13404	26024	11804
	300-420	379	080S	080L	29481	13372	25696	11656	31120	14116	27335	12399
	300-420	379	080L	080L	31569	14319	27276	12372	33208	15063	28915	13116
CVHG	480-565	489	050S	050S	22009	9983	19897	9025	23648	10727	21536	9769
	480-565	489	050S	050L	22945	10408	20672	9377	24584	11151	22311	10120
	480-565	489	050L	050L	24372	11055	21644	9818	26011	11798	23283	10561
	480-565	489	080S	080S	29726	13483	26199	11884	31365	14227	27838	12627
	480-565	489	080S	080L	31295	14195	27510	12478	32934	14939	29149	13222
	480-565	489	080L	080L	33383	15142	29090	13195	35022	15886	30729	13938
	670-780	621	080S	080S	31037	14078	27510	12478	32676	14822	29149	13222
	670-780	621	080S	080L	32606	14790	28821	13073	34245	15533	30460	13816
	670-780	621	080L	080L	34694	15737	30401	13790	36333	16480	32040	14533
	670-780	621	142M	142L	41176	18677	35244	15986	42815	19421	36883	16730
920-1100	892	210L	210L	52495	23811	44284	20087	54134	24555	45923	20830	
CDHG	1250-1750	621	210D	210D	86267	39131	74805	33932	88431	40112	76969	34913
	2250	892	210D	210D	93165	42259	79690	36147	Not applicable			
	2150	892	210M	210M	103018	46728	89124	40426	Not applicable			

These values represent chiller weights do not include the following:

- TECU .028" tubes
- 150 psig non-marine waterboxes
- INDP (Industrial Control Panel), add 50 lb (23kg)
- CPTR (Control Panel Transformer) option, add 130 lb (50 kg)
- SMP (Supplemental Motor Protection) option, add 500 lb (230 kg)
- Operating weights include the heaviest possible refrigerant charge weight
- Chillers with starter values include the weight of the heaviest possible starter
- Heaviest possible bundle and heaviest possible motor voltage combination for the applicable family of chillers

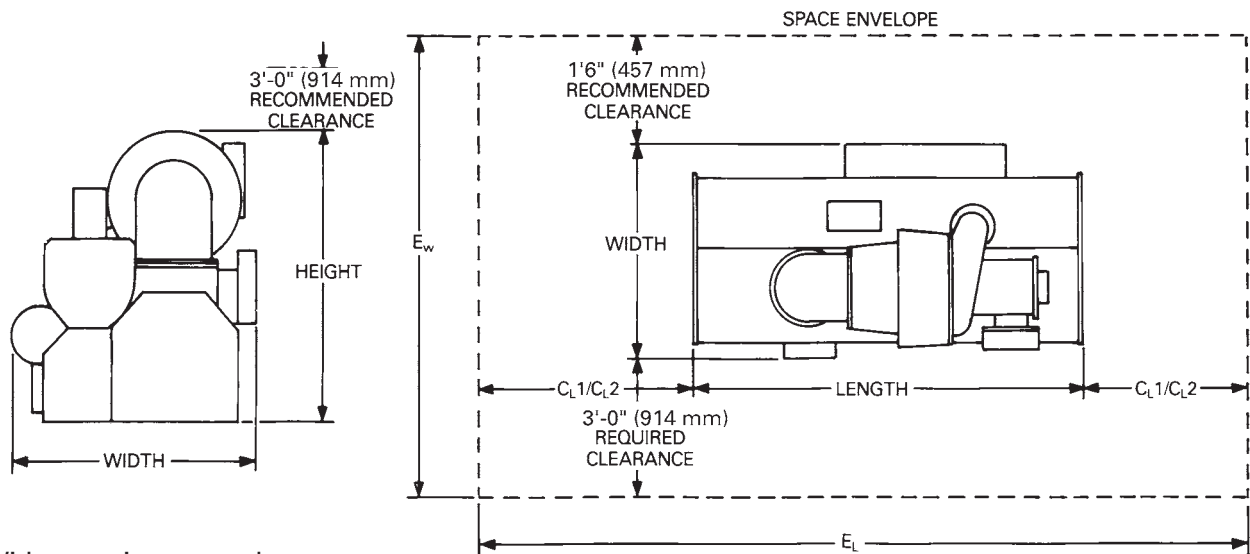
Physical Dimensions

Single-Compressor CenTraVac Chillers

Table 6. CenTraVac water connection pipe size

Water		Shell Size					
Passes	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

Figure 17. For Table 7 and 8. Space envelope for 60 and 50 Hz compressor chillers



*Without unit-mounted starters

50 Hz Compressor (IP & SI Units)

Table 7. For Figure 17. Physical dimensions 50Hz compressor chillers (IP and SI Units)

IP Units													
COMP	Shell Size	Shell Arrangement	Envelope			Clearance			Unit Dimensions				
			EL	W/O Unit Mounted Starters	With Unit Mounted Starters	Tube Pull	CL1	CL2	Length	Height	W/O Unit Mounted Starters	With Unit Mounted Starters	
				EW	EW						Width	Width	
CVHE	300-420	050	SS	26' 63/8"	11' 45/8"	12' 81/2"	11' 9"	3' 63/8"	11' 3"	8' 21/2"	6' 101/8"	7' 9"	
	300-420	050	SL & LL	34' 5/8"	11' 45/8"	12' 81/2"	15' 6"	3' 63/8"	15' 1/4"	8' 21/2"	6' 101/8"	7' 9"	
	300-420	080	SS	27' 41/4"	12' 51/4"	13' 91/4"	11' 9"	4' 41/4"	11' 3"	9' 63/8"	7' 113/8"	8' 71/2"	
	300-420	080	SL & LL	34' 101/2"	12' 51/4"	13' 91/4"	15' 6"	4' 41/4"	15' 1/4"	9' 63/8"	7' 113/8"	8' 71/2"	
CVHG	480-565	050	SS	26' 63/8"	11' 4 5/8"	13' 75/8"	11' 9"	3' 63/8"	11' 3"	8' 71/4"	6' 103/8"	7' 83/8"	
	480-565	050	SL & LL	34' 5/8"	11' 4 5/8"	13' 75/8"	15' 6"	3' 63/8"	15' 1/4"	8' 71/4"	6' 103/8"	7' 83/8"	
	480-565	080	SS	27' 41/4"	12' 51/4"	13' 15/8"	11' 9"	4' 41/4"	11' 3"	9' 8"	7' 111/2"	8' 7/8"	
	480-565	080	SL & LL	34' 101/2"	12' 5 1/4"	13' 15/8"	15' 6"	4' 41/4"	15' 1/4"	9' 8"	7' 111/2"	8' 7/8"	
	670-780	080	SS	27' 41/4"	12' 10"	13' 10"	11' 9"	4' 41/4"	11' 3"	9' 63/4"	7' 111/2"	8' 83/4"	
	670-780	080	SL & LL	34' 101/2"	12' 10"	13' 10"	15' 6"	4' 41/4"	15' 1/4"	9' 63/4"	7' 111/2"	8' 83/4"	
	670-780	142	ML & LL	35' 51/4"	14' 53/4"	14' 41/2"	15' 6"	4' 11"	15' 1/4"	10' 11/8"	9' 91/8"	9' 101/4"	
	920-1067	142	ML & LL	35' 51/4"	14' 53/4"	14' 41/2"	15' 6"	4' 11"	15' 1/4"	10' 11/8"	9' 91/8"	9' 101/4"	
CVHE	920-1067	210	LL	35' 51/4"	15' 33/4"	15' 83/8"	15' 6"	4' 11"	15' 1/4"	11' 7/8"	10' 61/2"	10' 93/4"	
	1100	142	ML & LL	35' 51/4"	14' 73/4"	14' 61/2"	15' 6"	4' 11"	15' 1/4"	10' 11/2"	9' 111/8"	10' 73/4"	
	1100	210	LL	35' 51/4"	15' 33/4"	15' 83/8"	15' 6"	4' 11"	15' 1/4"	11' 31/8"	10' 61/2"	10' 53/4"	
	SI Units (mm)												
	CVHE	300-420	050	SS	8087	3470	3874	3581	1076	3429	2502	2086	2362
		300-420	050	SL & LL	10379	3470	3874	4724	106	4578	2502	2086	2362
300-420		080	SS	8338	3867	4198	3581	1327	3429	2905	2424	2629	
300-420		080	SL & LL	10630	3867	4198	4724	1327	4578	2905	2424	2629	
CVHG	480-565	050	SS	8087	3470	4156	3581	1076	3429	2624	2086	2347	
	480-565	050	SL & LL	10379	3470	4156	3581	1076	4578	2624	2086	2347	
	480-565	080	SS	8338	3867	4003	4724	1327	3429	2946	2424	2461	
	480-565	080	SL & LL	10630	3867	4003	4724	1327	4578	2946	2424	2461	
	670-780	080	SS	8338	3912	216	3581	1327	3429	2915	2086	2661	
	670-780	080	SL & LL	10630	3912	4216	4724	1327	4578	2915	2086	2661	
	670-780	142	ML & LL	10754	4413	4381	4724	1499	4578	3077	2439	3004	
	920-1067	142	ML & LL	10754	4413	4381	4724	1499	4578	3077	2439	3004	
	920-1067	210	LL	10801	4667	4667	4724	1499	4578	3375	3211	3296	
	1100	142	ML & LL	10754	4464	4432	4724	1499	4578	3086	3026	3245	
1100	142	LL	10801	4667	4667	4724	1499	4578	3432	3211	3194		

CL1 CAN BE AT EITHER END OF THE MACHINE AND IS REQUIRED FOR TUBE PULL CLEARANCE.

CL2 IS ALWAYS AT THE OPPOSITE END OF THE MACHINE FROM CL1 AND IS REQUIRED FOR SERVICE CLEARANCE.



Physical Dimensions

60 Hz Compressor (IP & SI Units)

See Figure 17 on previous page for reference dimensions

Table 8. For Figure 17. Physical dimensions 60 Hz compressor chillers (IP and SI Units)

IP Units														
COMP	Shell Size	Shell Arrangement	Envelope			Clearance			Unit Dimensions					
			EL	EW	With Unit Mounted Starters	Tube Pull	CL1	CL2	Length	Height	W/O Unit Mounted Starters	With Unit Mounted Starters	CPTR	SMP/DMP
CVHE	360-500	500	SS	26' 63/8"	11' 45/8"	12' 81/2"	11' 9"	3' 63/8"	11' 3"	8' 21/2"	6' 101/8"	7' 81/2"	—	—
	360-500	500	SL & LL	34' 5/8"	11' 45/8"	12' 81/2"	15' 6"	3' 63/8"	15' 1/4"	8' 21/2"	6' 101/8"	7' 81/2"	—	—
	360-500	800	SS	27' 41/4"	12' 51/4"	13' 91/4"	11' 9"	4' 41/4"	11' 3"	9' 63/8"	7' 117/16"	8' 75/8"	—	—
	360-500	800	SL & LL	34' 101/2"	12' 51/4"	13' 91/4"	15' 6"	4' 41/4"	15' 1/4"	9' 63/8"	7' 117/16"	8' 75/8"	—	—
	350-570	500	SS	26' 63/8"	11' 45/8"	13' 75/8"	11' 9"	3' 63/8"	11' 3"	8' 4"	6' 101/8"	7' 81/2"	—	—
	350-570	500	SL & LL	34' 5/8"	11' 45/8"	13' 75/8"	15' 6"	3' 63/8"	15' 1/4"	8' 4"	6' 101/8"	7' 81/2"	—	—
	350-570	800	SS	27' 41/2"	12' 51/4"	13' 91/4"	11' 9"	4' 41/4"	11' 3"	9' 61/2"	7' 117/16"	8' 75/8"	8' 7/16"	8' 47/8"
	350-570	800	SL & LL	34' 101/2"	12' 51/4"	13' 91/4"	15' 6"	4' 41/4"	15' 1/4"	9' 61/2"	7' 117/16"	8' 75/8"	8' 7/16"	8' 47/8"
CVHF	650-910	800	SS	27' 41/4"	12' 10"	13' 10"	11' 9"	4' 41/4"	11' 3"	9' 63/4"	7' 117/16"	8' 7"	8' 61/8"	9' 7/8"
	650-910	800	SL & LL	34' 101/2"	12' 10"	13' 10"	15' 6"	4' 41/4"	15' 1/4"	9' 63/4"	7' 117/16"	8' 7"	8' 61/8"	9' 7/8"
	650-910	1420	ML & LL	35' 51/4"	14' 53/4"	14' 41/2"	15' 6"	4' 11"	15' 1/4"	10' 11/8"	9' 91/8"	9' 81/2"	9' 91/4"	10' 21/2"
	1070-1300	1420	ML & LL	35' 51/4"	14' 73/4"	14' 61/2"	15' 6"	4' 11"	15' 1/4"	10' 11/2"	9' 111/8"	10' 7"	9' 111/4"	10' 71/8"
	1070-1300	1420	EL	39' 27/8"	14' 73/4"	14' 61/2"	17' 5"	4' 11"	16' 103/4"	10' 3/4"	9' 111/8"	10' 7"	9' 111/4"	10' 71/8"
	1070-1300	2100	LL	35' 51/4"	15' 33/4"	15' 83/8"	15' 6"	4' 11"	15' 1/4"	11' 31/4"	10' 67/16"	10' 53/4"	10' 13/4"	10' 10"
	1070-1300	2500	EL	39' 57/8"	16' 7"	18' 25/8"	17' 5"	5' 21/8"	16' 103/4"	11' 71/4"	11' 67/8"	11' 111/2"	11' 51/2"	10' 11/2"
	1470-1720	2100	LL	35' 51/4"	15' 33/4"	N/A	15' 6"	4' 11"	15' 1/4"	11' 5"	10' 67/16"	10' 10"	10' 3/16"	11' 41/4"
1470-1720	2100	EL	39' 57/8"	16' 7"	N/A	17' 5"	5' 21/8"	16' 103/4"	11' 91/8"	11' 67/8"	11' 111/2"	11' 51/2"	11' 57/8"	
SI Units (mm)														
CVHE	360-500	500	SS	8087	3470	3874	3581	1076	3429	2502	2086	2350	—	—
	360-500	500	SL & LL	10379	3470	3874	4724	1076	4578	2502	2086	2350	—	—
	360-500	800	SS	8338	3867	4198	3581	1327	3429	2905	2424	2632	—	—
	360-500	800	SL & LL	10630	3867	4198	4724	1327	4578	2905	2424	2632	—	—
	350-570	500	SS	8087	3470	4156	3581	1076	3429	2540	2086	2350	—	—
	350-570	500	SL & LL	10379	3470	4156	4724	1076	4578	2540	2086	2350	—	—
	350-570	800	SS	8338	3867	4198	3581	1327	3429	2908	2424	2632	2449	2558
	350-570	800	SL & LL	10630	3867	4198	4724	1327	4578	2908	2424	2632	2449	2558
CVHF	650-910	800	SS	8338	3912	4216	3581	1327	3429	2915	2424	2617	2594	2761
	650-910	800	SL & LL	10630	3912	4216	4724	1327	4578	2915	2424	2617	2594	2761
	650-910	1420	ML & LL	10754	4413	4381	4724	1499	4578	3077	2975	2959	2978	3109
	1070-1300	1420	ML & LL	10754	6350	4432	4724	1499	4578	3086	3026	3226	3029	3229
	1070-1300	1450	EL	11909	6350	4432	5309	1499	5150	3086	3026	3226	3029	3229
	1070-1300	2100	LL	10801	4667	4667	4724	1499	4578	3435	3211	3194	3091	3300
	1070-1300	2500	EL	11069	5055	5553	5309	1578	5150	3435	3529	3645	2491	3341
	1470-1720	2100	LL	10801	4667	N/A	4724	1499	4578	3479	3211	3302	3256	3440
1470-1720	2100	EL	11069	5055	N/A	5309	1578	5150	3585	3491	3645	3491	3501	

CL1 CAN BE AT EITHER END OF THE MACHINE AND IS REQUIRED FOR TUBE PULL CLEARANCE.

CL2 IS ALWAYS AT THE OPPOSITE END OF THE 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.

DMP stands for Differential Motor Protection, SMP stands for Supplemental Motor Protection, no unit-mounted starter, CPTR stands for Control Power Transformer option, no unit-mounted starter

50 & 60 Hz (IP Units)

Dual Compressor CenTraVac Chillers

CenTraVac™ Water Connection Pipe Sizes

Water Passes	210D/M
EVAPORATOR	Nominal
1 Pass	16
CONDENSER	
1Pass	16
EVAPORATOR	Nominal
1 Pass	DN400
CONDENSER	
1 Pass	DN400

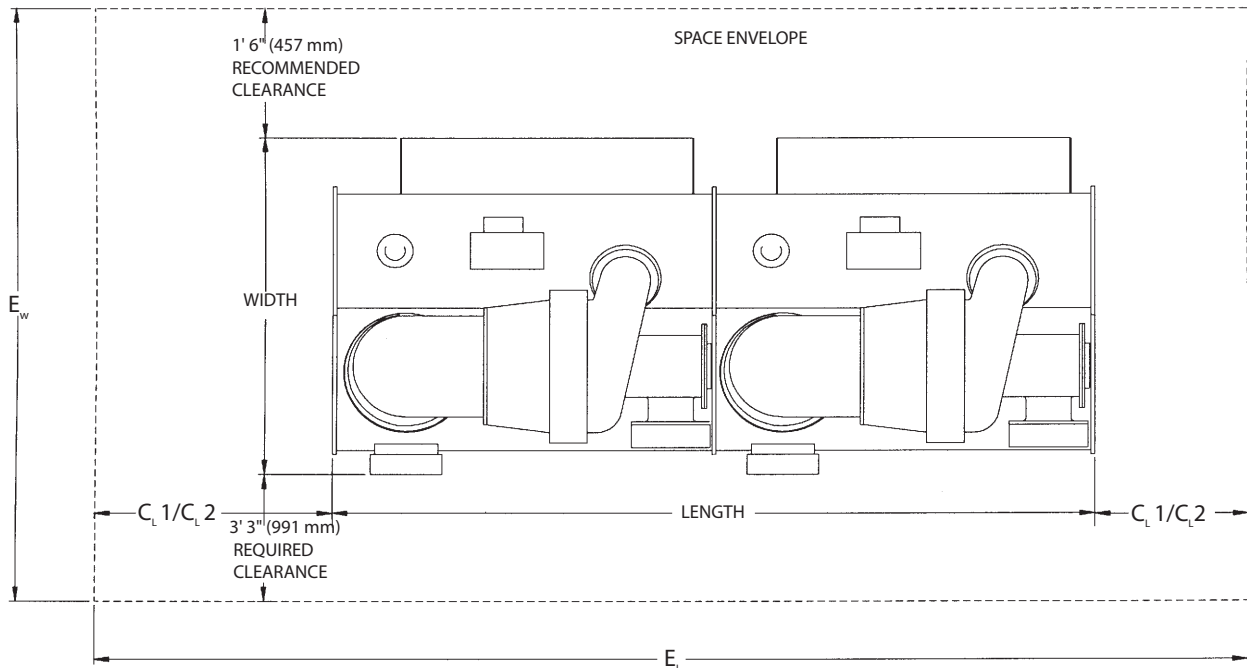
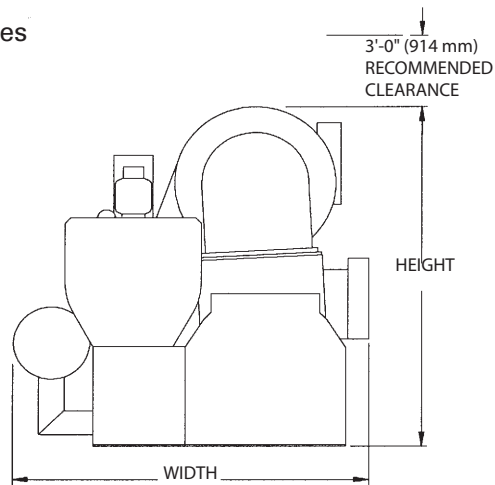


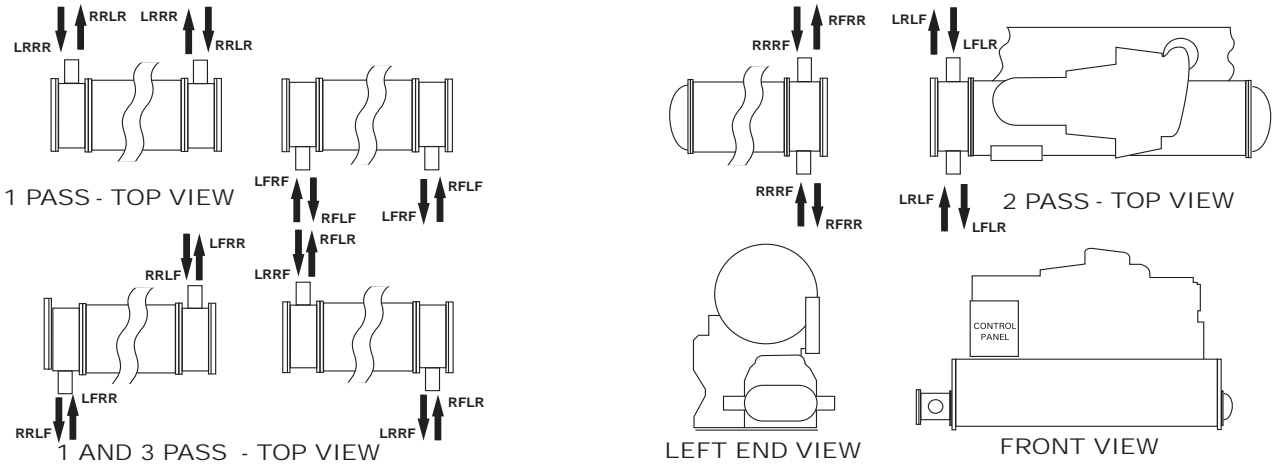
Table 9. Physical dimensions dual 50 and 60 Hz compressor units (IP and SI Units)

		Envelope		Clearance			Unit Dimensions					
				IP Units								
COMP	Shell Size	Shell Arrangement	W/O Unit Mounted Starters		With Unit Mounted Starters	Tube Pull	CL1	CL2	Length	Height	W/O Unit Mounted Starters	With Unit Mounted Starters
			EL	EW	EW						Width	Width
CDHG	2150	210M	MM	59'6"	15'9"	N/A	26'6"	7'0"	26'0"	11'3/4"	10'111/2"	N/A
CDHG	1250-2250	210D	DD	50'6"	15'9"	15'11"	22'0"	7'0"	21'6"	11'3/4"	10'111/2"	N/A
SI Units (mm)												
CDHG	2150	210M	MM	18136	4801	N/A	8078	2134	7925	3372	3340	N/A
CDHG	1250-2250	210D	DD	15392	4801	N/A	6706	2134	6553	3372	3340	N/A

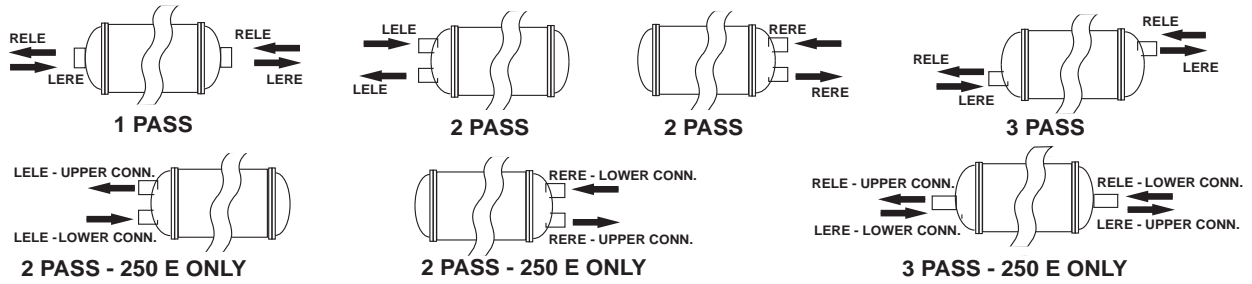
Table 9. Physical dimensions dual 50 and 60 Hz compressor units (IP and SI Units)
 CL2 IS ALWAYS AT THE OPPOSITE END OF THE MACHINE FROM CL1 AND IS REQUIRED FOR SERVICE CLEARANCE.

← = WATER FLOW

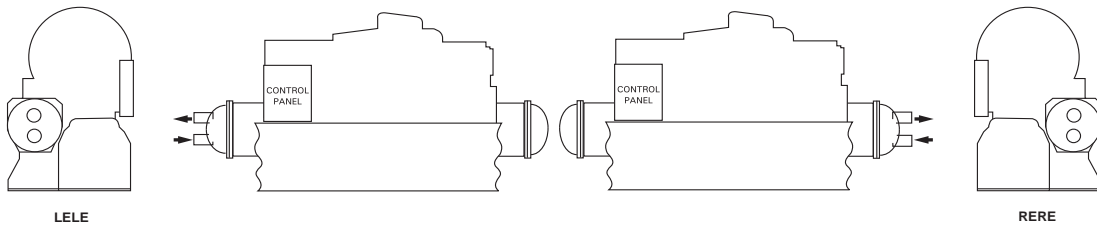
EVAPORATOR MARINE WATERBOXES



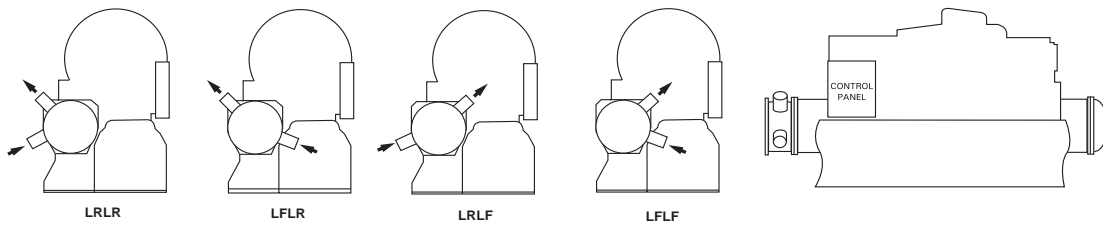
EVAPORATOR NON - MARINE



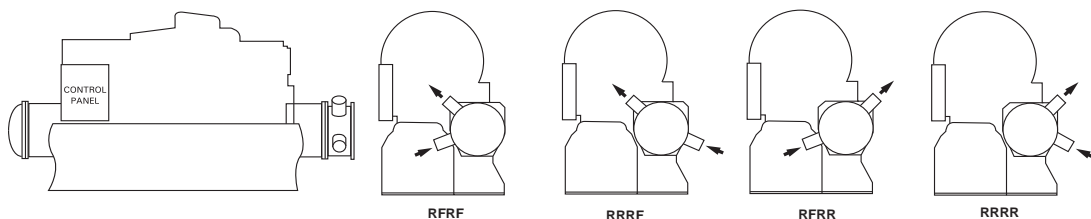
CONDENSER NON - MARINE 2 PASS ONLY



CONDENSER MARINE (LEFT HAND) 2 PASS ONLY



CONDENSER MARINE (RIGHT HAND) 2 PASS ONLY



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 to configure your selection for an as-built drawing to confirm it is available and to provide appropriate dimensions.

Table 10. Waterbox lengths—IP and SI Units

Evaporator								Condenser				
Shell	Psig	Type	Passes	Length		Return Length		Passes	Length		Return Length	
				IP	SI	IP	SI		IP	SI	IP	SI
050	150	Marine	1	18.5	470	6.73	171	2	16.31	414	7.875	200
			2									
			3									
050	150	Non-Marine	1	12.73	323	6.73	171	2	10.5 cast	267 cast	7.875	200
			2									
			3									
050	300	Marine	1	19	483	6.73	171	2	18.363	466	7.6	193
			2									
			3									
050	300	Non-Marine	1	12.73	323	6.73	171	2	12.86/20.46	327/520	7.6	193
			2									
			3									
080	150	Marine	1	23.225	590	7.21	183	2	23.75	603	8.32	211
			2	21.225	539							
			3	19.225	488							
080	150	Non-Marine	1	13.19	335	7.21	183	2	14.2	361	8.32	211
			2									
			3									
080	300	Marine	1	25	635	7.96	202	2	28.14	871	8.93	227
			2	23	584							
			3	21	533							
800	300	Non-Marine	1	13.96	355	7.96	202	2	14.4/23.27	366/591	8.93	227
			2									
			3									
142	150	Marine	1	28.25	718	9.33	237	2	28.25	718	9.25	235
			2	25	635							
			3	23	584							
142	150	Non-Marine	1	15.41	391	9.33	237	2	16	406	9.25	235
			2									
			3									
142	300	Marine	1	31.056	789	9.84	250	2	33.16	842	10.06	256
			2	27.8	706							
			3	25.8	655							
142	300	Non-Marine	1	15.59	396	9.84	250	2	15.79	401	10.06	256
			2									
			3									
210	150	Marine	1	N/A	N/A	N/A	N/A	2	29.632	753	9.382	238
			2	27.25	692	8.88	226					
			3	25.25	641							
210	150	Non-Marine	1	15.88	403	8.88	226	2	16.38	416	9.382	238
			2									
			3									
210	300	Marine	1	N/A	N/A	9.84	250	2	35	889	10.71	272
			2	29.64	753							
			3	29.64	753							
210	300	Non-Marine	1	16.84	428	9.84	250	2	17.71	450	10.71	272
			2									
			3									
250	150	Marine	1	N/A	N/A	11.75	298	2	32	813	10.75	273
			2	30	762							
			3	N/A	N/A							
250	150	Non-Marine	1	18.75	476	11.75	298	2	17.75	451	10.75	273
			2									
			3									
250	300	Marine	1	N/A	N/A	N/A	N/A	2	38.3	973	11.75	298
			2	N/A	N/A							
			3	N/A	N/A							
250	300	Non-Marine	1	20.25	514	13.25	337	2	18.75	476	11.75	298
			2									



Physical Dimensions

Waterbox Lengths (IP & SI Units)

Table 11. Waterbox lengths—IP and SI Units

Evaporator							Condenser			
Shell	Psig	Type	No. of Passes	Length		Return Length	No. of Passes	Length		No. of Passes
				IP	SI			IP	SI	
210D/M	150	Marine	1	28.25	718	N/A	1	31.88	810	N/A
210D/M	300			31.62	803	N/A		38.88	988	N/A
210D/M	150	Non-Marine	1	15388	403	N/A	1	16.38	416	N/A
210D/M	300			16.88	429	N/A		17.75	451	N/A

**Marine Waterbox Arrangement Tables
Evaporator Waterbox Arrangement**

CDWA	Inlet	Outlet
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
RTL R	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 made of high strength aluminum alloy are directly connected to the motor rotor shaft operating at 3,600 rpm (60 hertz) or 3,000 rpm (50 hertz). The 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-and leak-tested.

Motor

Compressor motors are hermetically sealed two-pole, 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 heat-treated carbon steel and designed such that the 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 reduced-voltage wye-delta starting. For low-voltage, solid-state starters and AFDs—connecting links are furnished to convert the motor to a 3-lead motor.

2,300 through 13,800 volt, three-phase 60-hertz and 3300 through 11,000 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

Motor cooling is accomplished by a patented refrigerant pump that supplies liquid refrigerant to the motor. The refrigerant circulates uniformly over the stator windings and between the rotor and stator. All motor windings are specifically insulated for operation within a refrigerant atmosphere.

Lubrication

A direct-drive, positive-displacement oil pump is driven by a 120 volt, single phase, $\frac{3}{4}$ horsepower motor. The motor and pump assembly is submerged in the oil pump to assure a positive oil supply to the compressor bearings at all times. A low watt-density heater maintains the oil temperature to minimize its affinity for refrigerant.

Evaporator

Shell and Waterboxes

The evaporator shell is constructed 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 a low limit controller, or customer use.

For all units, multiple 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, seamless copper tubing available in either one-inch or three-quarter-inch outside diameter is used as the evaporator heat transfer surface. Tubes are externally and internally enhanced, and mechanically expanded into the tube sheets (and are secured to the intermediate supports with tube 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. The eliminators prevent liquid refrigerant carryover into the compressor.

Refrigerant Distribution

A refrigerant distributor on 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 finally pressure leak tested with a helium mass spectrometer. The water side of the shell, with waterboxes in place, is hydrostatically tested at 1½ times the design working pressure, but not less than 225 psig.

Note: These tests are not to be repeated at installation.

Condenser/Heat Recovery Condenser

Shell and Waterboxes

The condenser shell is constructed of carbon steel plate designed and constructed in accordance with ANSI/ASHRAE 15 Safety Code.

For all units, multiple 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, seamless copper tubing available in either one-inch or three-quarter-inch outside diameter is used as the evaporator heat transfer surface. Tubes are externally and internally enhanced, and mechanically expanded into the tube sheets (and are secured to the intermediate supports with tube clips) to provide a leak-free seal and eliminate tube contact and abrasion due to relative motion.

Refrigerant Gas Distribution

A baffle plate between the tube bundle and the condenser shell distributes the hot compressor-discharge gas longitudinally throughout the condenser and downward over the tube bundle. The baffle plate prevents direct impingement of high velocity compressor-discharge gas upon the tubes.

Shell Tests

The refrigerant side of the condenser shell, complete with tubes, but without waterbox covers, is proof-tested at 45 psig, vacuum leak-tested, and finally pressure leak-tested with a helium mass spectrometer. The water side of the shell, with waterboxes in place, is hydrostatically tested at 1½ times the design working pressure, but not less than 225 psig.

Note: These tests are not to be repeated at installation.

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

Standard Features

- 115 VAC, 50/60 Hz, 1-Phase
- 12.3 minimum circuit ampacity
- 175 psig low side 10.3 total unit amps
- The purge is 25¾" high, 27½" wide and 21¾" deep
- 175 watt carbon tank heater
- 335 psig design pressure high side
- The purge uses an R-404A 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, which 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.

The panel features machine protection shutdown requiring manual reset for'

- Low oil flow
- Actuator drive circuit fault
- Extended compressor surge
- High condenser refrigerant pressure
- Low evaporator refrigerant temperature
- Low oil temperature
- Low differential oil pressure
- Excessive loss of communication
- Critical sensor or detection circuit faults
- Free-cooling valve closure failure (free cooling applications only)

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:

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

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

- Tracer SC™ building automation system (interface optional)
- A 4–20 mA or 2–10 Vdc signal from an external source (interface optional, control source not supplied by chiller manufacturer)
- The local operator interface (standard)
- 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 job site 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 as an option on all units. All low temperature surfaces are covered with ¾-inch Armaflex II or equal (thermal conductivity = 0.28 Btu/h·ft²), 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 be wye-delta, solid-state, or adaptive frequency drive in a NEMA 1 enclosure.

Medium-voltage starters (2,300–6,600 V) are available to unit-mount on most sizes in full-voltage, primary reactor, or autotransformer.

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 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 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

- Soft start, linear acceleration, coast-to-stop.
- Adjustable frequency from 38 to 60 hertz.
- AFD can be started without a motor connected.
- Output line-to-line and line-to-ground short-circuit protection.
- All control circuit voltages are physically and electrically isolated from power circuit voltage.
- The drive is rated for 480/60/3 input power, $\pm 10\%$, with a drive overload capability of 100% continuous to 150% for five seconds.
- Simple modular construction.
- Minimum efficiency of 97% at rated load and 60 hertz. 150% instantaneous torque available for improved surge control.
- Motor thermal overload protection 102% continuous, 140% for 1.5 seconds, 108% for 60 seconds.
- 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.

Chiller Unit Controller Features for all Trane AFDs

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

- Current limited to 100%
- Phase loss, reversal, imbalance protection
- 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.
- Output speed reference via IPC3 communication bus from the chiller controller to the AFD
- Motor overload protection
- Motor overtemperature protection
- Over/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

- 32°F to 104°F (0°C to 40°C) operating ambient temperature
- Humidity, 95% non-condensing
- Altitude to 3,300 feet (1,000 m), amperage derate of 1% per every 300 feet above 3,300 feet

Refrigerant-Cooled Trane AFD Design features

- A near unity displacement power factor of .96 or better at all loads.
- Full motor voltage is applied regardless of the input voltage.
- Integrated active rectification control of the building AC power assures low line-generated harmonics back to the user's power grid. The Trane AFD has 5% total demand distortion.



Trane optimizes the performance of homes and buildings around the world. A business of Ingersoll Rand, the leader in creating and sustaining safe, comfortable and energy efficient environments, Trane offers a broad portfolio of advanced controls and HVAC systems, comprehensive building services, and parts. For more information, visit www.Trane.com.

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