DAIKIN

DESIGN REFRIGERATION HOTELS HOT WATER TEMPERATURE RESTAURANTS HEATING VENTILATION OFFICE HOME SHOP Commercial PROCESS COOLING RESTAURANTS BANKS REFRIGERATION HEATING HOT WATER ICE RINK Residential EFFICIENCY PURIFICATION COMFORT OFFICE CINEMA HOTELS COOLING HEATING COOLING SCHOOLS Industrial PURIFICATION HEATING AIR BANKS HUMIDIFICATION COMFORT COOLING Solutions

Centrifugal Compressor Water Chillers

WSC, WDC, WCC, HSC

WSC : 200 TR to 1250 TR
WDC : 400 TR to 2500 TR
WCC : 1250 TR to 2700 TR

Table of Contents

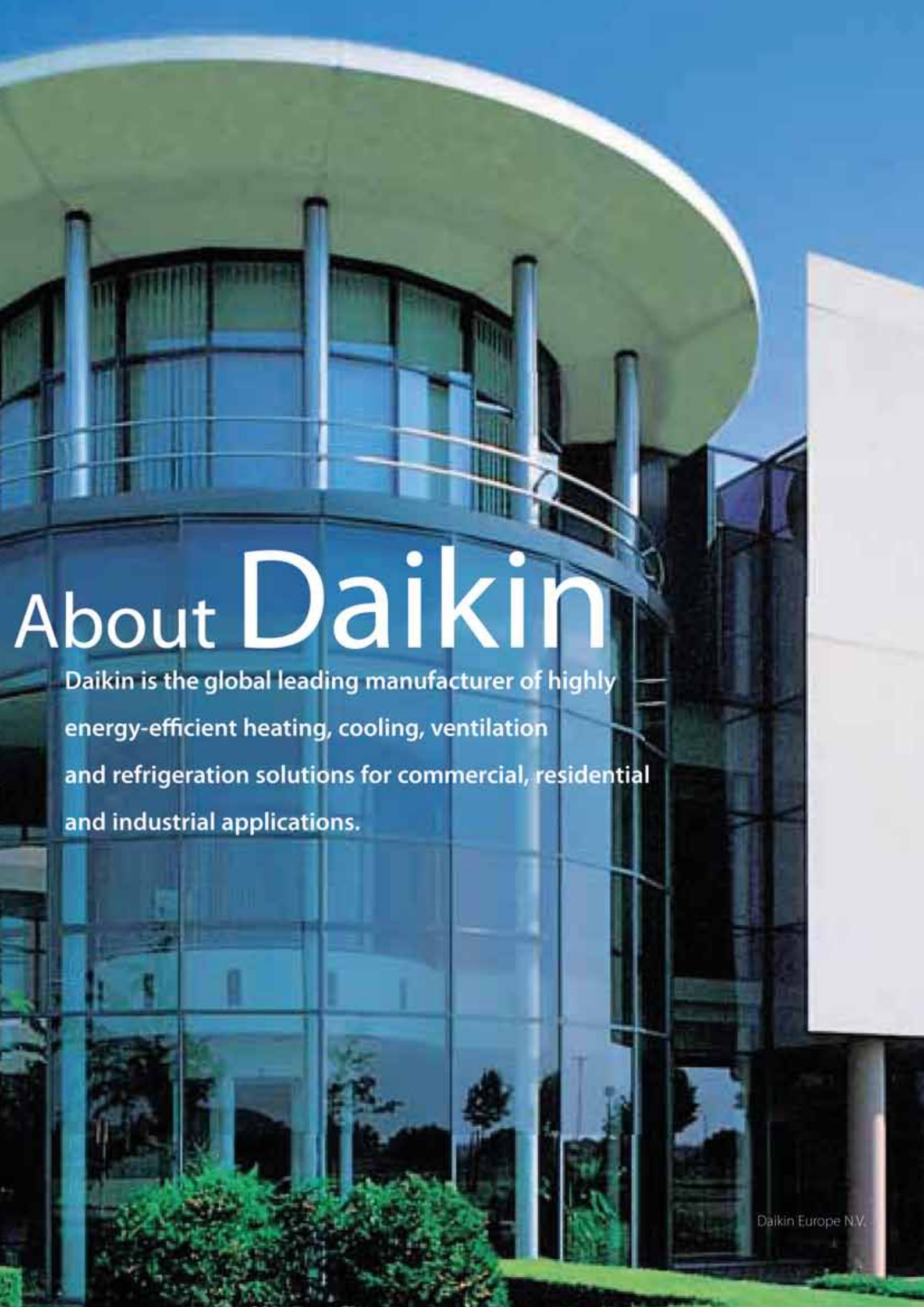
No matter how large your premises and whatever your air conditioning needs in climate control or process chilling and heating, there is a system that has proved worth in a multiplicity of situations - from industrial sites to retail warehouses, hotels and department stores.

The careful development of closely matched compressor/refrigerant combinations, has enabled Daikin to produce complete range of chillers - genuinely optimised for use with fan coil units and R-134a, R-407C and R-410A refrigerants.

Daikin chillers offer the ultimate in flexibility and control — a reflection of the advanced technology inherent within them. Unique in their precision, power, low operating noise, easy maintenance and low running costs, Daikin chillers represent the sure and safe route to an indoor environment that is comfortable, clean and consistent.

As a manufacturer that makes its own refrigerant and compressors, Daikin has total control at the production stage. Daikin also offers a complete range of air handling units to meet modern-day requirements for better indoor air quality and increased insulation standards.

It is this unique combination of advanced technology, experience and reliability that makes Daikin the obvious choice and long-term solution for the professional.



About Daikin

Daikin is the global leading manufacturer of highly energy-efficient heating, cooling, ventilation and refrigeration solutions for commercial, residential and industrial applications.

Daikin Europe N.V.

Opened in May 2009, the Daikin Applied Development Center is the world's most advanced facility for heating, ventilation and air conditioning (HVAC) research and development. The purpose of the new center is to develop and test advanced chiller, compressor and other HVAC technologies to reduce energy consumption and, ultimately the carbon footprint of the buildings where they will be used.

THE DAIKIN GROUP – GLOBAL LEADER IN HVAC SOLUTIONS

Daikin is a leader in using technologies that help preserve the environment, such as those that conserve energy and deliver high reliability to its customers. Daikin flexible applied systems deliver high efficiency for commercial, institutional and industrial buildings. The Applied Development Center allows the Daikin Group to fully leverage these strengths and accelerate the development of applied products that support the environment, energy savings, innovation, leadership and the best customer comfort. The Daikin Group is already a leading supplier for building projects pursuing LEED® certification.

Daikin Applied Development Center

Putting synergy to work for the environment and the best customer comfort

THE APPLIED DEVELOPMENT CENTER

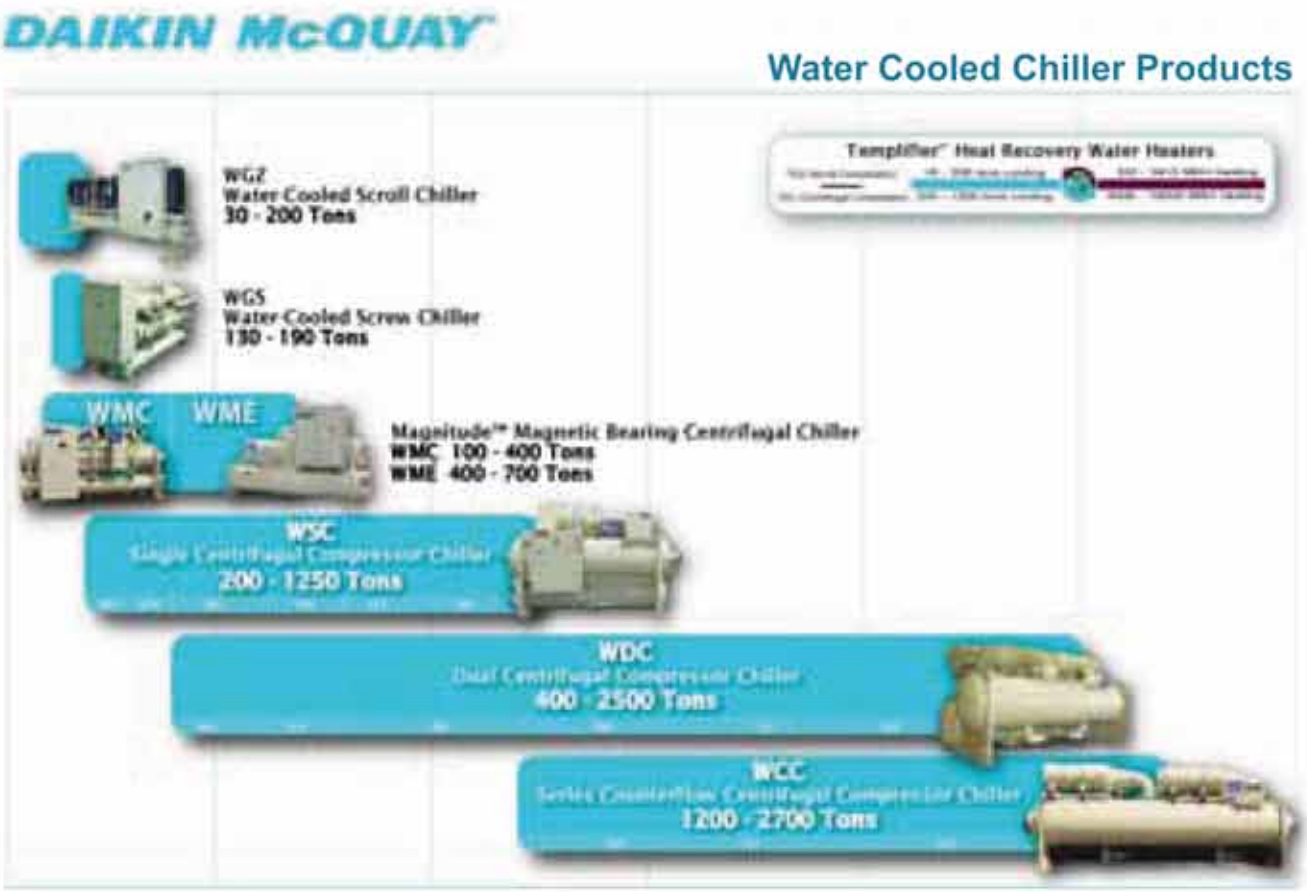
The 4,600-square-meter research center, located in Minneapolis, Minnesota, includes six test cells, with space for two additional cells in the future. Included are a worldwide range of electrical voltages, frequencies and a variety of procedures for testing ambient conditions (temperature and humidity). The Applied Development Center can simulate building, electrical and climate conditions of any location throughout the world, allowing the basic design development of new products to be centrally located in the facility. These 'global models' are then arranged into a suitable design to match market requirements at existing regional development centers throughout the world.

LEED® GOLD CERTIFICATION

Daikin officials have received Leadership in Energy and Environmental Design (LEED) Gold certification from the U.S. Green Building Council for the Applied Development Center. With more than 90 % of the building's energy generated by process loads (e.g. hot and cold water for chiller and compressor tests), energy savings are realized primarily by recovering 75 % of that energy and diverting it back into the system. Other environmental features include water-efficient landscaping, recycled construction waste, use of recycled content for interior surfaces, low-emitting sealants and locally purchased materials.

Introduction

Overview of Water-Cooled Product Line



Included in this manual:

Model WSC

- Capacity: 200-1250 tons (AHRI conditions)
- Excellent full load performance

Model WDC

- Capacity: 400-2500 tons (AHRI conditions)
- Outstanding part load performance
- Redundancy for increased reliability
- Some sizes available with 10/11kV50Hz power option

Model WCC

- Capacity: 1200-2700 tons (AHRI conditions)
- Two refrigerant circuits for true counterflow
- Outstanding full load performance
- Some sizes available with 10/11kV50Hz power option

Model HSC

- Recycles heat normally lost in cooling towers
- Produces simultaneous heating and cooling

Centrifugal Products included in separate manuals:

Magnitude™ Magnetic Bearing Compressor Chillers

Magnitude™ Model WMC

- Capacity: 145-400 tons
- Oil-free, frictionless compressor
- Excellent part-load performance
- See **CAT 602** for more information

Magnitude™ Model WME

- Capacity: 400-700 tons
- Oil-free, frictionless compressor
- Outstanding efficiency
- See **CAT 604** for more information

Templifier™ Model TSC Water Heater

- Recovers waste heat from process applications
- 5,000 - 19,000 MBH
- Hot water - 140°; COP as high as 7
- See **CAT Templifier** for more information

Features and Benefits

World-Class Design Leader

As part of Daikin Industries, a Fortune 1000 company, Daikin is the second largest air conditioning, heating, ventilating and refrigeration company in the world. We have earned a worldwide reputation for providing a full line of quality products and expertise to meet the demands of our customers. The engineered flexibility of our products allows you to fine tune your HVAC system to meet the specific requirements of your application. You benefit from lower installed and operating costs, high energy efficiency, quiet operation, superior indoor air quality (IAQ) and low cost maintenance and service.

Daikin Centrifugal Compressor Water Chillers are engineered for flexibility and performance - offering choices, options and features that provide the right solution for your specific application-and have been doing so for over fifty years. Some highlights of our world-class centrifugal design are:

Design Features

Excellent Performance

Daikin offeres a wide range of centrifugal vessel and component combinations to provide the right solution for your specific application. The single compressor WSC offers excellent full load performance, however, in most applications, chillers spend about 99% of their operating hours at part-load condidtions. Our dual compressor WDC chillers offer many attractive benefits, including outstanding part-load efficiency, and system redundancy similar to two separate chillers, with a lower total installed cost. WCC models also offer the dual compressor advantage but with counterflow vessels, and a separate refrigerant circuit for each compressor. WCC chillers excel at full load efficiency. Contact your Daikin representative for detailed information to decide which model is right for your job requirements.

Table 1: Centrifugal Models & Possible Applications

Application	Daikin Model
Cooling <1250 tons, most hours at full load	WSC
Cooling >1250 tons, most hours at full load	WCC
Cooling, most hours at part load	WDC
Heating Application	TSC Templifier™
Simultaneous Cooling and Heating	HSC
Optimized Part Load Performance	Optional VFD

Positive Pressure Design

Positive pressure systems offer numerous advantages over negative pressure design. In a negative pressure system, leaks allow air, moisture, and other contaminants to seep into system, which will gradually decrease performance, as well as cause corrosion which must be removed. The Daikin positive pressure design eliminates this worry, providing sustainable performance and trouble-free ownership for the life of the unit under normal operation.

Gear Driven Advantage

Daikin's precision-engineered gear driven design allows for lighter components, less vibration, and ability to select gear ratios that will provide the optimum impeller speed for your application. Older direct-drive designs must use large, heavy impellers to reach similar tip speeds, which cause more vibration and greater stress on shaft and motor during unexpected electrical interruptions.

The compact design and lighter weight components allow for efficient hydrodynamic bearings to be used. This means that during operation, the shaft is supported on a film of lubricant, with no shaft-to-bearing contact, providing theoretical infinte life bearings under normal circumstances. The design simplicity of the Daikin centrifugal compressors provides increased durability and reliable performance.

Smart Refrigerant

HFC-134a refrigerant contains no chlorine and has zero Ozone Depletion Potential (ODP), making it an environmentally superior alternative to other refrigerants such as HCFC-123. It also has an A1 ASHRAE Safety Classificiation - the lowest toxicity and flammability rating. R-134a provides the assurance of a safe, smart, and sustainable solution.

R-123 requires about 6 times the gas flow rate (cfm/ton) of R-134a, which means that the suction and discharge piping must also be six times larger. Using R-134a allows Daikin to provide you with a smaller footprint chiller.

Table 2: Refrigerant Comparison

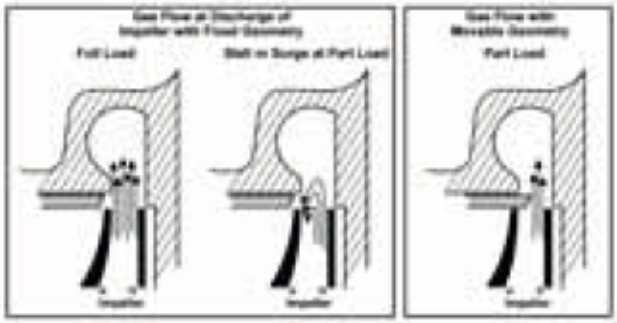
	HFC-134a	HCFC-123
ENVIRONMENTAL	No Ozone Depletion Potential	Ozone-depleting substance
	No Refrigerant Phase Out Date	Montreal Protocol requires phase out in new equipment by 2020; production cease by 2030
	HFC refrigerants qualify for 1 LEED point	HCFC refrigerants do not
INSTALLATION AND MAINTENANCE	Physically smaller, requiring less mechanical room space.	Requires larger refrigerant flow rate, with subsequent increase in component and unit size.
	In the event of a small leak, refrigerant escapes, allowing easy detection and repair	In the event of a small leak, air leaks into the chiller, making detection and repair difficult. Can degrade efficiency
	No purge unit required	Added cost and additional space for a purge unit. Must periodically purge unit to remove contaminants
	No oil change is required	Annual oil change is recommended
SAFETY	A1 ASHRAE Safety Classification -lowest toxicity/flammability rating	B1 ASHRAE Safety Classification- higher toxicity level

See www.DaikinApplied.com /Daikin/DesignSolutions/RefrigerantResourceCenter for references and more information.

Unmatched Unloading

Daikin pioneered the use of moveable discharge geometry to lower the surge point of centrifugal compressors. The point at which the compressor enters a stall or surge condition generally limits compressor unloading. Chillers with a fixed discharge will experience stall or surge at low loads due to refrigerant re-entering the impeller. When in a stall condition, the refrigerant gas is unable to enter the volute due to its low velocity and remains stalled in the impeller. In a surge condition the gas rapidly reverses direction in the impeller causing excessive vibration and heat. Daikin compressors reduce the discharge area as load decreases to maintain gas velocity and greatly reduce the tendency to stall or surge.

Figure 1: Fixed vs. Movable Discharge Geometry

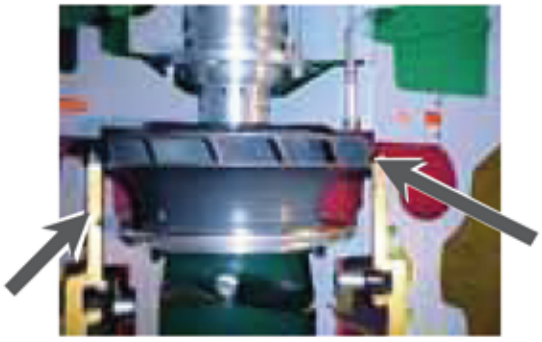


In Figure 1, above, the drawing on the left shows a cross-section view of the operation at full load of a unit with a fixed compressor discharge. At full load, a large quantity of gas is discharged with a fairly uniform discharge velocity as indicated by the arrows.

The center drawing shows a fixed compressor discharge at reduced capacity. Note that the velocity is not uniform and the refrigerant tends to reenter the impeller. This is caused by low velocity in the discharge area and the high pressure in the condenser, resulting in unstable surge operation and with noise and vibration generated.

The following cutaway picture shows the unique Daikin movable discharge geometry. As the capacity reduces, the movable unloader piston travels inward, reducing the discharge cross section area and maintaining the refrigerant velocity. This mechanism allows our excellent unloading capacity reduction.

Figure 2: Movable diffuser closes impeller discharge area as load decreases.



Controls Flexibility

MicroTech II® controls with our Open ChoicesTM feature allow easy integration with the BAS of choice using LonTalk®, BACnet® or Modbus® protocol

Retrofit Flexibility

Easy to retrofit with flexible knock-down options. See page 55 for details.

Trouble-Free Startup

All Daikin chillers are factory tested on AHRI qualified computer-controlled test stands. Each chiller is run-tested under load conditions for a minimum of one hour with evaporator and condenser water flow at job conditions (excluding glycol applications). Operating controls are checked and adjusted, and the refrigerant charge is adjusted for optimum operation and recorded on the unit nameplate. Units operating with 50-Hz power are tested with a 50-Hz power supply. The testing helps ensure correct operation prior to shipment, and allows factory calibration of chiller operating controls.

All domestic Daikin centrifugal chillers are commissioned by Daikin Factory Service personnel, or by authorized and experienced Daikin startup technicians. This procedure helps ensure that proper starting and checkout procedures are employed and helps in a speedy commissioning process, giving you confidence that your chiller is operating as expected.

Lubrication System

A separately driven electric oil pump assembly supplies lubrication at controlled temperature and pressure to all bearing surfaces and is the source of hydraulic pressure for the capacity control system.

The control system will not allow the compressor to start until oil pressure, at the proper temperature, is established. It also allows the oil pump to operate after compressor shutdown to provide lubrication during coast-down.Lubricant from the pump is supplied to the compressor through a water-cooled, brazed-plate heat exchanger and single or dual five-micron oil filters internal to the compressor. All bearing surfaces are

Dual Compressor Centrifugal Chillers

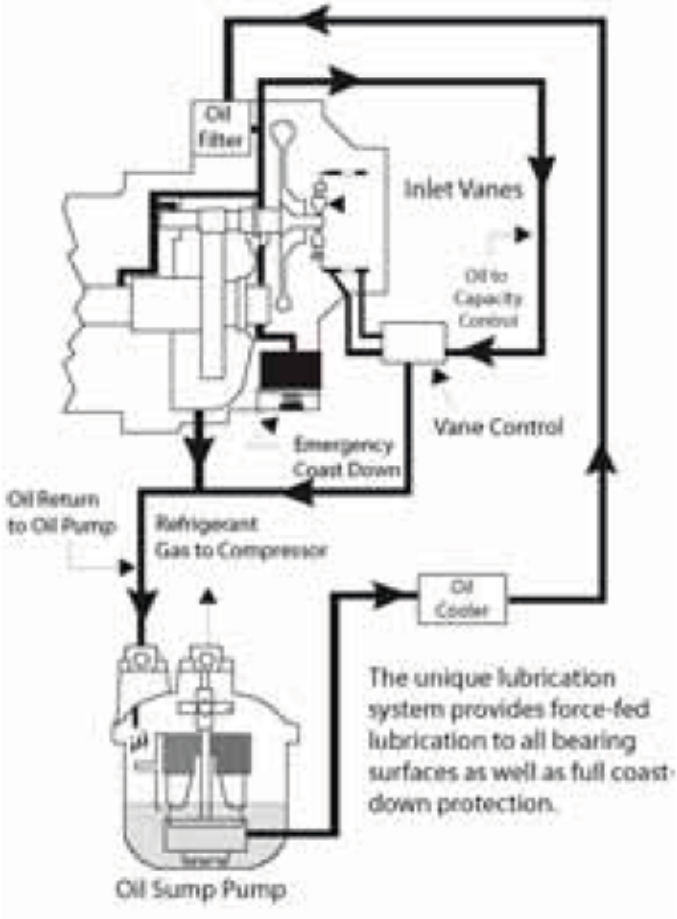
pressure lubricated. Drive gears operate in a controlled lubricant mist atmosphere that efficiently cools and lubricates them.

Lubricant is made available under pressure from the compressor oil filter to the unit capacity control system and is used to position the inlet guide vanes in response to changes in leaving chiller water temperature.

If a power failure occurs, an emergency oil reservoir provides adequate lubrication flow under pressure, and prevents damage that could occur during the coast-down period with the oil pump stopped.

Since the Daikin chillers are positive pressure, there is no need to change the lubricant or filter on a regular basis. As with any equipment of this type, an annual oil check is recommended to evaluate the lubricant condition.

Figure 3: Lubrication System Schematic



Enhanced Surge Protection

When centrifugal compressors operate at part load, the volume of refrigerant gas entering the impeller is reduced. At the reduced flow, the impeller's capacity to develop the peak load head is also reduced. At conditions of low refrigerant flow and high compressor head (pressure difference), stall and/or surge can occur (a stall is gas static in the impeller, a surge condition is gas rapidly reversing direction through the impeller). A number of things can contribute to this condition including inadequate maintenance of condenser tube cleanliness, a cooling tower or control malfunction, or unusual ambient temperatures among others.

For these abnormal conditions, Daikin compressor designers have developed a protective control system that senses the potential for a surge, looks at the entire chiller system operation and takes corrective action if possible; or stops the compressor, to help prevent any damage from occurring. This protection is provided as standard on all Daikin centrifugal compressors.

Dual Compressor Experience

Daikin is the expert when it comes to dual centrifugal compressor technology. We have been successfully building dual compressor centrifugal chillers since 1971. Daikin is the only company that builds them with either a single refrigerant circuit (Model WDC) or two refrigerant circuits (Model WCC).

Benefits of Dual Compressor Chillers

Superior Efficiency

When coupled with a variable frequency drive, the extremely efficient Dual Compressor Chillers are considerably more efficient than single compressor chillers in the same size range, with IPLVs (Integrated Part Load Value) as low as 0.3 kW per ton. IPLV conditions are set by AHRI and subject to stringent testing. Insist on AHRI-certified IPLV efficiency when making efficiency comparisons.

The Redundancy Feature

Daikin dual centrifugal chillers have two of everything connected to the evaporator and condenser - two compressors, two lubrication systems, two control systems, and two starters.

If any component on a compressor system fails, the component can be removed or repaired without shutting down the other compressor; providing an automatic back-up with at least 60 percent of the chiller design capacity available on WDC units and 50 percent on WCC units.

Redundancy is also built into the distributed control system, which consists of a unit controller, a compressor controller for each compressor and an operator interface touch screen. The chiller will operate normally without the touch screen being functional. If a compressor controller is unavailable, the other compressor will operate normally and handle as much of the load as possible.

Lower Installed Costs

The redundancy feature pays off in lower installed costs. An example of how to incorporate dual compressor chillers into a system requiring redundancy:

Job requirement: 1,200 tons (4200 kW), 50% Backup

WSC Single Compressor Chillers	WDC Dual Compressor Chillers
(2) 600 ton (2100 kW) On Line Units	(2) 750 ton (2100 kW) Units with
+(1) 600 (2100 kW) ton Standby Unit	1,200 (4200 kW) On Line tons *
1,800 ton (6300 kW) Installed Capacity	1500 ton (5250 kW) Installed Capacity

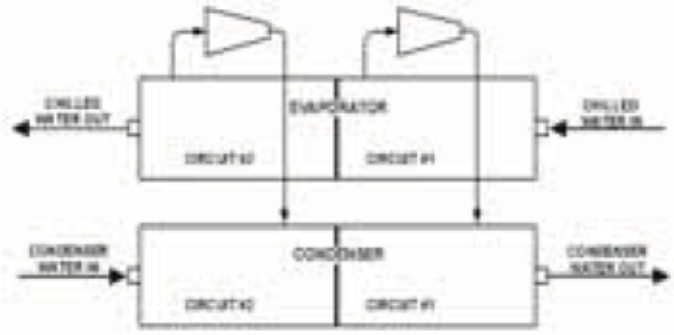
*One 750-ton (2100 kW) dual chiller running on two compressors for 750 tons (2100 kW), plus one 750-ton (2100 kW) dual chiller running on one compressor for 60% of 750 tons (2100 kW) = 450 tons (1575 kW), for a total of 1200 tons (4200 kW) on any 3 of the 4 total compressors.

The elimination of the extra pumps, valves, piping, controls, rigging, and floor space can result in as much as a 35% reduction in the installation cost for a chiller plant, plus the savings on the chillers themselves.

Dual Compressor Chiller Overview

There are subtle but important differences between the single circuit WDC and two circuit WCC chillers.

Dual Circuit WCC Counterflow Chillers



These chillers have a separate refrigerant circuit for each compressor. They are available in single pass only. They provide the high full load efficiency advantage of two separate chillers arranged for counterflow operation in a single, compact unit.

Single Circuit WDC Chillers

These chillers have a single-refrigerant circuit for the evaporator and condenser with two compressors running in parallel and are available in one, two or three-pass configurations. Their salient feature is that at single-compressor, part load operation, the running compressor can utilize the entire chiller's heat transfer surface, providing outstanding part load performance.

Application of Dual Compressor Chillers

Designers and owners must decide which chiller type, or combination of chiller types, is best for their installation. Considerations include first cost, system efficiency, system reliability, space requirements, and total owning costs.

Use WCC chillers when:

- Project requirement is lowest kW per ton performance at full load with high electrical demand charges.
- Project has a large central plant where cycling chillers for system capacity reduction is expected (three or more chillers).
- High chilled water delta-T and low water pressure drops are desired.
- Built-in redundancy is required. A single compressor will provide 50% of the unit's full load capacity.
- High efficiency and large capacity is required with series flow. Use two WCC units in series-counterflow in the 3,000 to 4,000 ton range.

Use WDC chillers when:

- Project requirement is overall lowest energy consumption with best part load performance.
- Project has smaller chilled water plant where unit unloading is expected versus cycling of chillers associated with large multi-chiller plants.
- Floor space is limited (16-foot vessel length compared to 20-foot for WCC).
- Two or three pass vessels are required, typical of retrofit applications.
- Built-in redundancy is required. A single compressor will provide 60% of the unit's full load capacity.

Use a combination of WDC and WCC chillers when:

- Peak overall system efficiency is important; for example, use three WCC and one WDC chiller, all in parallel. The WCC units are optimized for running at full load and the WDC is optimized for part load operation. The WCC units cycle on and off and the WDC unit (consider variable frequency drives on this unit) trims the load, running between five and one hundred percent capacity.

Why a Compressor Motor Failure Will Not Contaminate the Common Refrigerant Circuit on WDC dual chillers

Some people are concerned with the result of a motor burnout on a single-circuit dual compressor chiller. This is not a problem on the Daikin WDC chillers because of compressor construction and chiller layout.

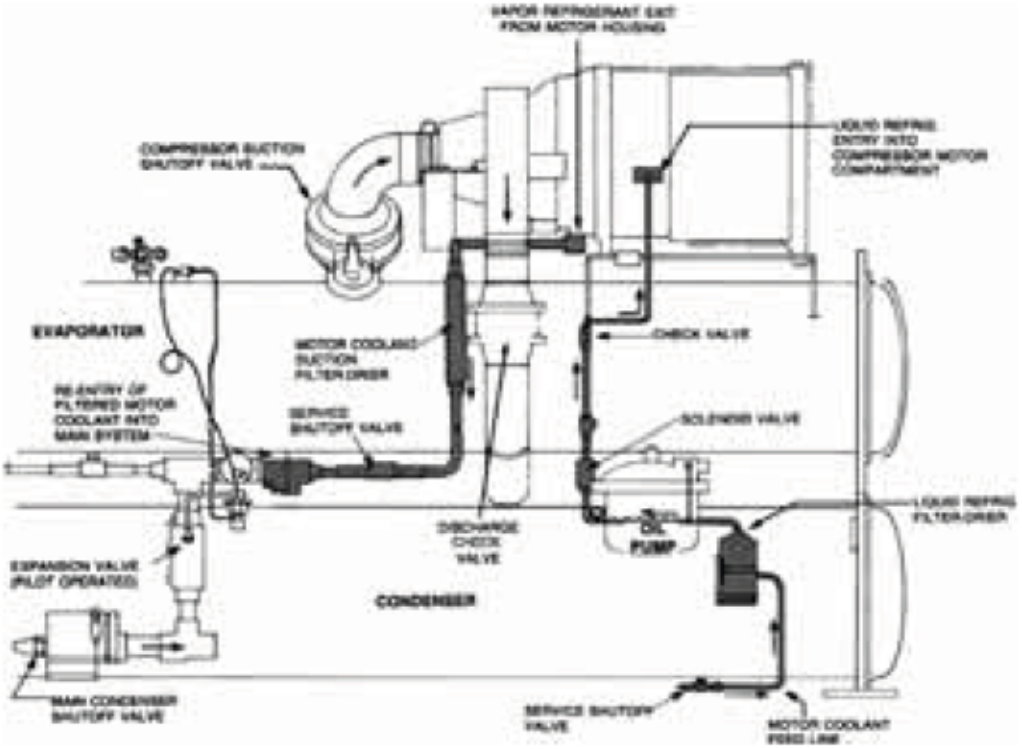
The compressor motor is isolated from the main refrigerant flow circuit so that any contaminants generated by a motor failure will not pass into the main refrigerant circuit. Moisture, acid and/or carbon particles will be automatically trapped within the compressor's dedicated coolant feed and exit lines.

Internally, the compressor motor compartment is separated and sealed from the main refrigerant compression chamber. A double shaft seal on the motor side of the gear housing prevents cross flow of refrigerant along the motor shaft. The motor coolant feed line is equipped with both a solenoid valve and a check valve. These mechanical components, plus the higher pressure of the liquid refrigerant, prevent back feed into the main refrigerant system. Refrigerant vapor exiting the motor compartment must pass through a high pressure drop filter-drier, sized to immediately plug up and seal off the motor compartment. Both the coolant feed and return lines are equipped with manual shutoff valves to permit component service.

Over 30 years of field experience have proven the reliability of these compressor motors. Despite the reliability inherent in the motor design and the protective control, electrical distribution system faults and lightning strikes can occur that are beyond the control of the most conscientious designer. The coolant protective system protects the unit charge from being contaminated.

Special WDC Warranty: In the unlikely event of a motor burnout, the chiller refrigerant charge will not be contaminated. This is so well proven that it is guaranteed for five years. In areas supported by Daikin Factory Service, if a motor burnout occurs in one compressor and contaminates the refrigerant circuit, any resultant damage to the other compressor will be repaired and the refrigerant charge replaced at no cost to the customer for parts and labor. The terms of the original chiller warranty apply to the original burned out compressor.

Figure 4: Motor Cooling



Efficiency

Chillers usually spend 99% of their operating hours under part load conditions, and most of this time at less than 60% of design capacity. One compressor of a dual WDC chiller operates with the full heat transfer surface of the entire unit. For example, one 500-ton (1,750 kW) compressor on a 1,000 ton (3,500 kW) dual chiller utilizes 1,000 tons (3500 kW) of evaporator and condenser surface. This increases the compressor's capacity and also results in very high efficiency.

Typical efficiencies for a WDC dual chiller, taken from a selection computer run, look like this:

Full load efficiency: 0.550 kW per ton (6.5 COP)

60% load, one compressor: 0.364 kW per ton (9.6 COP)

IPLV: 0.415 kW per ton (8.5 COP)

The addition of VFDs to the WDC dual compressor chiller produces an astonishing AHRI certified IPLV of 0.340 for the above case. Specific selections can vary up or down from this example. IPLV is defined in the Selection section of this manual beginning on page 28

WCC chillers, with their counterflow design, excel at full load efficiency. Each of the two compressors operates at a lower head (pressure differential) than single compressor chillers in parallel. With any pump or compressor, lower head means lower power for a given flow. As shown on the right, the #2 (downstream compressor) makes 42 F water but has only 89 F condenser water leaving instead of 95 F typical of a single compressor unit. The #1 compressor has 95 F condenser water leaving, but only has to make 47.6 F chilled water.

The Replacement Market Advantage

- Bolt-together construction on single and dual compressor chillers along with factory disassembly available as an option simply the tough entrance situations.
- Put 20% or more tons in the same footprint.
- Add dual compressor redundancy.
- Greatly reduce chiller energy consumption.
- Install a refrigerant with no phase-out date.
- Opens many options for multiple chiller plants using WSC, WDC and WCC combinations.

Heat Recovery Models

Heat Recovery Models

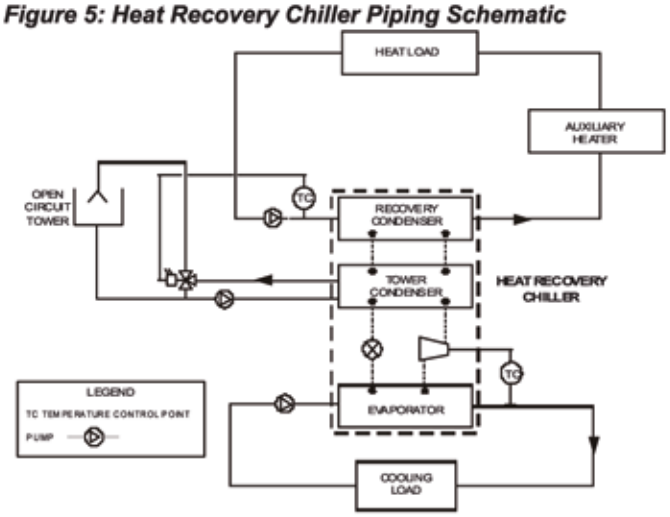
For decades, Daikin has pioneered the use of heat recovery chillers and the unique Daikin Templifier Heat Pump Water Heater to reduce energy costs. These products have become more important than ever with the current emphasis on total building efficiency. ASHRAE Efficiency Standard 90.1 mandates the use of heat recovery equipment of this type in a wide range of buildings.

Heat Recovery Chillers

Model HSC heat recovery chillers, with a single compressor, have a single condenser with split bundles, i.e., two separate water passages divided by separate water heads as shown in the photograph to the right. The inboard water connections are connected to the cooling tower, the other water side is connected to the heating system.

The economic feasibility of hot water generated with these units depends on heating and cooling load profiles and on the relative cost of the available energy sources. A compressor's kW per ton is heavily influenced by the pressure head it is pumping against. During heat recovery operation, the entire cooling load is operating against the high head required by the hot water temperature. For this reason, it is desirable to maximize the percentage of the total rejected heat used for the heating load. Daikin's economic evaluation program, Energy Analyzer , available on CD from your local Daikin sales office, is the perfect tool to determine the economic feasibility of using this proven technology.

Figure 5: Heat Recovery Chiller Piping Schematic



Templifier Heat Pump Water Heaters

Model TSC: 5,000 to 19,000 MBH

The Model TSC Templifier was developed in the 1970s, after the 1973 oil embargo, as a device to replace fossil-fired water heaters with electric heaters. The concept was simple; direct a stream of warm waste heat to the evaporator of a refrigeration unit, amplify the temperature of the heat through the compression cycle, and then deliver the heat from the condenser, at a higher useful temperature, to a heating load.

The flow diagram shown to the left illustrates just how the Templifier unit is placed in a chilled water system. The decision to include a Templifier water heater is almost always a financial one. Evaluation of load profiles, energy costs, and owning costs is made simple by using the Daikin Energy Analyzer evaluation program to determine if the return on investment meets the owner's requirements.

When there is sufficient waste heat available, Templifier units can be very attractive where fossil fuels are not available, or where their use is restricted due to pollution problems or other reasons. Compared to electric resistance heating, the energy cost for a Templifier unit to heat domestic water, for example, could be 7 to 8 times less!

Where to Use Templifier Water Heaters:

Typical Building Types	Typical Applications
Hotels/Motels	Space Heating
Health Care	Outside Air Heating
Athletic Facilities	Reheat
Resorts	Service Hot Water
Schools	Laundries
Food Service	Kitchens
Nursing Homes	

Table 3: Typical COP's

Hot Water Temperatures	110°F	120°F	130°F	140°F
COP (Based on 85°F off Chiller to Templifier)	8.3	6.8	6.0	4.5

Figure 6: Templifier Heat Pump Water Heater Schematic

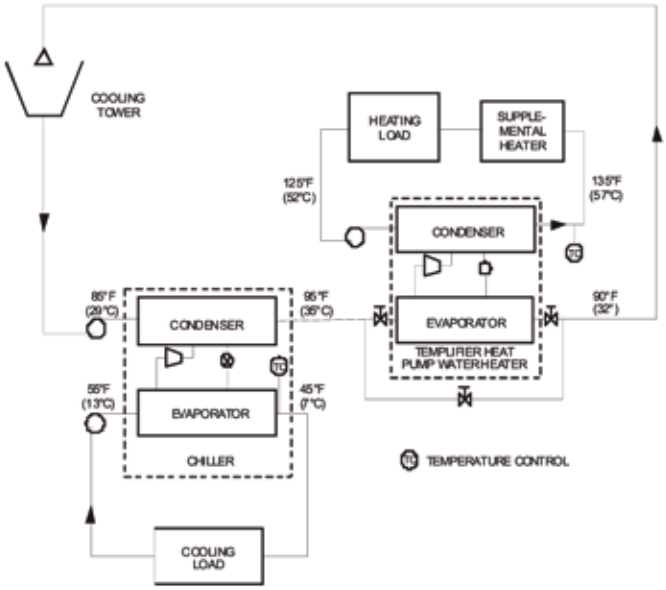
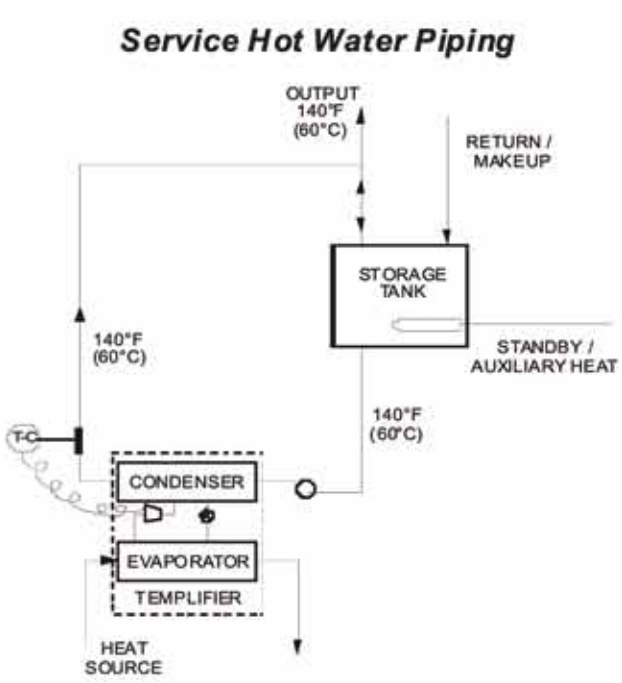
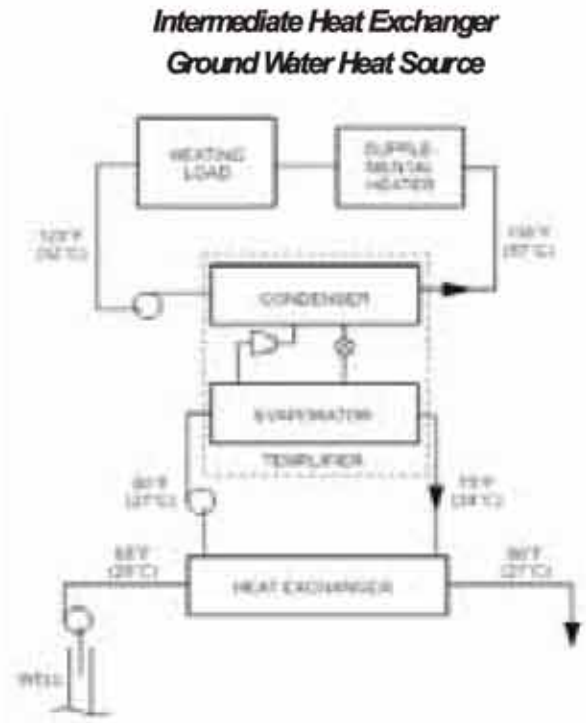


Figure 7: Typical Templifier Applications





Controls

MicroTech® II Controls

Daikin Centrifugal chillers are equipped with the proven reliability of the MicroTech® II controls system with touch-screen interface. The control system is designed for easy and intuitive operation, and configured for efficient and reliable operation. Plus, Daikin's Open Choices™ feature allows integration with your building automation system (BAS) through an optional communication module
(see Options and Accessories section, page 52).

Designed with the System Operator in Mind

Reliable, economic use of any chiller depends on an easy operator interface. That's why operation simplicity was one of the primary considerations in the development of the MicroTech®II controller and Operator Interface Touch-Screen (OITS). The 15-inch color touch-screen is mounted on a fully adjustable arm. The chiller is graphically displayed, with key operating parameters viewable on the screen. Alarm history and operation setpoints are easily accessed through intuitive touch-screen buttons. The chiller operating manual is also viewable on the touch screen and can be downloaded via USB.

MicroTech II Controls Enhance Operating Economy

Many features have been integrated into MicroTech II controls to ensure optimum operating economy. In addition to replacing normal relay logic circuits, we've enhanced the controller's energy saving capabilities with the following features:

- **Direct control of water pumps** Optically isolated, digital output relays provide automatic lead-lag of the evaporator and condenser pumps, permitting pump operation only when required.
- **User-programmable compressor soft loading** Prevents excessive power draw during pull down from high chilled water temperature conditions.
- **Chilled-water reset** Reset the leaving water temperature based on the return water temperature. Raising the chilled water setpoint during periods of light loads dramatically reduces power consumption.
- **Demand limit control** Maximum motor current draw can be set on the panel, or can be adjusted from a remote 4-20ma or 1-5 VDC BAS signal. This feature controls maximum demand charges during high usage periods.
- **Condenser water temperature control** Capable of four stages of tower fan control, plus an optional analog control of either a three-way tower-bypass valve or variable speed tower-fan motor. Stages are controlled from condenser-water temperature. The three-way valve can be controlled to a different water temperature or track the current tower stage. This allows optimum chilled water plant performance based on specific job requirements.
- **Staging Options (Multiple Chiller Installations)** The MicroTech II controller is capable of compressor staging decisions and balancing compressor loads between up to four WSC,WDC or WSC Daikin chillers using defaults or operator-defined staging.
- **Plotting Historic Trends** Past operation of the chiller can be plotted as trend lines and even downloaded to a spreadsheet for evaluation and analysis.

Proactive Controls

MicroTech II controls constantly monitor chiller status, and automatically take proactive measures to relieve abnormal conditions or shut the unit down if a fault occurs. For example, if a problem occurs in the cooling tower and discharge pressure starts to rise, the controller will automatically hold the load point and activate an alarm signal. A further rise in pressure will initiate compressor unloading in an effort to maintain the setpoint pressure. If the pressure continues to rise, the unit will shut off at the cutout pressure setting to protect the unit.

Table 4: Daikin MicroTech® II Controls Features and Benefits

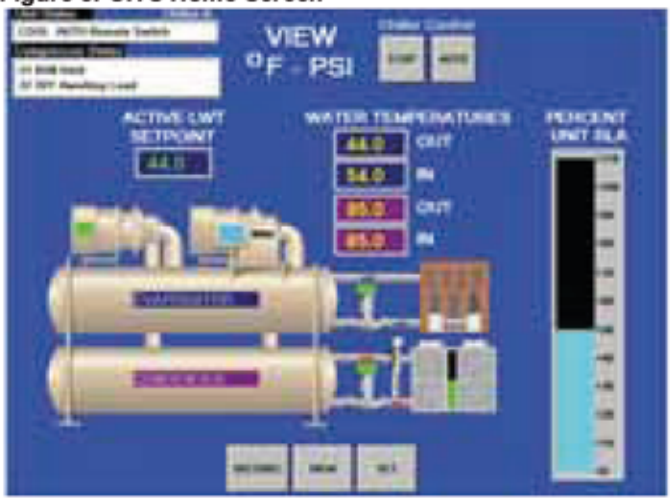
FEATURE	BENEFIT
Open Choices™ Option	Easy integration into a building management system via a factory or field-installed module communicating with BACnet , LONMARK or Modbus protocols.
Touch-screen Interface	Easy to read, adjustable, large 15-inch, color touch screen; See chiller operation at a glance; easily view and change setpoints
Alarm/Fault History and Trend Logging	Historical trend data can be downloaded from an onboard USB port
Precise ± 0.2 °F chilled water controls	Provides stability in chilled water system
Proactive Controls	Proactive correction of "unusual conditions" allows chiller to stay online; activates alarm and modifies chiller operation to provide maximum possible cooling
Integrated lead/lag pump control	Automatic control of chilled water and condenser water pumps; permits pump operation only when required
Condenser Water Temperature Control	Provides tower fan control /modulation based on system conditions
Multiple language capability - Metric or IP units of measure	Great asset for world-wide applications

Alarm History for Easy Troubleshooting

The controller memory can retain and display the cause of the current fault and the last twenty-five fault conditions. This feature is extremely useful for troubleshooting and maintaining an accurate record of unit performance and history.

The Home Screen shown below is the primary viewing screen on the Operator Interface Touch Screen (OITS). It gives real-time data on unit status, water temperatures, chilled water setpoint and motor amp draw.

Figure 8: OITS Home Screen

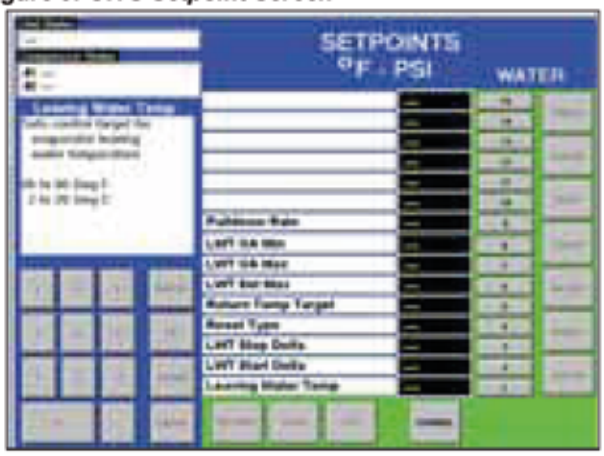


If an alarm occurs, a red button appears on the screen that leads to the Active Fault Screen whichgives complete fault information so that the fault can be corrected and cleared.

Changing Setpoints

Changing setpoints is easy with the MicroTech II control. For example, to change the chilled water setpoint, press SET button from any screen, then press WATER and this screen appears, now press button #1, Leaving Water Temperature, and you are ready to input a password and a new value. (The controller features a three-level password security system to provide protection against unauthorized use.)

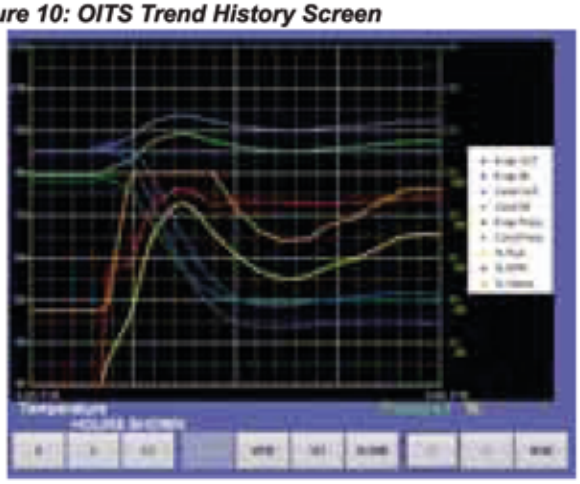
Figure 9: OITS Setpoint Screen



Trend Logging

Ever wonder how your chiller performed last night? Were you holding the correct chilled water temperature? What kind of cooling load did the chiller have? The Daikin MicroTech II controller can provide the answers, thanks to its huge memory, and plot water temperatures, refrigerant pressures, and motor load data. These values can also be downloaded through a convenient USB port (located on the unit control panel) into a spreadsheet for detailed evaluation and analysis.

Figure 10: OITS Trend History Screen



WDC/WCC Chiller Controls

Dual compressor model centrifugal chillers feature a MicroTech II unit controller and a separate controller for each compressor. This distributed control scheme allows the operation of each compressor independently from the other. Performance data for each compressor is monitored separately by each controller, and can be controlled and monitored on the interface panel.

Compressor staging and the load balance function are standard features of MicroTech II controllers. Smart scheduling starts the compressor with the fewest number of starts first, and will only start remaining compressors when sufficient load has been established. The staging function will stop the compressor with the most run-hours as the load decreases to single compressor range. During two-compressor operation, the load balance function will equalize the load between each compressor, providing optimum unit efficiency.

Versatile Communications For Even More Control

For flexibility there are three ways to interface with the MicroTech II controller:

- Direct entry via Operator Interface Touch-Screen.
- Direct entry as above, plus remote digital and analog input/output signals for certain functions such as enable run input, alarm signal output, chilled water reset and load limiting, outputs for pump and tower fan control, for variable speed tower fan and/or tower bypass valve.

- Interface with a building automation system (BAS) with optional modules, communicating directly with BACnet, LONMARK or Modbus protocols.

Building Automation Systems

All MicroTech II controllers are capable of communication with BAS, providing seamless integration and comprehensive monitoring, control, and two-way data exchange with industry standard protocols such as LONMARK , Modbus or BACnet .

Open Choices Benefits

- Easy to integrate into your building automation system
- Factory- or field-installed communication modules
- Comprehensive point list for system integration, equipment monitoring and alarm notification
- Comprehensive data exchange

Integration Made Easy

Daikin unit controllers strictly conform to the interoperability guidelines of the LONMARK Interoperability Association and the BACnet Manufacturers Association. They have received LONMARK certification with the optional LONWORKS communication module.

Protocol Options

- BACnet MS/TP
- BACnet IP
- BACnet Ethernet
- LONWORKS (FTT-10A)
- Modbus RTU

The BAS communication module can be ordered factory-mounted with your chiller, or can be field-installed at any time after the chiller is installed.

Electric Power Options

In order for the BAS to read the full complement of power data on low and medium voltage solid state, across-the-line, and wye-delta starters, the optional Field Metering Package must be ordered with the chiller. Otherwise the BAS will only read the average unit amps. This power data is not available to a BAS on all other starter voltages and types.

Table 5: Typical BAS Read/Write Data Points

Typical Data Points[1] (W = Write, R = Read)					
Active Setpoint	R	Cond EWT	R	Evap Water Pump Status	R
Actual Capacity	R	Cond Flow Switch Status	R	Heat Recovery EWT	R
Capacity Limit Output	R	Cond LWT	R	Heat Recovery LWT	R
Capacity Limit Setpoint	W	Cond Pump Run Hours	R	Heat Setpoint	W
Chiller Enable	W	Cond Refrigerant Pressure	R[2]	Ice Setpoint	W
Chiller Limited	R	Cond Sat. Refrigerant Temp	R[2]	Liquid Line Refrigerant Pressure	
Chiller Local/Remote	R	Cond Water Pump Status	R	Liquid Line Refrigerant Temp	R
Chiller Mode Output	R	Cool Setpoint	W	Maximum Send Time	W
Chiller Mode Setpoint	W	Current Alarm	R	Minimum Send Time	W
Chiller On/Off	R	Default Values	W	Network Clear Alarm	W
Chiller Status	R	Evap EWT	R	Oil Feed Pressure	R
Compressor Discharge Temp	R	Evap Flow Switch Status	R	Oil Feed Temp	R
Compressor Percent RLA	R	Evap LWT for Unit	R	Oil Sump Pressure	R
Compressor Run Hours	R	Evap LWT for Compressor	R	Oil Sump Temp	R
Compressor Select	W	Evap Pump Run Hours	R	Outdoor Air Temp	
Compressor Starts	R	Evap Refrigerant Pressure	R2	Pump Select	W
Compressor Suction Line Temp	R	Evap Sat. Refrigerant Temp	R2	Run Enabled	R

1.) Data points available are dependent upon options selected
2.) Per compressor

Application Considerations

Location

These chillers are intended only for installation in an indoor or weather protected area consistent with the NEMA 1 rating on the chiller, controls, and electrical panels. If indoor sub-freezing temperatures are possible, special precautions must be taken to avoid equipment damage. Equipment room temperature for operating and standby conditions is 40°F-122°F (4.4°C-50°C)

⚠ CAUTION

Daikin Centrifugal Chillers are intended only for installation in indoor areas protected from temperature extremes. Failure to comply may result in equipment damage and may void the manufacturer warranty.

Operating/Standby Limits

Table 6: Operating/Standby Limits

Equipment room operating temperature:	40°-104°F (4.4°-40°C)
Equipment room temperature, standby, with water in vessels and oil cooler:	40°-104°F (4.4°-40°C)
Equipment room temperature, standby, without water in vessels and oil cooler:	0°F-122F (-18°C-50°C)
Maximum entering condenser water temperature, startup:	design + 5°F (2.7°C)
Maximum entering condenser water temperature, operating:	job-specific design temperature
Minimum entering condenser water temperature, operating:	see this page.
Minimum leaving chilled water temperature:	38°F (3.3°C)
Minimum leaving chilled fluid temperature with correct anti-freeze fluid:	15°F (9.4°C)
Maximum entering chilled water temperature, operating:	90°F (32.2°C)
Maximum oil cooler or VFD entering temperature:	80°F (26.7°C)
Minimum oil cooler/VFD entering temperature:	42°F (5.6°C)

Piping

Piping must be adequately supported to remove weight and strain on the chiller's fittings and connections. Do not use PVCor CPVC piping. Be sure piping is adequately insulated. Install a cleanable 20-mesh water strainer upstream of the evaporator and condenser. Install enough shutoff valves to permit draining water from the evaporator or condenser without draining the complete system.

⚠ CAUTION

Freeze Notice: The evaporator and condenser are not self-draining. Both must be blown out to completely remove water to help prevent freeze-up.

Include thermometers and pressure gauges at the chiller inlet and outlet connections and air vents at the high points of piping. The water heads can be interchanged (end for end), allowing water connections to be made at either end of the unit. Use new head gaskets when interchanging water heads. When water pump noise is objectionable, use rubber isolation sections at both the inlet and outlet of the pump. Vibration eliminator sections in the condenser inlet and outlet water lines are not normally required. Where noise and vibration are critical and the unit is mounted on spring isolators, flexible piping and conduit connections are necessary. If not factory installed, a flow switch or pressure differential switch must be installed in the leaving chilled water line in accordance with the flow switch manufacturer's instructions.

Note: Victaulic connections are AWWA C-606. Field supply transitions if Victaulic brand AGS® (Advanced Groove System) type grooves are used on the field piping.

Optimum Water Temperatures and Flow Rates

A key to improving energy efficiency for any chiller is minimizing the lift, or pressure difference, between the compressor suction and discharge pressures. Reducing the lift reduces the compressor work, and hence its energy consumption per unit of output. The chiller typically has the largest motor of any component in a chilled water system.

Higher leaving chilled water temperatures

Warmer leaving chilled water temperatures will raise the compressor's suction pressure and decrease the lift, improving efficiency. Using 45 F (7.0 C) leaving water instead of 42 F (5.5 C) will make a significant improvement.

Evaporator temperature drop

The industry standard has been a ten-degree temperature drop in the evaporator. Increasing the drop to 12 or 14 degrees will improve the evaporator heat transfer, raise the suction pressure, and improve chiller efficiency. Chilled water pump energy will also be reduced.

Condenser entering water temperature

As a general rule, a one-degree drop in condenser entering water temperature will reduce chiller energy consumption by two percent. Cooler water lowers the condensing pressure and reduces compressor work. One or two degrees can make a noticeable difference. The incremental cost of a larger tower can be small and provide a good return on investment.

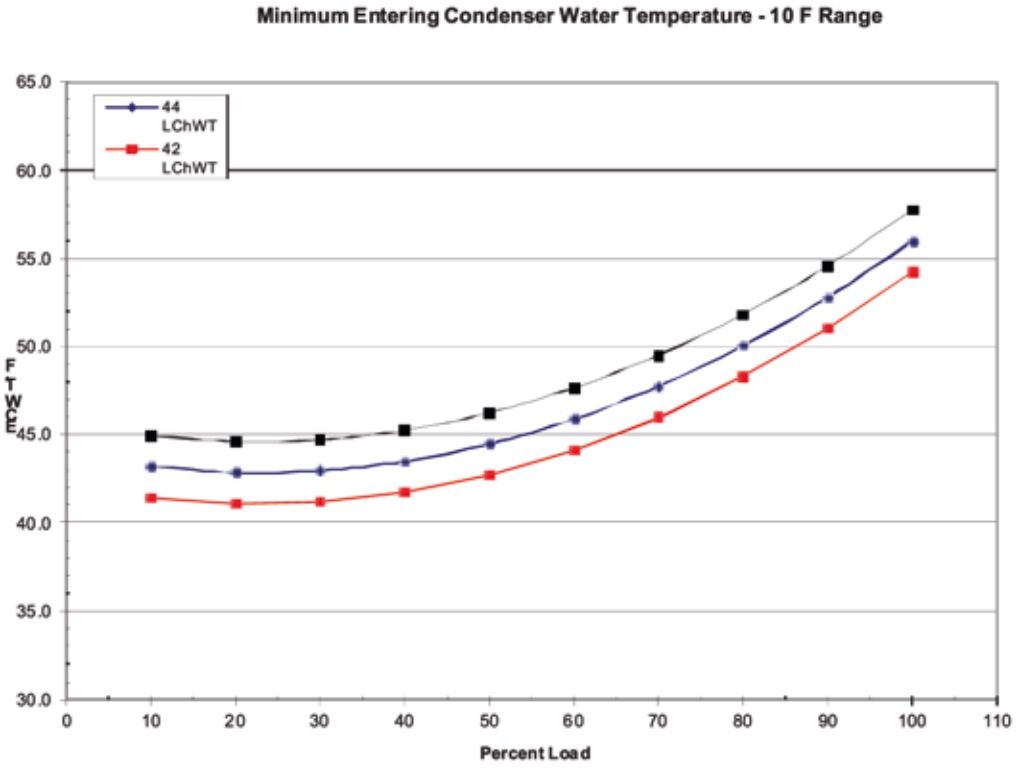
Minimum Condenser Water Temperature Operation

When ambient wet bulb temperatures are lower than design, the condenser water temperature can be allowed to fall. Lower temperatures will improve chiller performance.

Up to 600 Tons

Daikin centrifugal chillers up to 600 Tons are equipped with electronic expansion valves (EXV) and will start and run with entering condenser water temperatures as low as shown in Figure 11 (based on a 10 degree F condenser Delta-T) or as calculated from the following equation on which the curves are based

Figure 11: Minimum Entering Condenser Water Temperature (With Electronic Expansion Valve)



Min. ECWT = 5.25 + 0.88*(LWT) - DT_{FL}*(PLD/100) + 22*(PLD/100)^2

- ECWT = Entering condenser water temperature
- LWT = Leaving chilled water temperature
- DT_{FL} = Chilled Water Delta-T at full load
- PLD = The percent chiller load point to be checked

- For example; at 44°F LWT, 10 degree F Delta-T, and 50% full load operation, the entering condenser water temperature could be as low as 44.5°F. This provides excellent operation with water-side economizer systems.

Over 600 Tons

Chillers over approximately 600 Tons are equipped with thermal expansion valves (TXV) and will start and run with entering condenser water temperatures as low as calculated by the following equation and shown in the chart following.

Min. ECWT = 7.25 + LWT- 1.25* DTFL(PLD/100) + 22*(PLD/100) ^{2}

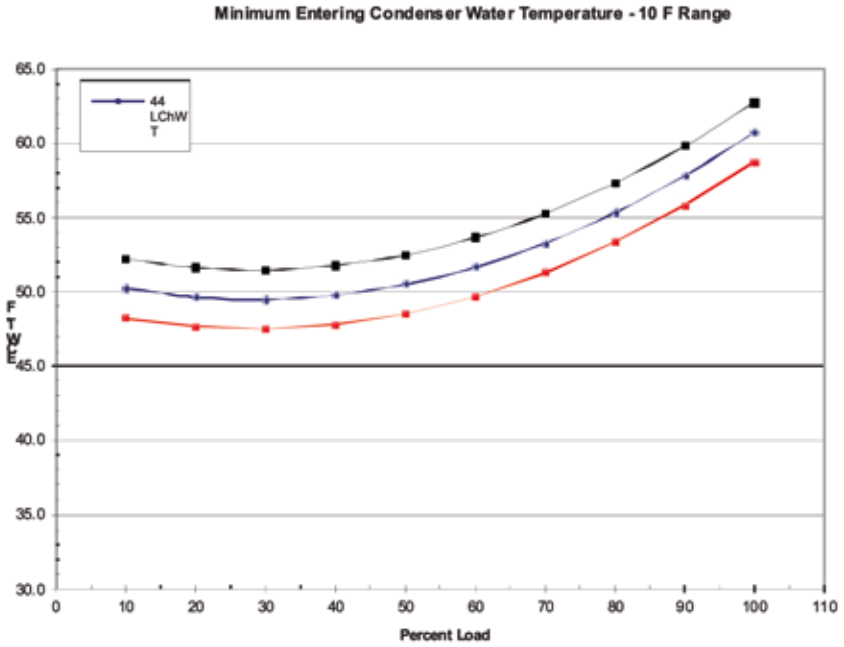
"ECWT = Entering condenser water temperature

"LWT = Leaving chilled water temperature

"DTFL = Chilled Water Delta-T at full load

"PLD = The percent chiller load point to be checked

Figure 12: Minimum Entering Condenser Water Temperature (Thermal Expansion Valve)



For example; at 44 F LWT, 10 degree F Delta-T, and 50% full load operation, the entering condenser water temperature could be as low as 50.5 F. This provides excellent operation with water-side economizer systems.

Depending on local climatic conditions, using the lowest possible entering condenser water temperature may be more costly in total system power consumed than the expected savings in chiller power would suggest, due to the excessive fan power required.

Cooling tower fans must continue to operate at 100% capacity at low wet bulb temperatures. As chillers are selected for lower kW per ton, the cooling tower fan motor power becomes a higher percentage of the total peak load chiller power. Daikin's Energy Analyzer program can optimize the chiller/ tower operation for specific buildings in specific locales.

Even with tower fan control, some form of water flow control, such as tower bypass, is recommended.

Condenser water temperature rise

The industry standard of 3 gpm/ton or about a 9.5-degree delta-T works well for most applications. Reducing condenser water flow to lower pumping energy will increase the water temperature rise, resulting in an increase in the compressor's condensing pressure and energy consumption. This is usually not a productive strategy.

System analysis

Although Daikin is a proponent of analyzing the entire system, it is generally effective to place the chiller in the most efficient mode because it is, by far, a larger energy consumer than pumps. The Daikin Energy Analyzer program is an excellent tool to investigate the entire system efficiency, quickly and accurately. It is especially good at comparing different system types and operating parameters. Contact your local Daikin sales office for assistance on your particular application.

For Best Chiller Efficiency

The designer must determine the proper chiller efficiency for a given application. The most efficient chiller is not always the best. A life cycle analysis (as performed by Daikin's Energy Analyzer program, for example) is the only way to be sure of the best selection. Utility costs, load factors, maintenance costs, cost of capital, tax bracket; in other words, all the factors affecting owning cost, must be considered.

Generally, the attempts to save the last few full load kW are very costly. For example, the cost to go from 0.58 to 0.57 kW/

ton could be very costly because of the large number of copper tubes that would have to be added to the heat exchangers.

Table 7:

Vessel	Activity	Example
Evaporator	Higher leaving water Temperatures	44°F instead of 42°F
Evaporator	Higher water temperature drops	12°F instead of 10°F
Evaporator	Lower flow rates	2.4 gpm/ton instead of 3.0 gpm/ton
Condenser	Lower entering water temperature	84°F instead of 85°F
Condenser	Higher flow rates (3.0 gpm/ ton or higher)	3.0 gpm/ton instead of 2.5 gpm/ton

Mixing Single and Dual Compressor Chillers

WDC dual compressor chillers excel at part load operation, while single compressor chillers usually have better full load efficiency. A good chiller plant strategy is to install one dual and one or more single compressor units. Run the dual until it is fully loaded, then switch to the single compressor unit and run it only at full load, using the dual to trim the load.

Series Counterflow and Series Parallel Chillers

The design of piping systems can greatly impact chiller performance. A popular system is to place the evaporators in series with the chilled water flowing from one evaporator to the next as shown in Figure 13 and Figure 14. Two different condenser water piping arrangements can be used. Parallel flow (Figure 13) divides the total condenser flow between the two condensers. The counterflow system (Figure 14) puts all of the condenser water through the condenser of the lag chiller (chiller producing the coldest evaporator leaving water) and then through the lead chiller (chiller seeing the warmest evaporator water temperatures).

Typically, since the lead machine will see the warmest evaporator water, it will have the greater capacity and larger portion of the total system evaporator temperature drop. Again referring to Figure 13 and Figure 14, the lead machine has an 8.4 degree drop (56.0°F-47.6°F) and the lag machine has a 5.6 degree drop (47.6°F - 42.0°F).

Condenser water flow is important to overall system efficiency. With parallel flow (Figure 13), the condensers have identical flow conditions (95 to 85 degrees in this example) with the compressor lift shown. With counterflow arrangement the lift on the lead machine is significantly lower, reducing compressor work and making the overall system efficiency about 2% better. Even though the chiller performance is different, it is good practice to use the same chiller models.

Both the WSC and WDC chillers are suitable for series counterflow arrangement and include controls specifically designed for series chillers. For more information, please refer to Application guide AG -31-003: Chiller Plant Design. Daikin's model WCC dual compressor chiller (1200 to 2700 tons) combines counterflow design into one unit. See page 6 for details.

Figure 13: Series Parallel Flow

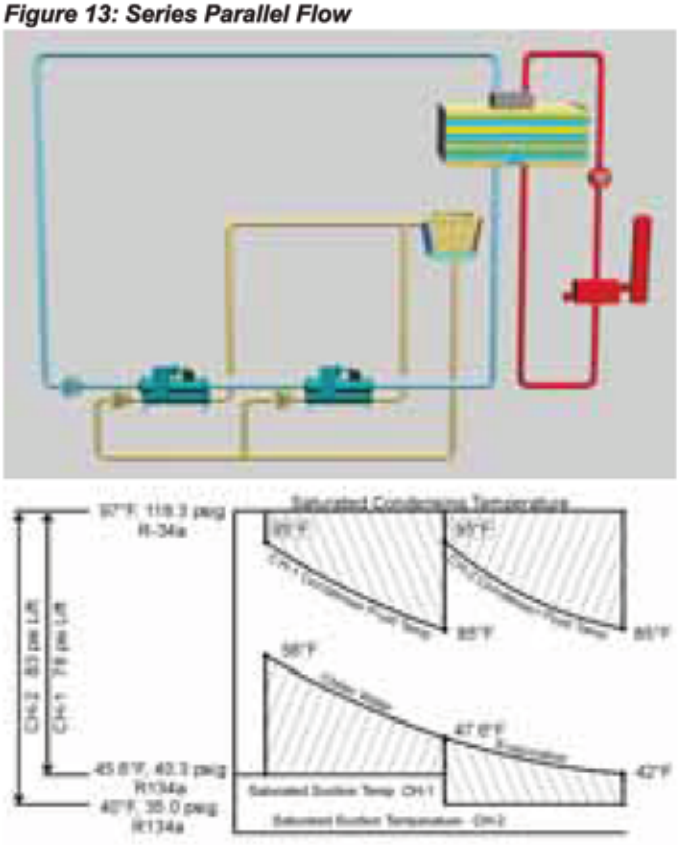
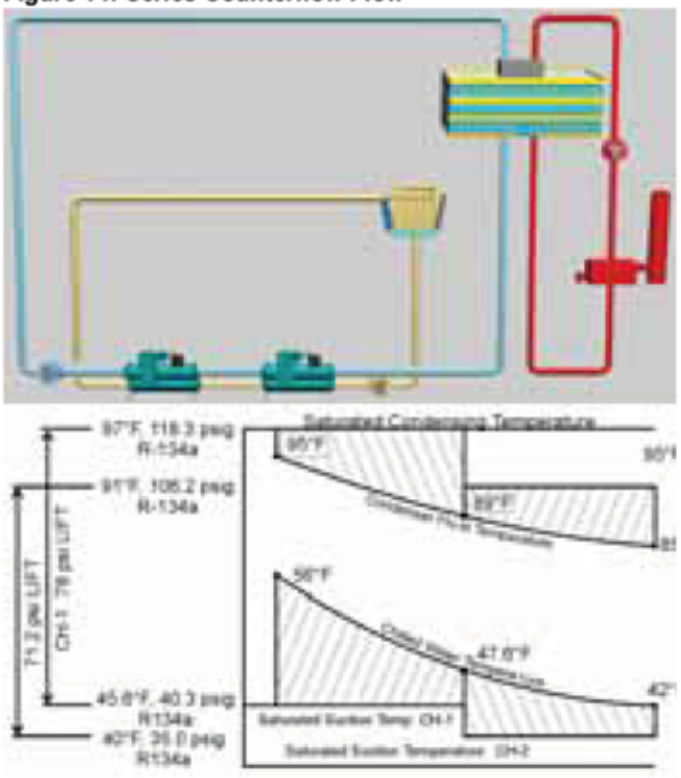


Figure 14: Series Counterflow Flow



Oil Coolers

Daikin centrifugal chillers have a factory-mounted, water-cooled oil cooler with a temperature controlled water regulating valve and solenoid valve for each compressor. Cooling water connections are located at the rear of the unit, near the compressor and are shown on the specific unit certified drawings. Models WDC 063 through 087 and all WCC have the cooling water connections in the lower portion of one tube sheet.

WDC 063, 079, 087, 100 and 126 dual compressor chillers are equipped as above, but the water piping for the two oil coolers is factory piped to a common inlet and outlet connection.

Field water piping to the inlet and outlet connections must be installed according to good piping practices and must include stop valves to isolate the cooler for servicing. A 1" minimum cleanable filter (40 mesh maximum) and drain valve or plug must also be field installed. The water supply for the oil cooler must be from the chilled water circuit, or from an independent clean source such as city water. When using chilled water, it is important that the water pressure drop across the evaporator is greater than the pressure drop across the oil cooler or insufficient oil cooler flow will result. If the pressure drop across the evaporator is less than the oil cooler, the oil cooler must be piped across the chilled water pump, provided that its pressure drop is sufficient. The water flow through the oil cooler will be adjusted by the unit's regulating valve so that the temperature of oil supplied to the compressor bearings (leaving the oil cooler) is between 90°F and 110°F (32°C and 43°C).

NOTE: The system must be designed for the highest cooling water temperature possible, which may occur for a short time during startup.

Compressors using chilled water for oil cooling will often start with warm "chilled water" in the system until the chilled water loop temperature is pulled down. With cooling water in the 40°F to 55°F (4°C to 13°C) range, considerably less water will be used and the pressure drop will be greatly reduced. The following table contains oil cooler data at various inlet water temperatures.

Table 8: WSC Oil Cooler Data

	Hot Side POE Lube	Cold Side Water			
WSC 063 - 087					
Flow, gpm	9.9	11.9	2.9	2.0	1.54
Inlet Temperature, °F	118.0	80.0	65.0	55.0	45.0
Outlet Temp., °F	100.0	87.3	94.5	98.3	101.4
Pressure Drop, psi	-	4.3	0.3	0.14	0.09
WSC 100 - 126					
Flow, gpm	15.8	21.9	5.11	3.5	2.7
Inlet Temperature, °F	120.0	80.0	65.0	55.0	45.0
Outlet Temp., °F	100.0	87.0	95.0	99.0	102.3
Pressure Drop, psi	-	3.78	0.23	0.11	0.07

Table 9: WSC with VFD Oil Cooler Data

	Hot Side POE Lub.	Cold Side Water			
WSC/HSC 063 - 087					
Flow, gpm	9.9	13.4	4.0	2.9	2.3
Inlet Temperature, °F	118.0	80.0	65.0	55.0	45.0
Outlet Temp., °F	100.0	90.3	99.6	103.1	105.6
Pressure Drop, ft.	-	30.5	6.7	4.8	3.6
WSC/HSC 100 - 126					
Flow, gpm	15.8	24.4	7.0	5.0	4.0
Inlet Temp., °F	120.0	80.0	65.0	55.0	45.0
Outlet Temp., °F	100.0	89.8	100.1	103.6	106.2
Pressure Drop, ft.	-	30.6	15.7	11.4	9.3

NOTES:

1WDC and WCC units have twice the cooling water flow rate of the comparable WSC chiller.

2Pressure drops include valves on the unit.

When supplied with city water, the oil piping must discharge through a trap into an open drain to prevent draining the cooler by siphoning. The city water can also be used for cooling tower makeup by discharging it into the tower sump from a point above the highest possible water level.

Note: Particular attention must be paid to chillers with variable chilled water flow through the evaporator. The pressure drop available at low flow rates can very well be insufficient to supply the oil cooler with enough water. In this case an auxiliary booster pump can be used or city water employed.

Cooling Water Connection Sizes: WDC/WCC 100/126 have 1-1/2 in. FPT connections, all other WDC and WSCs are 1 in. FPT.

Figure 15: Oil Cooler Piping Across Chilled Water Pump

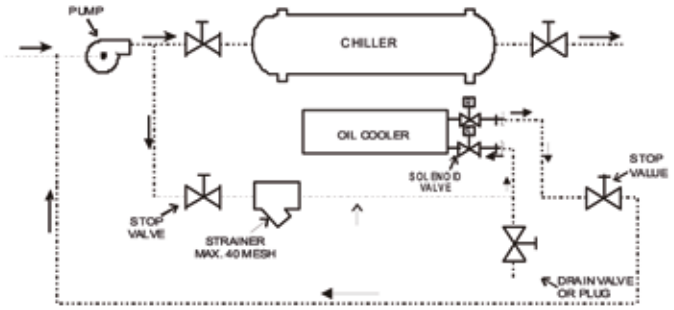
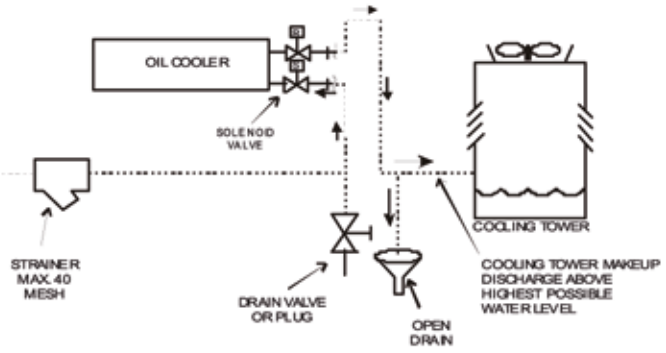


Figure 16: Figure 17, Oil Cooler Piping With City Water



Pumps

Model WSC, WDC and WCC chiller compressor motors operate at 3600 rpm on 60 Hz power (3000 rpm on 50 Hz). When VFDs are employed, the hertz/speed can be reduced by 70%. To avoid the possibility of objectionable harmonics in the system piping, 4-pole, 1800/1500 rpm system pumps should be used. The condenser water pump(s) must be cycled off when the last chiller of the system cycles off. This will keep cold condenser water from migrating refrigerant to the condenser. Cold liquid refrigerant in the condenser can make start-up difficult. In addition, turning off the condenser water pump(s) when the chillers are not operating will conserve energy.

Include thermometers and pressure gauges at the chiller inlet and outlet connections and air vents at the high points of piping. The water heads can be interchanged (end for end), allowing water connections to be made at either end of the unit. Use new head gaskets when interchanging water heads. When water pump noise is objectionable, use rubber isolation sections at both the inlet and outlet of the pump. Vibration eliminator sections in the condenser inlet and outlet water lines are not normally required. Where noise and vibration are critical and the unit is mounted on spring isolators, flexible piping and conduit connections are necessary. If not factory installed, a flow switch or pressure differential switch must be installed in the leaving chilled water line in accordance with the flow switch manufacturer's instructions.

Victaulic connections are AWWA C-606 on 14-inch and larger sizes. Field supply transitions if Victaulic brand AGS® (Advanced Groove System) type grooves are used on the field piping.

Filtering and Treatment

Owners and operators must be aware that if the unit is operating with a cooling tower, cleaning and flushing the cooling tower is required. Make sure tower blow-down or bleed-off is operating. Atmospheric air contains many contaminants, which increases the need for water treatment. The use of untreated water will result in corrosion, erosion, slime buildup, scaling, or algae formation. A water treatment service should be used. Daikin is not responsible for damage or faulty operation from untreated or improperly treated water.

Machine Room Ventilation

In the market today, centrifugal chillers are available with either hermetic or open type motors. Hermetic motors are cooled with refrigerant and dissipate their heat through the cooling tower. On the other hand, open motors circulate equipment room air across themselves for cooling and reject the heat to the equipment room. Daikin chillers have hermetic motors and DO NOT require additional ventilation.

For chillers with open-drive type, air-cooled motors, good engineering practice dictates that the motor heat be removed to prevent high equipment room temperatures. In many applications this requires a large volume of ventilation air, or mechanical cooling to properly remove this motor heat.

EXAMPLE: 1000 tons x 0.6 kW/Ton x 0.04 motor heat loss x 0.284 Tons/kW = 7 tons (24 kW) cooling

The energy and installation costs of ventilation or mechanical cooling equipment must be considered when evaluating various chillers. For a fair comparison, the kW used for the ventilation fans, or if mechanical cooling is required, the additional cooling and fan energy must be added to the open motor compressor energy when comparing hermetic drives. Additionally, significant costs occur for the purchase, installation, and maintenance of the ventilation or air handling units.

Equipment room ventilation and safety requirements for various refrigerants is a complex subject and is updated from time to time. The latest edition of ASHRAE 15 should be consulted.

Thermal Storage

Daikin chillers are designed for use in thermal storage systems. The chillers have two operating conditions that must be considered. The first is normal air-conditioning duty where leaving evaporator fluid temperatures range from 40°F to 45°F (4.4°C to 7.2°C).

$$D_{Common} = \left(\frac{2}{1} + \frac{2}{2} \ldots . D_n^2 \right)^5$$

The second condition occurs during the ice making process when leaving fluid temperatures are in the 22°F to 26°F

(-5.6°C to -3.3°C) range.

The MicroTech II control system will accommodate both operating points. The ice mode can be started or stopped by an input signal to the microprocessor from a BAS or through a chilled water reset signal. When a signal is received to change from the ice mode to the normal operating mode, the chiller will shut down until the system fluid temperature rises to the higher setpoint. The chiller will then restart and continue operation at the higher leaving fluid temperature. When changing from normal cooling to the ice mode, the chiller will load to maximum capacity until the lower setpoint is reached.

Computer selections must be made to check that the chiller will operate at both conditions. If the "ice mode" is at night, the pressure differentials between the evaporator and condenser are usually similar to normal cooling applications. The leaving fluid temperature is lower, but the condensing temperature is also lower because the cooling tower water is colder. If the ice mode can also operate during the day, when cooling tower water temperatures are high, a proper selection becomes more difficult because the two refrigerant pressure differentials are significantly different.

A three-way condenser water control valve is always required.

Variable Speed Pumping

Variable speed pumping involves changing system water flow relative to cooling load changes. Daikin centrifugal chillers are designed for this duty with two limitations.

First, the rate of change in the water flow needs to be slow, not greater than 10% of the change per minute. The chiller needs time to sense a load change and respond.

Second, the water velocity in the vessels must be 3 to 10 fps (0.91 and 3.0 m/sec). Below 3 fps (0.91 m/sec), laminar flow occurs which reduces heat transfer. Above 10 fps (3.0 m/sec), excessively high pressure drops and tube erosion occur. These flow limits can be determined from the Daikin selection program.

We recommend variable flow only in the evaporator because there is virtually no change in chiller efficiency compared to constant flow. In other words, there is no chiller energy penalty. Although variable speed pumping can be done in the condenser loop, it is usually unwise. The intent of variable flow is to reduce pump horsepower. However, reducing condenser water flow increases the chiller's condensing pressure, increasing the lift that the compressor must overcome which, in turn, increases the compressor's energy use. Consequently, pump energy savings can be lost because the chiller operating power is significantly increased.

Low condenser flow can cause premature tube fouling and subsequent increased compressor power consumption. Increased cleaning and/or chemical use can also result.

Vibration Mounting

Every Daikin chiller is run tested and compressor vibration is measured and limited to a maximum rate of 0.14 inches per second, which is considerably more stringent than other available compressors. Consequently, floor-mounted spring isolators are not usually required. Rubber mounting pads are shipped with each unit. It is wise to continue to use piping flexible connectors to reduce sound transmitted into the pipe and to allow for expansion and contraction.

AHRI Standard 575 Sound Ratings

Sound data in accordance with AHRI Standard 575 for individual units are available from your local Daikin representative. Due to the large number of component combinations and variety of applications, sound data is not included in this catalog.

Discharge Line Sound Packages

For extremely sensitive projects, an optional discharge line sound package is offered consisting of sound insulation installed on the unit's discharge line. An additional 2 to 4 dbA reduction normally occurs.

System Water Volume

All chilled water systems need adequate time to recognize a load change, respond to that load change and stabilize, without undesirable short cycling of the compressors or loss of control. In air conditioning systems, the potential for short cycling usually exists when the building load falls below the minimum chiller plant capacity or on close-coupled systems with very small water volumes.

Some of the things the designer should consider when looking at water volume are the minimum cooling load, the minimum chiller plant capacity during the low load period and the desired cycle time for the compressors.

Assuming that there are no sudden load changes and that the chiller plant has reasonable turndown, a rule of thumb of "gallons of water volume equal to two to three times the chilled water gpm flow rate" is often used.

A properly designed storage tank should be added if the system components do not provide sufficient water volume.

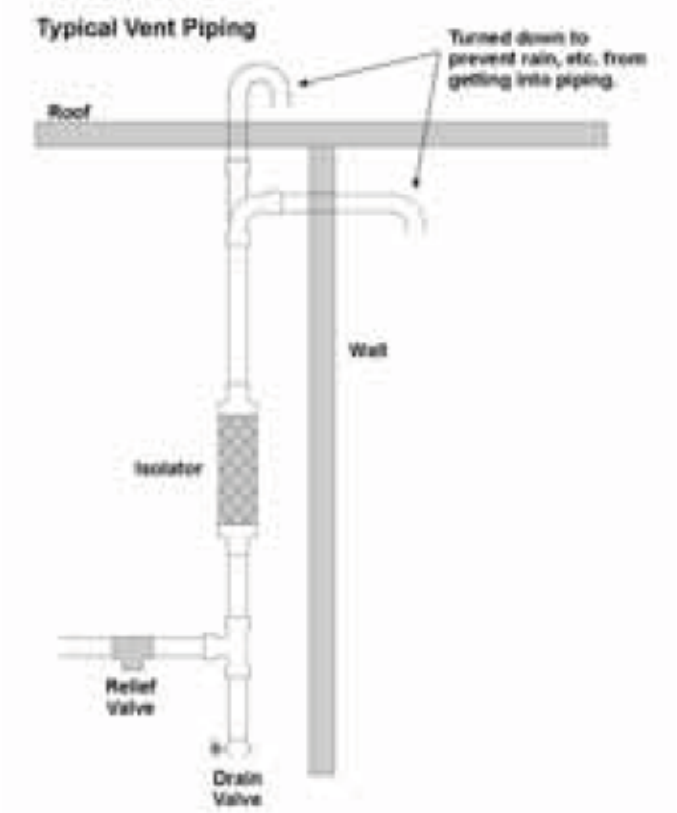
Relief Valves

Relief valve connection sizes are 1-inch FPT and are in the quantity shown in Table 10 and Table 11 for the evaporator and condenser. In addition, there is a relief valve (3/8 inch flare) on the top of the oil sump of all units.

All relief valves (including the oil sump) must be piped to the outside of the building in accordance with ANSI/ASHRAE 15-2001. The new 2001 standard has revised the calculation method compared to previous issues.

Twin relief valves, mounted on a transfer valve, are used on the condenser so that one relief valve can be shut off and removed for testing or replacement, leaving the other in operation. Only one of the two valves is in operation at any time. Where 4 valves are shown, on some large vessels, they consist of two relief valves mounted on each of two transfer valves. Only two relief valves of the four are active at any time.

Figure 17: Typical Vent Piping



Vent piping is sized for only one valve of the set since only one can be in operation at a time.

Relief Pipe Sizing (ASHRAE Method)

Relief valve pipe sizing is based on the discharge capacity for the given evaporator or condenser and the length of piping to be run.

Daikin centrifugal chillers have the following relief valve settings and discharge capacity:

- WSC/WCC evaporator (1 valve) and condenser (2 valves piped together to common vent pipe) = 200 psi, 75.5 lb of air/min
- WDC evaporator (1) = 180 psi, 68.5 lb of air/min
- WDC condenser(2) = 225 psi, 84.4 lb of air/min
- Note: some large condensers have 4 relief valves

Since the pressures and valve size are fixed for Daikin chillers, the ASHRAE equation can be reduced to the simple table shown below.

Table 10: Relief Valve Piping Sizes

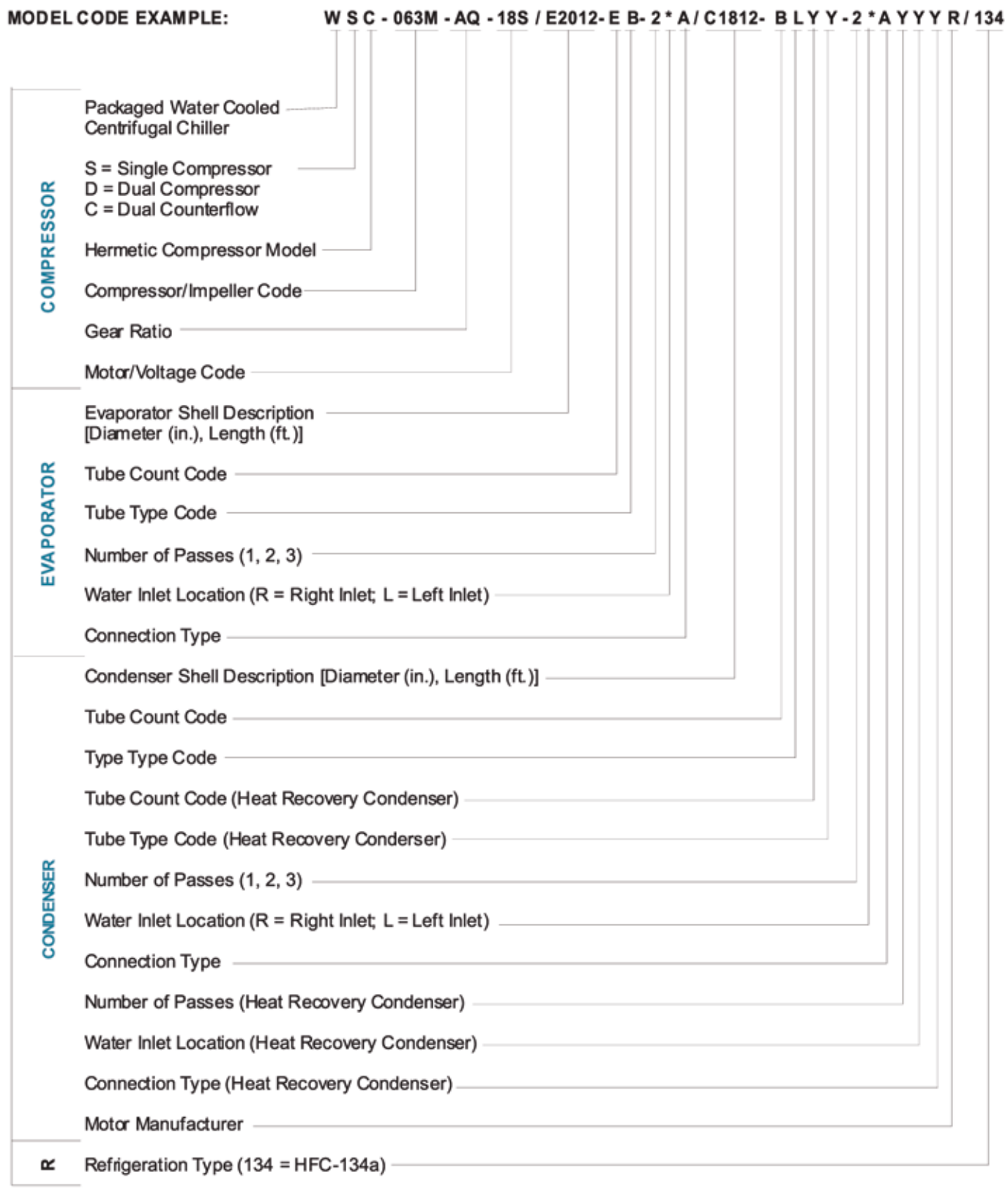
Pipe Size inch (NPT)	1.25	1.5	2	2.5	3	4
Moody Factor	0.0209	0.0202	0.0190	0.0182	0.0173	0.0163
Equivalent length (ft)	2.2	18.5	105.8	296.7	973.6	4117.4

Note: A 1-inch pipe is too small to handle these valves. A pipe increaser must be installed at the valve outlet.

Per ASHRAE Standard 15, the pipe size cannot be less than the relief device. The discharge from more than one relief valve can be run into a common header, the area of which shall not be less than the sum of the areas of the connected pipes. For further details, refer to ASHRAE Standard 15. The common header can be calculated by the formula:

The above information is a guide only. Consult local codes and/or latest version of ASHRAE Standard 15 for sizing data.

Figure 18: Chiller Identification (Code String Index)



Electrical Data

Wiring and Conduit

Wire sizes must comply with local and state electrical codes. Where total amperes require larger conductors than a single conduit would permit, limited by dimensions of motor terminal box, two or more conduits can be used. Where multiple conduits are used, all three phases must be balanced in each conduit. Failure to balance each conduit will result in excessive heating of the conductors and unbalanced voltage.

An interposing relay can be required on remote mounted starter applications when the length of the conductors run between the chiller and starter is excessive.

Note: On WDC and WCC dual compressor units, dual power leads are standard, requiring separate power leads properly sized and protected to each compressor starter or VFD. Separate disconnects must be used.

Use only copper supply wires with ampacity based on 75°C conductor rating. (Exception: for equipment rated over 2000 volts, 90°C or 105°C rated conductors shall be used).

Power Factor Correction Capacitors

Do not use power factor correction capacitors with centrifugal chillers with a compressor VFD. Doing so can cause harmful electrical resonance in the system. Correction capacitors are not necessary since VFDs inherently maintain high power factors.

Control Power

The 115-volt control power can be supplied from the starter or a transformer (meeting the requirements of Daikin Starter Specification 359999 Rev 29) separate from the starter. Either source must be properly fused with 25-amp dual element fuses or with a circuit breaker selected for motor duty. If the control transformer or other power source for the control panel is remote from the unit, conductors must be sized for a maximum voltage drop of 3%. Required circuit ampacity is 25 amps at 115 volts. Conductor size for long runs between the control panel and power source, based upon National Electrical Code limitations for 3% voltage drop, can be determined from the table below.

Control Power Line Sizing

Maximum Length, ft (m)	Wire Size (AWG)	Maximum Length, ft (m)	Wire Size (AWG)
0 (0) to 50 (15.2)	12	120 (36.6) to 200 (61.0)	6
50 (15.2) to 75 (22.9)	10	200 (61.0) to 275 (83.8)	4
75 (22.9) to 120 (36.6)	8	275 (83.8) to 350 (106.7)	3

Notes:

1. Maximum length is the distance a conductor will traverse between the control power source and the unit control panel.
2. Panel terminal connectors will accommodate up to number 10 AWG wire. Larger conductors will require an intermediate junction box.

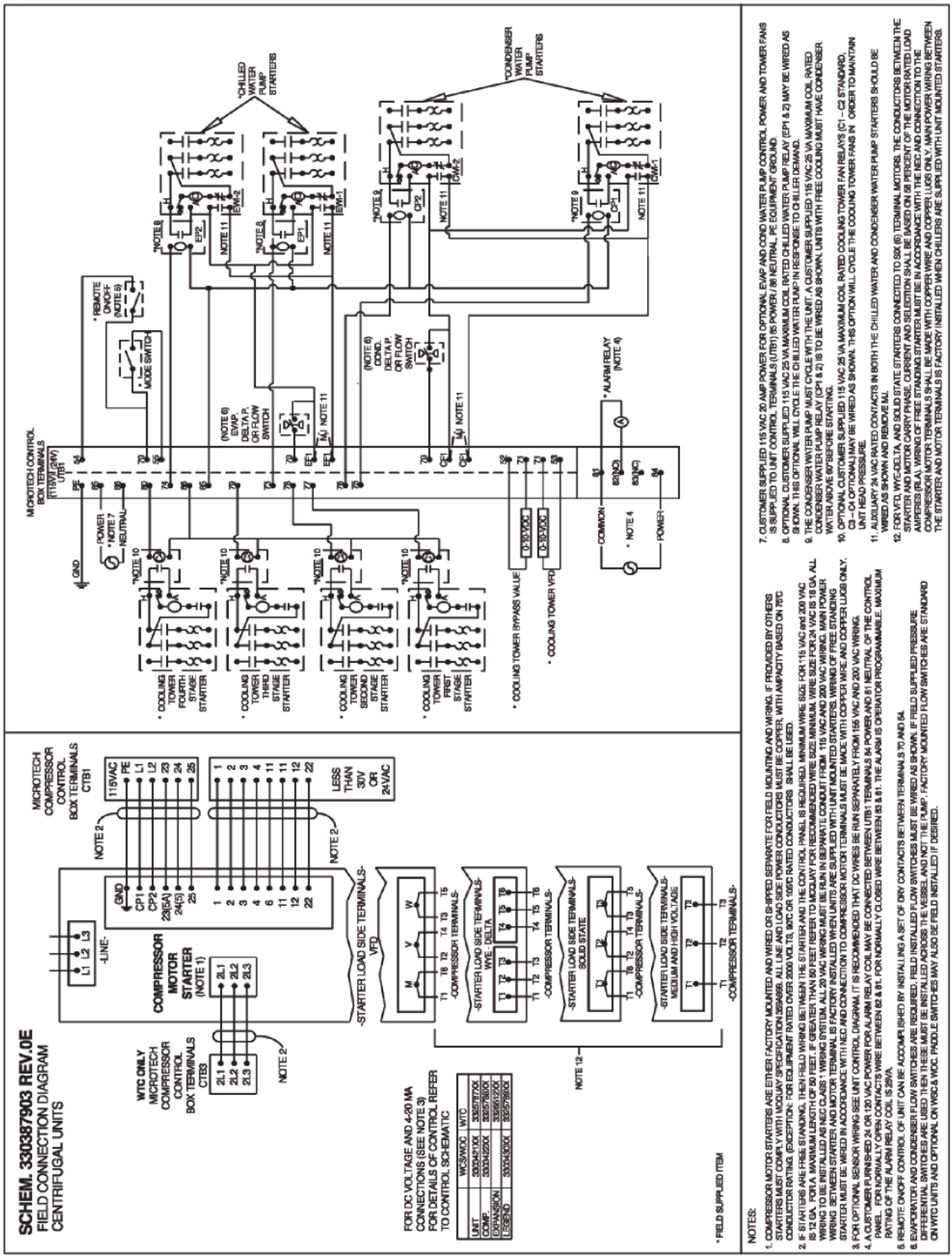
Starters and VFDs

Information on starters and VFDs can be found in Daikin Catalog CAT 608.

NOTES for Following Wiring Diagram

1. Compressor motor starters are either factory mounted and wired, or shipped separate for field mounting and wiring. If provided by others, starters must comply with Daikin specification 359999 Rev 29. All line and load side power conductors must be copper.
2. If starters are freestanding, then field wiring between the starter and the control panel is required. Minimum wire size for 115 Vac is 12 GA for a maximum length of 50 feet. If greater than 50 feet, refer to Daikin sales office for recommended wire size minimum. Wire size for 24 Vac is 18 GA. All wiring to be installed as NEC Class 1 wiring system. All 24 Vac wiring must be run in separate conduit from 115 Vac wiring. Main power wiring between starter and motor terminal is factory-installed when units are supplied with unit-mounted starters. Wiring of free-standing starter must be wired in accordance with NEC and connection to compressor motor terminals must be made with copper wire and copper lugs only. Control wiring on free-standing starters is terminated on a terminal strip in the motor terminal box (not the unit control panel). Wiring from the unit control panel to the motor terminal is done in the factory.
3. For optional sensor wiring, see unit control diagram. It is recommended that dc wires be run separately from 115 Vac wiring.
4. Customer furnished 24 or 120 Vac power for alarm relay coil can be connected between UTB1 terminals 84 power and 51 neutral of the control panel. For normally open contacts, wire between 82 & 81. For normally closed contacts, wire between 83 & 81. The alarm is operator programmable. The maximum rating of the alarm relay coil is 25 VA.
5. Remote on/off control of unit can be accomplished by installing a set of dry contacts between terminals 70 and 54.
6. Evaporator and condenser flow switches are required and must be wired as shown. If field supplied pressure differential switches are used then these must be installed across the vessel and not the pump.
7. Customer supplied 115 Vac, 20 amp power for optional evaporator and condenser water pump control power and tower fans is supplied to unit control terminals (UTBI) 85 power / 86 neutral, PE equipment ground.
8. Optional customer supplied 115 Vac, 25 VA maximum coil rated chilled water pump relay (EP 1 & 2) can be wired as shown. This option will cycle the chilled water pump in response to building load.
9. The condenser water pump must cycle with the unit. A customer supplied 115 Vac 25 VA maximum coil rated condenser water pump relay (CP1 & 2) is to be wired as shown.
10. Optional customer supplied 115 Vac, 25 VA maximum coil rated cooling tower fan relays (CL - C4) can be wired as shown. This option will cycle the cooling tower fans in order to maintain unit head pressure.
11. Auxiliary 24 Vac rated contacts in both the chilled water and condenser water pump starters can be wired as shown for additional protection.
12. For VFD, Wye-Delta, and solid state starters connected to six (6) terminal motors, the conductors between the starter and motor carry phase current and their ampacity must be based on 58 percent of the motor rated load amperes (RLA) times 1.25. Wiring of free-standing starter must be in accordance with the NEC and connection to the compressor motor terminals shall be made with copper wire and copper lugs only. Main power wiring between the starter and motor terminals is factory-installed when chillers are supplied with unit-mounted starters.
13. Optional Open Choices BAS interfaces. The locations and interconnection requirements for the various standard protocols are found in their respective installation manuals, obtainable from the local Daikin sales office and also shipped with each unit: Modbus IM 743-0LonWorks IM 735-0BACnet IM 736-0
14. The "Full Metering" or "Amps Only Metering" option will require some field wiring when free-standing starters are used. Wiring will depend on chiller and starter type. Consult the local Daikin sales office for information on specific selections.

Figure 19: Typical Field Connection Diagram



NOTES:

1. COMPRESSOR MOTOR STARTERS ARE EITHER FACTORY MOUNTED AND WIRED OR SHIPPED SEPARATE FOR FIELD MOUNTING AND WIRING. IF PROVIDED BY OTHERS STARTERS MUST COMPLY WITH MCQUAY SPECIFICATION 3594899. ALL LINE AND LOAD SIDE POWER CONDUCTORS MUST BE COPPER, WITH AMPACITY BASED ON 75°C CONDUCTOR RATING. (EXCEPTION: FOR EQUIPMENT RATED OVER 2000 VOLTS, 90°C OR 105°C RATED CONDUCTORS SHALL BE USED.
2. IF STARTERS ARE FREE STANDING, THEN FIELD WIRING BETWEEN THE STARTER AND THE CONTROL PANEL IS REQUIRED. MINIMUM WIRE SIZE FOR 115 VAC and 200 VAC IS 12 GA. FOR A MAXIMUM LENGTH OF 50 FEET. IF GREATER THAN 50 FEET REFER TO MCQUAY FOR RECOMMENDED WIRE SIZE. MINIMUM WIRE SIZE FOR 24 VAC IS 18 GA. ALL WIRING TO BE INSTALLED AS NEC CLASS 1 WIRING SYSTEM. ALL 20 VAC WIRING MUST BE RUN IN SEPARATE CONDUIT FROM 115 VAC AND 200 VAC WIRING. MAIN POWER WIRING BETWEEN STARTER AND MOTOR TERMINAL IS FACTORY INSTALLED WHEN UNITS ARE SUPPLIED WITH UNIT MOUNTED STARTERS. WIRING OF FREE STANDING STARTER MUST BE WIRED IN ACCORDANCE WITH NEC AND CONNECTION TO COMPRESSOR MOTOR TERMINALS MUST BE MADE WITH COPPER WIRE AND COPPER LUGS ONLY.
3. FOR OPTIONAL SENSOR WIRING SEE UNIT CONTROL DIAGRAM. IT IS RECOMMENDED THAT DC WIRES BE RUN SEPARATELY FROM 115 VAC AND 200 VAC WIRING.
4. A CUSTOMER FURNISHED 24 OR 120 VAC POWER FOR ALARM RELAY COIL MAY BE CONNECTED BETWEEN UTB1 TERMINALS 84 POWER AND 81 NEUTRAL OF THE CONTROL PANEL. FOR NORMALLY OPEN CONTACTS WIRE BETWEEN 82 & 81. FOR NORMALLY CLOSED WIRE BETWEEN 83 & 81. THE ALARM IS OPERATOR PROGRAMMABLE. MAXIMUM RATING OF THE ALARM RELAY COIL IS 25VA.
5. REMOTE ON/OFF CONTROL OF UNIT CAN BE ACCOMPLISHED BY INSTALLING A SET OF DRY CONTACTS BETWEEN TERMINALS 70 AND 54.
6. EVAPORATOR AND CONDENSER FLOW SWITCHES ARE REQUIRED. FIELD INSTALLED FLOW SWITCHES MUST BE WIRED AS SHOWN. IF FIELD SUPPLIED PRESSURE DIFFERENTIAL SWITCHES ARE USED THEN THESE MUST BE INSTALLED ACROSS THE VESSEL AND NOT THE PUMP. FACTORY MOUNTED FLOW SWITCHES ARE STANDARD ON WTC UNITS AND OPTIONAL ON WSC & WDC. PADDLE SWITCHES MAY ALSO BE FIELD INSTALLED IF DESIRED.
7. CUSTOMER SUPPLIED 115 VAC 20 AMP POWER FOR OPTIONAL EVAP AND COND WATER PUMP CONTROL POWER AND TOWER FANS IS SUPPLIED TO UNIT CONTROL TERMINALS (UTB1) 85 POWER / 86 NEUTRAL. PE EQUIPMENT GROUND.
8. OPTIONAL CUSTOMER SUPPLIED 115 VAC 25 VA MAXIMUM COIL RATED CHILLED WATER PUMP RELAY (CP1 & 2) MAY BE WIRED AS SHOWN. THIS OPTION WILL CYCLE THE CHILLED WATER PUMP IN RESPONSE TO CHILLER DEMAND.
9. THE CONDENSER WATER PUMP MUST CYCLE WITH THE UNIT. A CUSTOMER SUPPLIED 115 VAC 25 VA MAXIMUM COIL RATED CONDENSER WATER PUMP RELAY (CP1 & 2) IS TO BE WIRED AS SHOWN. UNITS WITH FREE COOLING MUST HAVE CONDENSER WATER ABOVE 60°F BEFORE STARTING.
10. OPTIONAL CUSTOMER SUPPLIED 115 VAC 25 VA MAXIMUM COIL RATED COOLING TOWER FAN RELAYS (C1 – C2 STANDARD, C3 – C4 OPTIONAL) MAY BE WIRED AS SHOWN. THIS OPTION WILL CYCLE THE COOLING TOWER FANS IN ORDER TO MAINTAIN UNIT HEAD PRESSURE.
11. AUXILIARY 24 VAC RATED CONTACTS IN BOTH THE CHILLED WATER AND CONDENSER WATER PUMP STARTERS SHOULD BE WIRED AS SHOWN AND REMOVE 84J.
12. FOR VFD, WYE-DELTA, AND SOLID STATE STARTERS CONNECTED TO SIX (6) TERMINAL MOTORS, THE CONDUCTORS BETWEEN THE STARTER AND MOTOR CARRY PHASE CURRENT AND SELECTION SHALL BE BASED ON 58 PERCENT OF THE MOTOR RATED LOAD AMPERES (RLA). WIRING OF FREE STANDING STARTER MUST BE IN ACCORDANCE WITH THE NEC AND CONNECTION TO THE COMPRESSOR MOTOR TERMINALS SHALL BE MADE WITH COPPER WIRE AND COPPER LUGS ONLY. MAIN POWER WIRING BETWEEN THE STARTER AND MOTOR TERMINALS IS FACTORY INSTALLED WHEN CHILLERS ARE SUPPLIED WITH UNIT MOUNTED STARTERS.

Starters and VFDs

Motor Starters

Daikin has a wide variety of starter types and options to fit virtually all applications. The specifics of the final selection of size, enclosure, and options are covered in the catalog Cat Starter available on www.DaikinApplied.com . Please consult the local Daikin sales office or the starter catalog for details. This section contains a general overview only.

Mounting Options, Low Voltage, 200 to 600 Volts

Factory-mounted
Starters are furnished, mounted and wired in the factory. Due to shipping width limitations, the starters for WSC 100 through 126 are shipped loose with cable kits and mounting brackets for field installation on the unit by others.

Freestanding
Furnished by Daikin and shipped to the job site for setting and wiring by others.

Starters by others
Starters furnished by others must meet Daikin Specification 359999 Rev 29, available from the local Daikin sales office. The starters are furnished and installed by others.

Table 11: Low Voltage Starter Mounting Options

Size	Factory-Mounted	Free-Standing	Brackets & Cables
WSC/WDC 063-087	X	X	
WSC/WCC 100-126		X	X
WDC 100-126		X	
WCC 100-126		X	X

Mounting Options, Medium Voltage, 2300 to 6000 Volts

All starter types in these voltages are for field setting and wiring only.

Starter Types and Descriptions

Solid state starters are available for both low and medium voltages and are similar in construction and features regardless of voltage. For low voltage application, Wye-Delta Closed Transition starters are available, in addition to solid state. For medium voltage application, autotransformer, primary reactor reduced voltage and across-the-line starters are offered in addition to solid state.

Variable Frequency Drives (VFD)

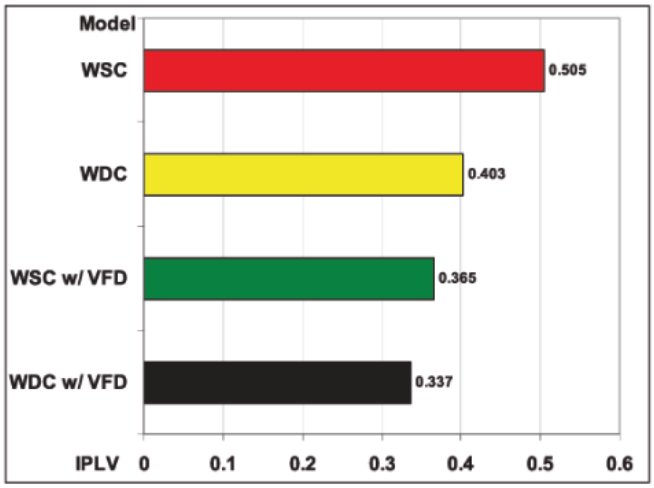
A VFD modulates the compressor speed in response to load and evaporator and condenser pressures. Due to the outstanding part load efficiency, and despite the small power penalty attributed to the VFD, the chiller can achieve outstanding overall efficiency. VFDs really prove their worth when there is reduced load combined with low compressor lift (lower condenser water temperatures) dominating the operating hours.

The traditional method of controlling centrifugal compressor capacity is by inlet guide vanes. Capacity can also be reduced by slowing the compressor speed and reducing the impeller tip speed, providing sufficient tip speed is retained to meet the discharge pressure requirements. This method is more efficient than guide vanes by themselves.

In actual practice a combination of the two techniques is used. The microprocessor slows the compressor (to a fixed minimum percent of full load speed) as much as possible, considering the need for tip speed to make the required compressor lift. Guide vanes take over to make up the difference in required capacity reduction. This methodology provides the optimum efficiency under any operating condition.

Impact of Variable Frequency Drives

The chart below illustrates the relative IPLV efficiencies of various Daikin options for a typical 500-ton selection. The chiller cost increases as the efficiency improves. ***Figure 20: IPLV Comparison by Model***



The IPLV values (defined on page 29) are AHRI Certified Ratings based on AHRI Standard 550/590, Standard for Water Chilling Packages Using the Vapor Compression Cycle. Full load is at 44 F chilled water temperature with 2.4 gpm/ton, 85 F entering condenser water temperatures with 3 gpm/ton. Part load points of 75%, 50%, and 25% employ condenser water temperature relief (reduction) per the standard.

VFD Options

Reactor
- Used for control of line harmonics in some installations.

Incoming Line Termination (Choose one)
- Terminal block
- Non-fused disconnect with through-the-door handle
- Fused disconnect, time delay fuses with through-the-door handle
- Standard interrupting circuit breaker with through-the-door handle
- High interrupting circuit breaker with through-the-door handle
- Ultra high circuit breaker with through-the-door handle

Volts/Amps Meter
- With 3-phase Switch

General Arrangement

VFD Mounting

VFDs from size VFD 019 through VFD 072 can be factory-mounted on the same units and in the same location as conventional starters or can be free-standing as shown below. Sizes VFD 090 through 120 are for free-standing only.

Dimensions begin on page 30.

Table 12: VFD Mounting Options

Chiller Model	Unit Mounted at Factory[1]	Unit Mounted in Field	Free-Standing[2]
WSC/WDC 063-087	X		X
WSC 100-126		X[3]	X
WDC 100-126			X
WCC 100-126		X[3]	x

Note 1: Optional reactor is field-mounted and wired to unit mounted VFD.
Note 2: Optional reactor is factory-mounted in the VFD enclosure.
Note 3: Brackets and interconnecting cables shipped with unit.

VFD Line Harmonics

Care must be taken when applying VFDs due to the effect of line harmonics on the electric system. VFDs cause distortion of the AC line because they are nonlinear loads; that is, they don't draw sinusoidal current from the line. They draw their current from only the peaks of the AC line, thereby flattening the top of the voltage waveform. Some other nonlinear loads are electronic ballasts and uninterruptible power supplies. Line harmonics and their associated distortion may be critical to AC drive users for three reasons:

1. Current harmonics can cause additional heating to transformers, conductors and switchgear.
2. Voltage harmonics upset the smooth voltage sinusoidal waveform.
3. High-frequency components of voltage distortion can interfere with signals transmitted on the AC line for some control systems.

The harmonics of concern are the 5th, 7th, 11th, and 13th. Even harmonics, harmonics divisible by three, and high magnitude harmonics are usually not a problem.

Current Harmonics

An increase in reactive impedance in front of the VFD helps reduce the harmonic currents. Reactive impedance can be added in the following ways:

1. Mount the drive far from the source transformer.
2. Add line reactors.
3. Use an isolation transformer.

Voltage Harmonics

Voltage distortion is caused by the flow of harmonic currents through a source impedance. A reduction in source impedance to the point of common coupling (PCC) will result in a reduction in voltage harmonics. This may be done in the following ways:

1. Keep the PCC as far from the drives (close to the power source) as possible.
2. Increase the size (decrease the impedance) of the source transformer.
3. Increase the capacity (decrease the impedance) of the busway or cables from the source to the PCC.
4. Make sure that added reactance is downstream (closer to the VFD than the source) from the PCC.

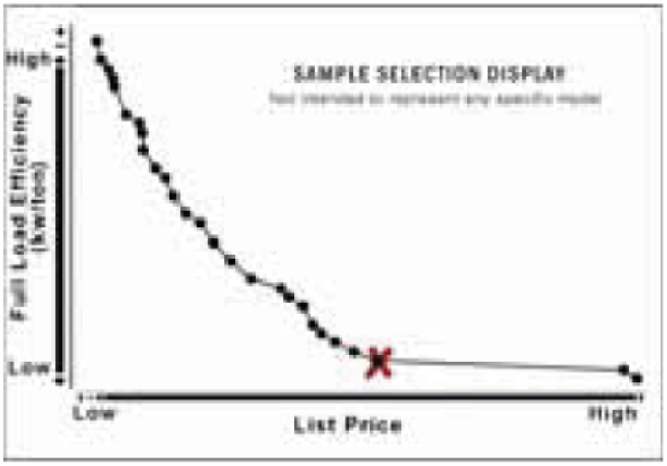
The IEEE 519 Standard

The Institute of Electrical and Electronics Engineers (IEEE) has developed a standard that defines acceptable limits of site specific system current and voltage distortion.. Line reactors, isolation transformers, or phase-shifting transformers may be required on some installations.

Daikin has a full line of optional air cooled and water-cooled harmonic filters suitable for mitigating harmonic distortion. See CAT 608, *Starters and Variable Frequency Drives* for complete infoemation.

Selection Procedures

Many combinations of compressor configuration and condensers and evaporators are available for a given capacity. The units range from low first cost and relatively high kW per ton (COP) to high first cost and low kW per ton (COP). An example illustration of the performance vs. cost display is shown below. Optimum unit selection for maximum operating return on the invested first cost is in the area identified by the red "X".



Actual optimum unit selection will vary with building application and system design. Applications with minimal hours of operation cannot justify a very low kW per ton (COP) unit. Applications with high hours of operation will justify high part load as well as full load efficiency units. For optimum selection an energy analysis is available through your local Daikin Sales Representative.

Basic unit selections

All Daikin centrifugal chillers are computer selected to optimize the cooling output and total kW. Computer selection allows for the specification of leaving chilled water temperature, entering condenser water temperature, evaporator and condenser flow rates, number of passes, and fouling factors. Glycol applications can also be specified.

Glycol operation

The addition of glycol to the chilled water system for freeze protection can be required for special applications. Glycol solutions are required where the evaporating temperatures are below 33°F (1°C).

AHRI Certification

Daikin is committed to supplying chillers that perform as specified. Subsequently , Daikin centrifugal chillers are part of the AHRI Certification program. On-going performance verification of chiller capacity and power input plus AHRI certified computerized selection output provide the owner with the assurance of specified performance.

Scope of Certification Program

AHRI Standard 550/590 for Centrifugal or Screw Water-Chilling Packages defines certifi cation and testing procedures and performance tolerances of all units that fall within the scope of the program. All chillers that fall within the scope of AHRI Standard 550/590 will have an AHRI certification label at no cost to the owner. Equipment covered includes all water-cooled chilling packages rated up to 2500 tons (8793 kW), operating within the range shown in Table 13, with either an hermetic or open drive, with electric driven motor not exceeding 5000 volts, and cooling water (glycol applications are outside the scope AHRI Standard 550/590). he program excludes the following applications: air and evaporative cooled chillers, capacity exceeding 2500 tons (8793 kW), voltages above 5000 volts, brine and special fluids other than water and heat recovery units.

Table 13: Application Condition Range of AHRI 550/590

Leaving chilled water temperature:	40°F to 48°F (4.4°C to 8.9°C)
Entering condenser water temperature:	60°F to 95°F (15.6°C to 35°C)

Published certified ratings at AHRI standard rating conditions (shown in include the following values :

- Capacity, tons (kW)
- Power, kW/ton (COP)
- Pressure drop, ft. of water (kPa)
- Integrated Part Load Value (IPLV) or Non-Standard Part Load Value (NPLV)

The standard rating conditions are:

Table 14: AHRI Standard Rating conditions

Leaving chilled water temperature:	44°F (6.7°C)
Evaporator waterside field fouling allowance:	0.0001 ft^2 x hr x°F/BTU (0.0176 m^2 x °C/kW)
Chilled water flow rate:	2.4 gpm/ton (0.043 l/s / kW)
Entering condenser water temperature:	85°F (29.4°C)
Condenser waterside field fouling allowance:	0.00025 ft^2 x hr x°F/BTU (0.044 m^2 x °C/kW)
Condenser water flow rate:	3.0 gpm/ton (0.054 l/s / kW)

Daikin SelectTools (MST) for Centrifugal Chillers is the selection program used to custom select and rate chillers for specific job conditions. It is part of the AHRI certification program, and the certified program version number and issue date is listed in the AHRI Directory of Certified Applied Air-Conditioning Products available at www.ahridirectory.org. MST ratings are available from your local Daikin Sales Representative.

Full AHRI 550/590 participation and certification has been an on-going commitment at Daikin. The AHRI label affixed to certified units certifies that the unit will meet the specified performance. This equipment is certified in accordance with AHRI Standard 550/590, latest edition,

provided the application ratings are within the scope of the certification program.

Figure 21: IPLV/NPLV Defined

IPLV/NPLV Defined

Part load performance can be presented in terms of Integrated Part Load Value (IPLV), which is based on AHRI standard rating conditions (listed above), or Non-Standard Part Load Values (NPLV), which is based on specified or job site conditions. IPLV and NPLV are based on the following weighting equation from AHRI 550/590:

$$IPLVorNPLV = \frac{1}{\frac{0.01}{A} + \frac{0.42}{B} + \frac{0.45}{C} + \frac{0.12}{D}}$$

Using kW/ton, where:

A = kW/ton (or COP) at 100%
B = kW/ton (or COP) at 75%
C = kW/ton (or COP) at 50%
D = kW/ton (or COP) at 25%

Weighting

The percent of annual hours of operation at the four load points are as follows:

100% Load at 1% of operating time
75% Load at 42% of operating time
50% Load at 45% of operating time
25% Load at 12% of operating time

Tolerances

The AHRI test tolerance, per AHRI Standard 550/590-98, for capacity (tons), power input per ton (kW/ton), and heat balance is:

$$\%Tolerance = 10.5 - (0.07x\%FL) + \left(\frac{1500}{DTFLx\%FL}\right)$$

Where:

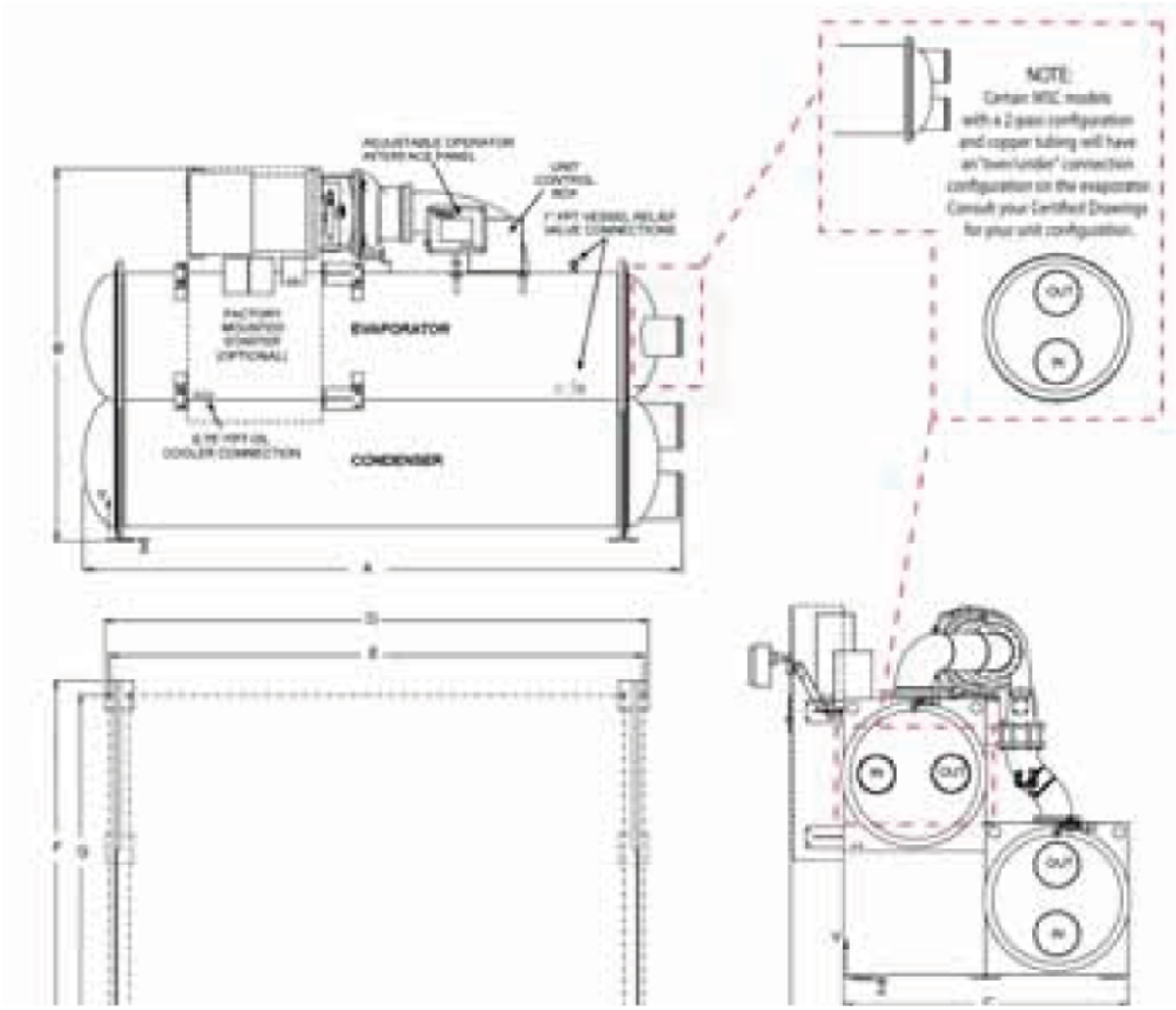
FL = Full Load

DTFL = Chilled Water Delta-T at Full Load

This formula results in a ±5% tolerance on tons and kW/ton at the 100% load point and AHRI conditions.

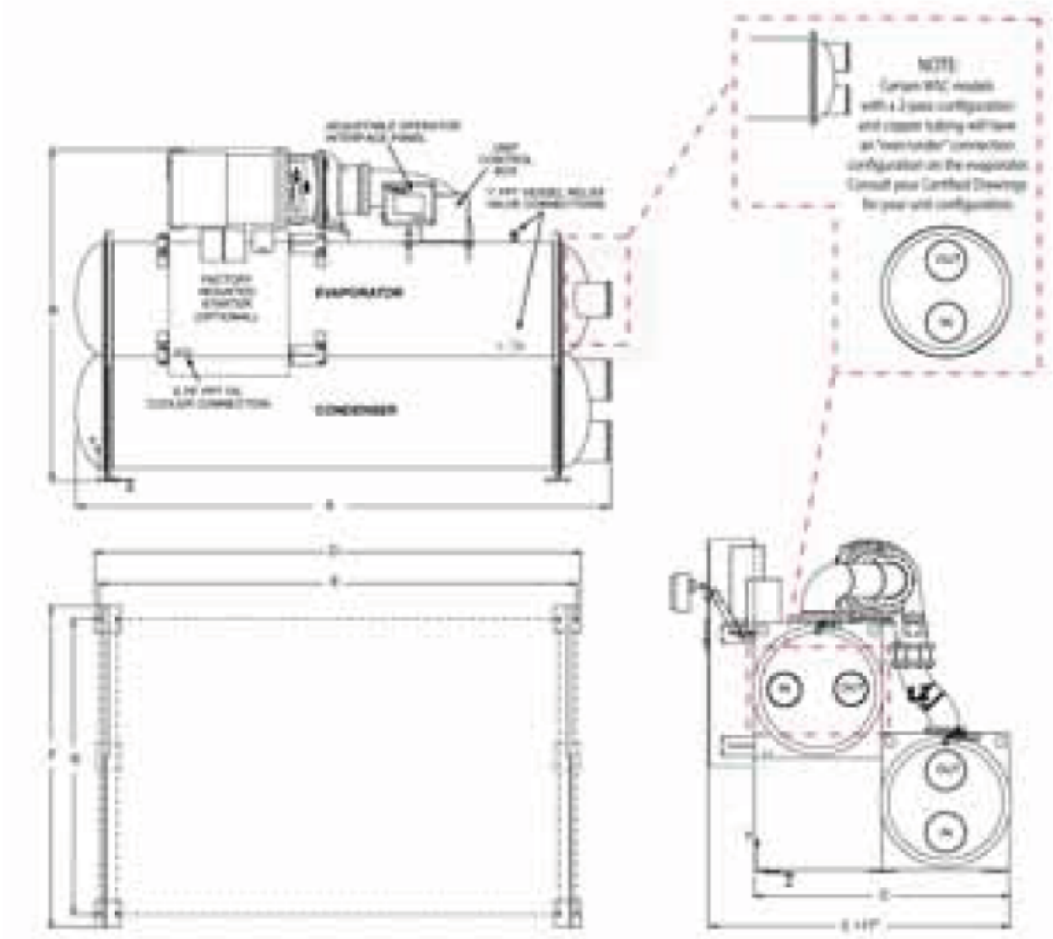
Dimensions

Figure 22: WSC063 (160-300 tons/ 560 to 1050 kW) See Drawing Notes page 44



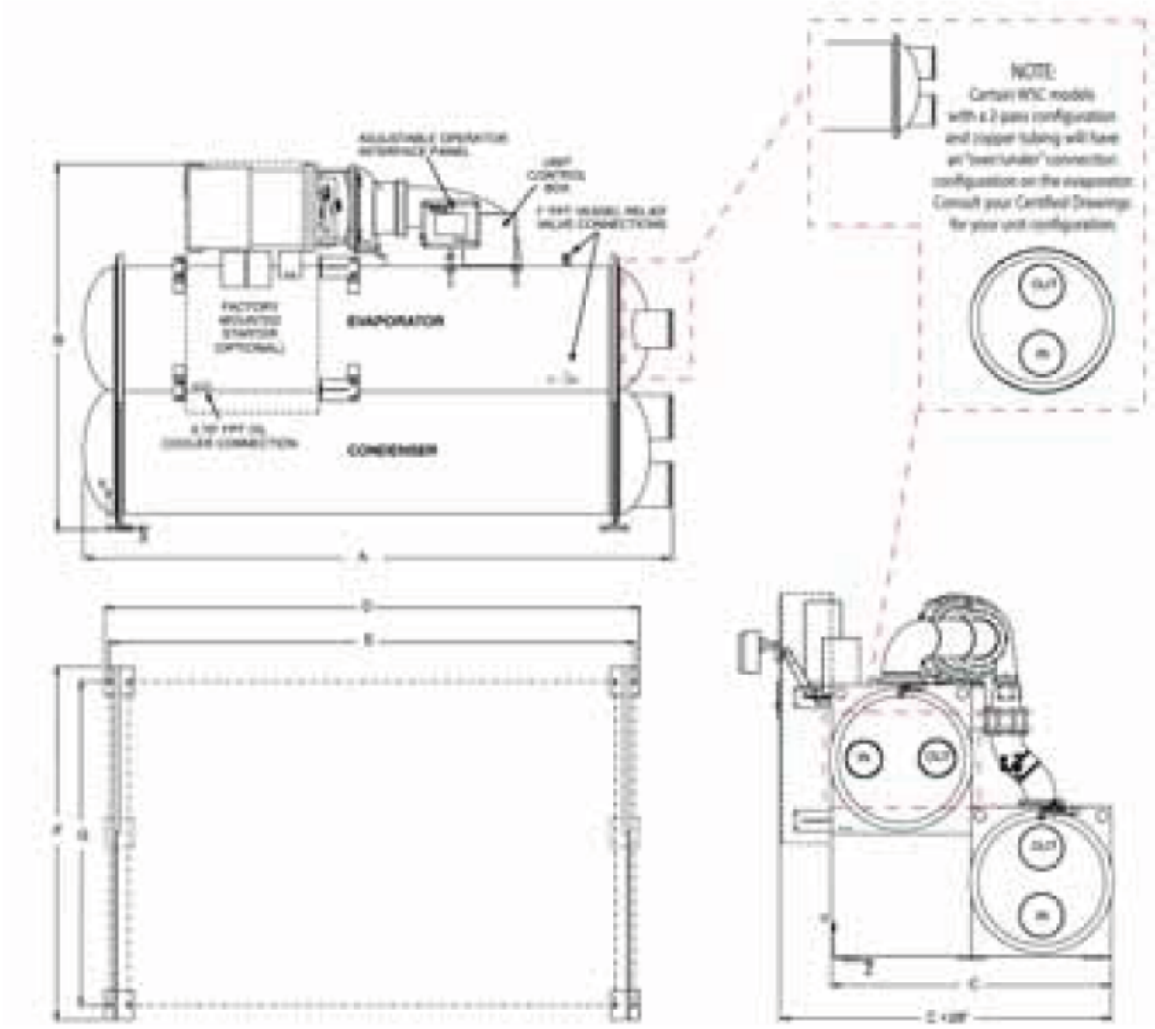
VESSEL CODE		OVERALL LENGTH			OVERALL HEIGHT	OVERALL WIDTH W/O STARTER	CENTER OF GRAVITY			FOOTPRINT				CONNECTIONS	
EVAP	COND	1&3-PASS	2-PASS	HEAD CONN. BOTH ENDS										EVAP 2-PASS	COND 2-PASS
		A	A	A	B	C	X	Y	Z	D	E	F	G		
E2009	C1809	134 (3404)	128 (3251)	134 (3404)	76 (1930)	42 (1067)	50 (1270)	37 (940)	16 (406)	113 (2870)	111 (2819)	42 (1067)	34 (864)	6	6
E2012	C1812	169 (4293)	163 (4140)	169 (4293)	76 (1930)	42 (1067)	68 (1727)	36 (914)	17 (432)	148 (3759)	145 (3683)	42 (1067)	34 (864)	6	6
E2209	C2009	134 (3404)	129 (3277)	134 (3404)	76 (1930)	42 (1067)	50 (1270)	36 (914)	17 (432)	113 (2870)	111 (2819)	42 (1067)	34 (864)	8	6
E2212	C2012	169 (4293)	164 (4166)	169 (4293)	76 (1930)	42 (1067)	68 (1727)	34 (864)	17 (432)	148 (3759)	145 (3683)	42 (1067)	34 (864)	8	6
E2209	C2209	134 (3404)	129 (3277)	134 (3404)	76 (1930)	42 (1067)	51 (1295)	35 (889)	17 (432)	113 (2870)	111 (2819)	42 (1067)	34 (864)	8	8
E2212	C2212	169 (4293)	164 (4166)	169 (4293)	76 (1930)	42 (1067)	68 (1727)	34 (864)	17 (432)	148 (3759)	145 (3683)	42 (1067)	34 (864)	8	8
E2609	C2209	134 (3404)	129 (3277)	134 (3404)	80 (2032)	46 (1168)	51 (1295)	37 (940)	20 (508)	113 (2870)	111 (2819)	46 (1168)	38 (965)	8	8
E2612	C2212	169 (4293)	164 (4166)	169 (4293)	80 (2032)	46 (1168)	69 (1753)	35 (889)	20 (508)	148 (3759)	145 (3683)	46 (1168)	38 (965)	8	8
E2609	C2609	134 (3404)	129 (3277)	134 (3404)	86 (2184)	48 (1219)	51 (1295)	40 (1016)	20 (508)	113 (2870)	111 (2819)	48 (1219)	40 (1016)	8	8
E2612	C2612	169 (4293)	164 (4166)	169 (4293)	86 (2184)	48 (1219)	69 (1753)	38 (965)	21 (533)	148 (3759)	145 (3683)	48 (1219)	40 (1016)	8	8
E3012	C2612	175 (4445)	167 (4242)	175 (4445)	90 (2286)	53 (1346)	67 (1702)	41 (1041)	21 (533)	148 (3759)	145 (3683)	53 (1646)	45 (1143)	10	8
E3009	C2609	140 (3556)	132 (3353)	140 (3556)	91 (2235)	52 (1321)	52 (1321)	41 (1041)	25 (635)	113 (2870)	111 (2819)	56 (1422)	48 (1219)	10	8

Figure 23: WSC079/087 (300-600 tons/ 1050 to 2110 kW) See Drawing Notes page 44



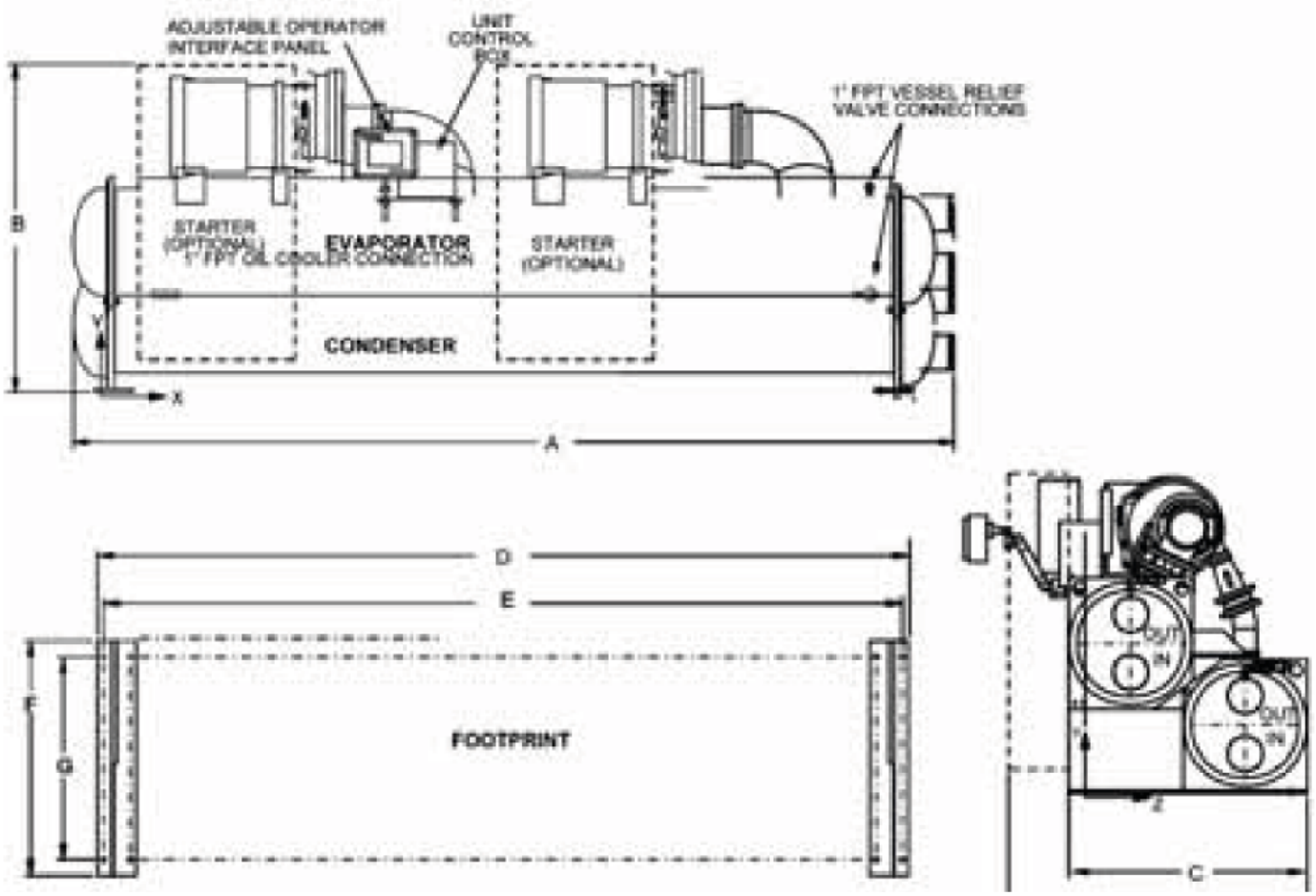
VESSEL CODE		"A" OVERALL LENGTH			OVERALL HEIGHT	OVERALL WIDTH W/O STARTER	CENTER OF GRAVITY			FOOTPRINT				CONNECTIONS	
EVAP	COND	1&3 PASS	2 PASS	HEAD CONN. BOTH ENDS										EVAP 2-PASS	COND 2-PASS
		A	A	A	B	C	X	Y	Z	D	E	F	G		
E2209[5]	C2209[5]	134 (3404)	129 (3277)	134 (3404)	74 (1880)	45 (1143)	50 (1270)	35 (889)	18 (457)	113 (2870)	111 (2819)	45 (1173)	37 (9398)	8	8
E2212[5]	C2212[5]	169 (4293)	164 (4166)	169 (4293)	74 (1880)	45 (1143)	68 (1727)	34 (864)	18 (457)	148 (3759)	145 (3683)	45 (1173)	37 (9398)	8	8
E2609	C2209	134 (3404)	129 (3277)	134 (3404)	78 (1981)	49 (1245)	51 (1295)	40 (1016)	22 (559)	113 (2870)	111 (2819)	49 (1245)	41 (1041)	8	8
E2612	C2212	169 (4293)	164 (4166)	169 (4293)	78 (1981)	49 (1245)	69 (1753)	35 (889)	21 (533)	148 (3759)	145 (3683)	49 (1245)	41 (1041)	8	8
E2609	C2609	134 (3404)	129 (3277)	134 (3404)	83 (2108)	52 (1321)	51 (1295)	37 (940)	21 (533)	113 (2870)	111 (2819)	52 (1321)	44 1118)	8	8
E2612	C2612	169 (4293)	164 (4166)	169 (4293)	83 (2108)	52 (1321)	69 (1753)	38 (965)	22 (559)	148 (3759)	145 (3683)	52 (1321)	44 1118)	8	8
E3009	C2609	140 (3556)	132 (3353)	140 (3556)	88 2235)	56 (1422)	52 (1321)	41 (1041)	25 (635)	113 (2870)	111 (2819)	56 (1422)	48 (1219)	10	8
E3009	C3009	140 (3556)	132 (3353)	140 (3556)	93 (2362)	58 (1473)	52 (1321)	43 (1092)	26 (660)	113 (2870)	111 (2819)	58 (1473)	50 (1270)	10	10
E3012	C2612	175 (4445)	167 (4242)	175 (4445)	88 (2235)	56 (1422)	69 (1753)	40 (1016)	25 (635)	148 (3759)	145 (3683)	56 (1422)	48 (1219)	10	8
E3012	C3012	175 (4445)	167 (4242)	175 (4445)	93 (2362)	58 (1473)	70 (1778)	41 (1041)	26 (660)	148 (3759)	145 (3683)	58 (1473)	50 (1270)	10	10
E3609	C3009	140 (3556)	133 (3378)	140 (3556)	94 (2388)	74 (1880)	52 (1321)	43 (1092)	34 (864)	113 (2870)	111 (2819)	74 (1880)	66 (1676)	12	10
E3612	C3012	175 (4445)	168 (4267)	175 (4445)	94 (2388)	74 (1880)	70 (1778)	41 (1041)	34 (864)	148 (3759)	145 (3683)	74 (1879)	66 (1676)	12	10
E3612[6]	C3612[6]	175 (4445)	168 (4267)	175 (4445)	105 (2667)	80 (2032)	70 (1778)	46 (1168)	38 (965)	148 (3759)	145 (3683)	80 (2032)	72 (1829)	12	12

Figure 24: WSC100/113/126 (600-1250 tons/ 2100 to4400 kW) See Drawing Notes page 44



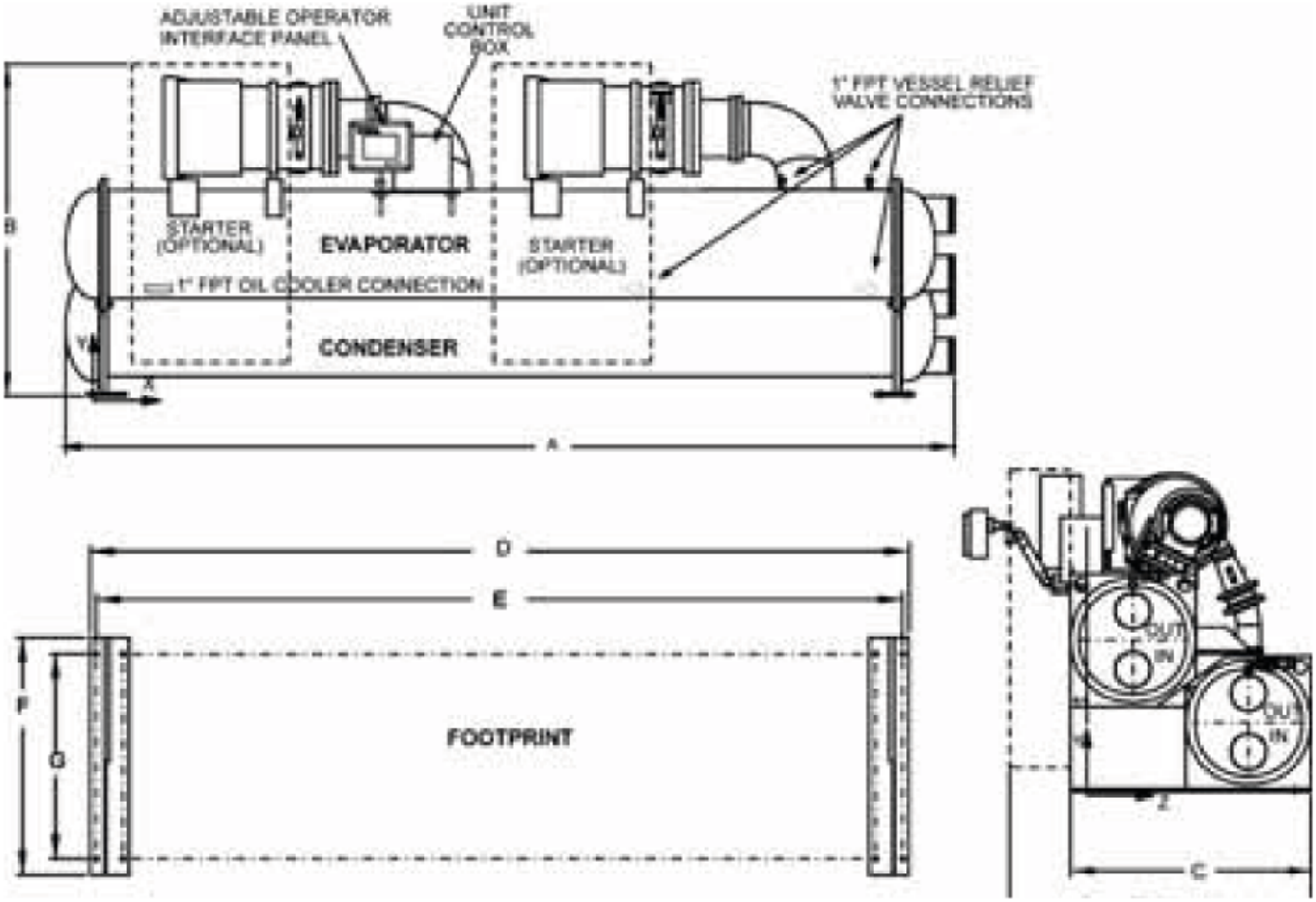
VESSEL CODE		OVERALL LENGTH			OVERALL HEIGHT	OVERALL WIDTH W/O STARTER	CENTER OF GRAVITY			FOOTPRINT				CONNECTIONS (NOTE 10)	
EVAP	COND	1&3 PASS	2 PASS	HEAD CONN BOTH ENDS										EVAP 2-PASS	COND 2-PASS
		A	A	A	B	C	X	Y	Z	D	E	F	G		
E3612	C3012	175 (4445)	168 (4267)	175 (4445)	99 (2515)	74 (1880)	68 (1727)	47 (1194)	27 (686)	148 (3759)	145 (3683)	74 (1880)	66 (1676)	12	10
E3612	C3612	175 (4445)	168 (4267)	175 (4445)	99 (2515)	80 (2032)	68 (1727)	46 (1168)	31 (787)	148 (3759)	145 (3683)	80 (2032)	72 (1829)	12	12
E4212	C3612	175 (4445)	170 (4318)	175 (4445)	99 (2515)	86 (2184)	69 (1753)	45 (1143)	35 (889)	148 (3759)	145 (3683)	86 (2184)	78 (1981)	14	12
E4212	C4212	175 (4445)	170 (4318)	175 (4445)	102 (2591)	92 (2337)	69 (1753)	45 (1143)	37 (940)	148 (3759)	145 (3683)	92 2337)	84 (2134)	14	14
E4812	C4212	181 (4597)	175 (4445)	181 (4597)	106 (2692)	98 (2489)	69 (1753)	46 (1168)	42 1067)	148 (3759)	145 (3683)	98 2489)	90 (2286)	18	14
E4812[7]	C4812[7]	181 (4597)	175 (4445)	181 (4597)	106 (2692)	104 (2642)	70 (1778)	46 (1168)	46 (1168)	145 (3683)	145 (3683)	104 (2642)	96 (2438)	18	18

Figure 25: WDC063 (400-600 tons / 1400-2100 kW) See Drawing Notes page 44



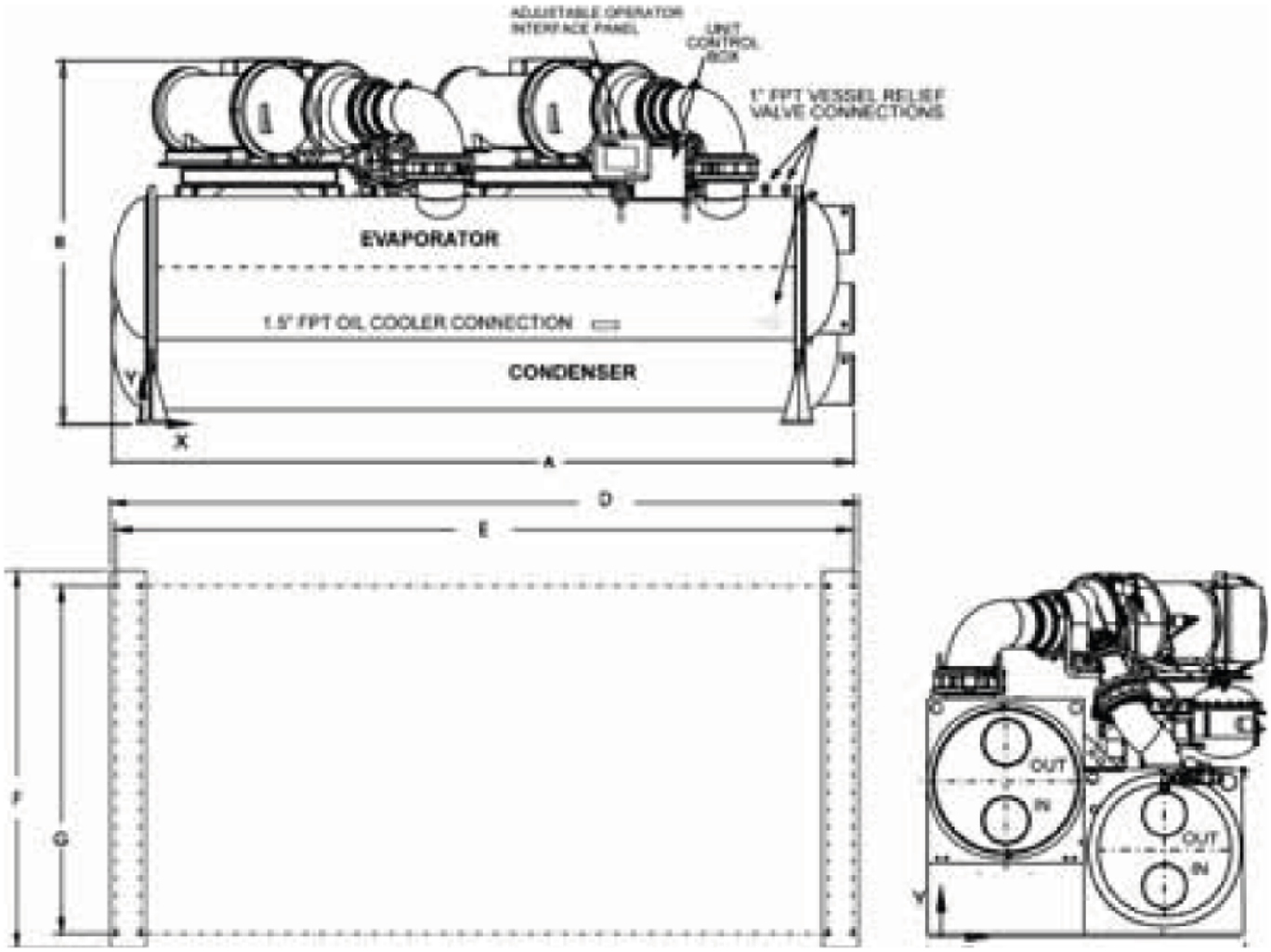
VESSEL CODE		OVERALL LENGTH			OVERALL HEIGHT	OVERALL WIDTH W/O STARTER	CENTER OF GRAVITY			FOOTPRINT				CONNECTIONS	
EVAP	COND	1&3 PASS	2 PASS	HEAD CONN BOTH ENDS										EVAP 2 PASS	COND 2 PASS
		A	A	A	B	C	X	Y	Z	D	E	F	G		
E2416	C2416	218 (5544)	214 (5426)	218 (5544)	80 (2032)	58 (1470)	91 (2318)	36 (911)	17 (425)	199 (5048)	196 (4972)	58 (1470)	50 (1267)	8	8
E2416	C2616	218 (5544)	214 (5426)	218 (5544)	80 (2032)	58 (1470)	91 (2324)	35 (895)	17¼ (438)	199 (5048)	196 (4972)	58 (1470)	50 (1267)	8	8
E2616	C2416	218 (5544)	214 (5426)	218 (5544)	80 (2032)	58 (1470)	91 (2324)	36 (911)	16 (419)	199 (5048)	196 (4972)	58 (1470)	50 (1267)	8	8
E2616	C2616	218 (5544)	214 (5426)	218 (5544)	80 (2032)	58 (1470)	92 (2340)	35 (899)	17 (435)	199 (5048)	196 (4972)	58 (1470)	50 (1267)	8	8
E3016	C3016	221 (5623)	214 (5445)	221 (5623)	90 (2280)	64 (1619)	95 (2410)	40 (1029)	21 (537)	199 (5048)	196 (4972)	64 (1619)	56 (1416)	10	10
E3616	C3616	224 (5685)	218 (5518)	224 (5685)	106 (2686)	75 (1886)	(2)	(2)	(2)	199 (5048)	196 (4972)	75 (1886)	67 (1682)	12	12

Figure 26: WDC079/087 (600-1200 tons/ 2100-4220 kW) See Drawing Notes page 44



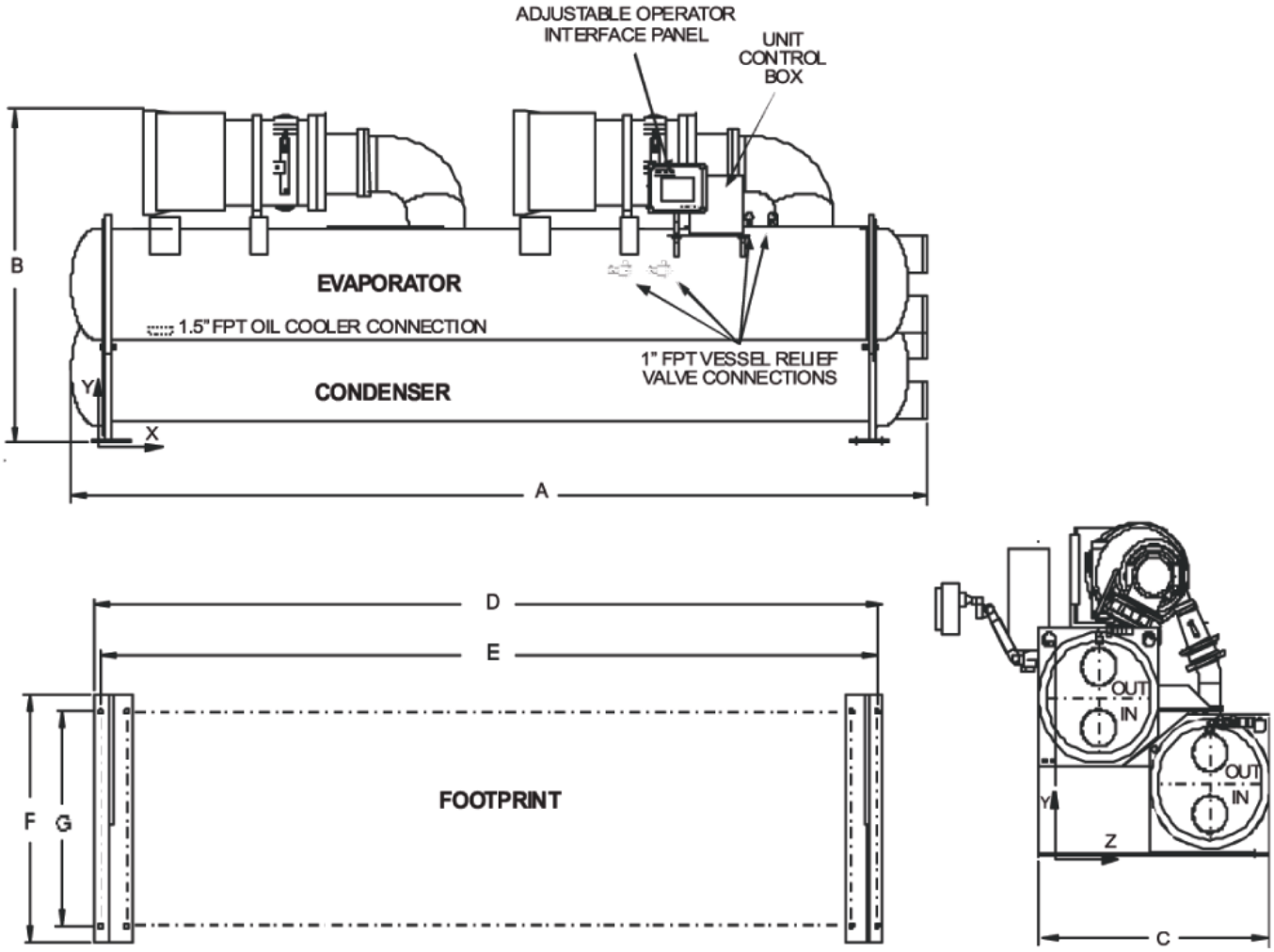
VESSEL CODE		OVERALL LENGTH			OVERALL HEIGHT	OVERALL WIDTH W/O STARTER	CENTER OF GRAVITY			FOOTPRINT				CONNECTIONS	
EVAP	COND	1&3 PASS	2 PASS	HEAD CONN BOTH ENDS										EVAP 2 PASS	COND 2 PASS
		A	A	A	B	C	X	Y	Z	D	E	F	G		
E3016	C3016	221 (5620)	214 (5442)	221 (5620)	95 (2413)	57 (1454)	93 (2369)	44 (1127)	19 (492)	199 (5050)	196 (4974)	57 (1453)	49 (1250)	10	10
E3616	C3016	224 (5696)	218 (5531)	224 (5696)	100 (2530)	71 (1808)	94 (2388)	45 (1149)	32 (803)	199 (5050)	196 (4974)	71 (1803)	63 (1600)	12	10
E3616	C3616	224 (5698)	218 (5531)	224 (5698)	106 (2686)	74 (1886)	94 (2392)	48 (1232)	32 (822)	199 (5050)	196 (4974)	74 (1886)	66 (1682)	12	12
E4216	C4216	224 (5698)	219 (5556)	224 (5698)	93 (2362)	93 (2362)	97 (2458)	44 (1127)	47 (1172)	199 (5050)	196 (4974)	93 (2343)	84 (2134)	14	14

Figure 27: WDC100 - 16' Shells (1200-1700 tons/ 4200-5950 kW) Medium Voltage (<7kV) ONLY (See Drawing Notes page 44)
WDC113 - 16' shells (1400-1900 tons / 4900-6700 kW) Medium Voltage (<7kV) ONLY (See Drawing Notes page 44)
WDC126 - 16' shells (1600-2700 tons / 5600-9450 kW) Medium Voltage (<7kV) ONLY (See Drawing Notes page 44)



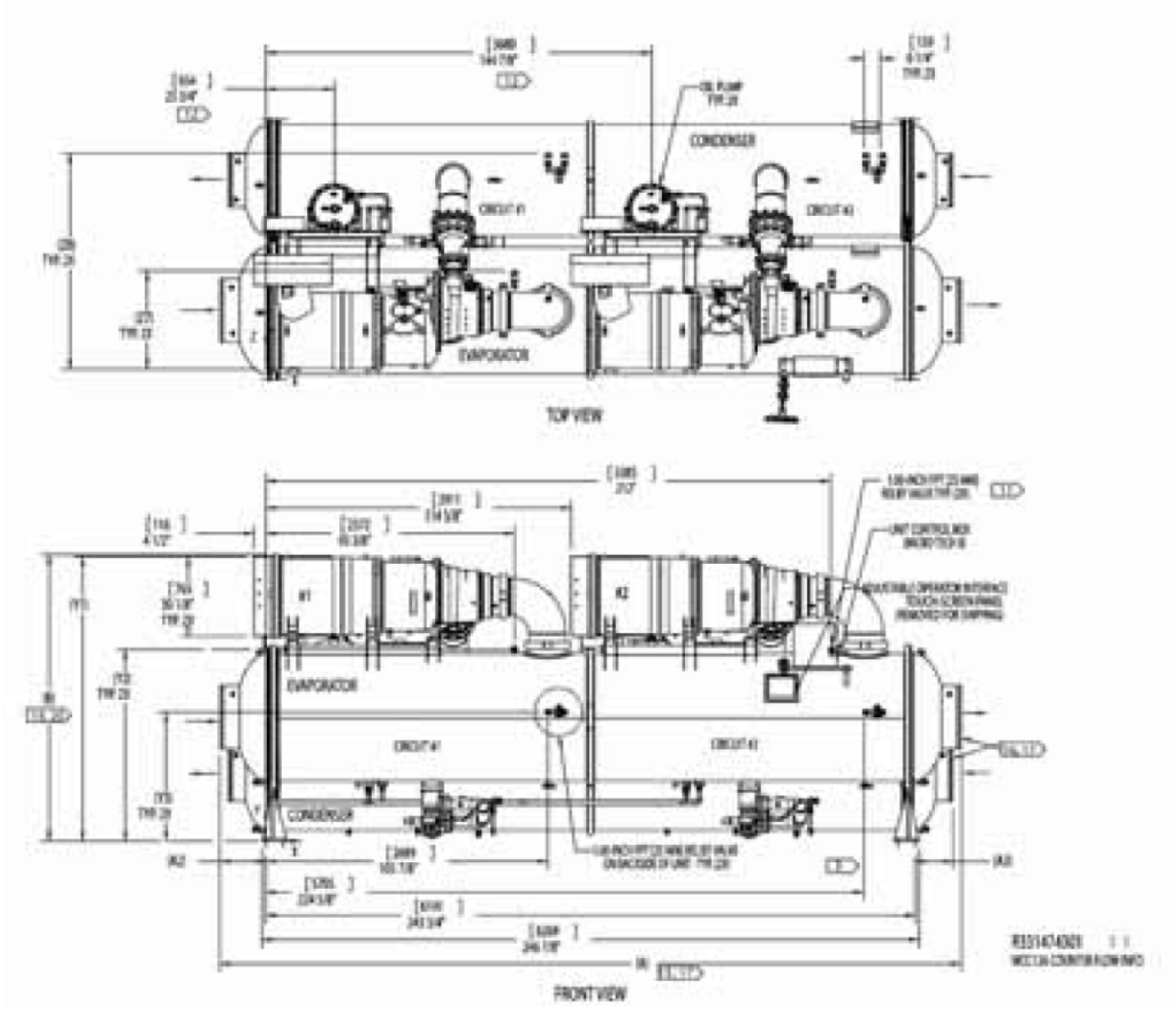
VESSEL CODE		OVERALL LENGTH			OVERALL HEIGHT	OVERALL WIDTH W/O STARTER	CENTER OF GRAVITY W/O STARTER			FOOTPRINT				CONNECTIONS	
EVAP	COND	1&3 PASS	2 PASS	HEAD CONN BOTH ENDS										EVAP 2 PASS	COND 2 PASS
		A	A	A	B	C	X	Y	Z	D	E	F	G		
E3616	C3616	224 (5692)	218 (5528)	224 (5692)	105 (2667)	95 (2419)	93 (2353)	51 (1292)	40 (1003)	199 (5050)	196 (4974)	95 (2419)	87 (2216)	12	12
E4216	C4216	224 (5692)	219 (5554)	224 (5692)	108 (2743)	100 (2545)	94 (2381)	50 (1254)	44 (1105)	199 (5050)	196 (4974)	100 (2545)	92 (2342)	14	16
E4816	C4816	230 (5848)	224 (5703)	230 (5848)	115 (2921)	110 (2792)	95 (2400)	52 (1318)	51 (1292)	199 (5050)	196 (4974)	110 (2792)	102 (2589)	18	18

Figure 28: WDC100 - 20' Shells (1200-1700 tons/ 4200-5950 kW) Medium Voltage (<7kV) ONLY (See Drawing Notes page 44)
WDC113 - 20' Shells (1400-1900 tons / 4900-6700 kW) Medium Voltage (<7kV) ONLY (See Drawing Notes page 44)
WDC126 - 20' Shells (1600-2700 tons / 5600-9450 kW) Medium Voltage (<7kV) ONLY (See Drawing Notes page 44)



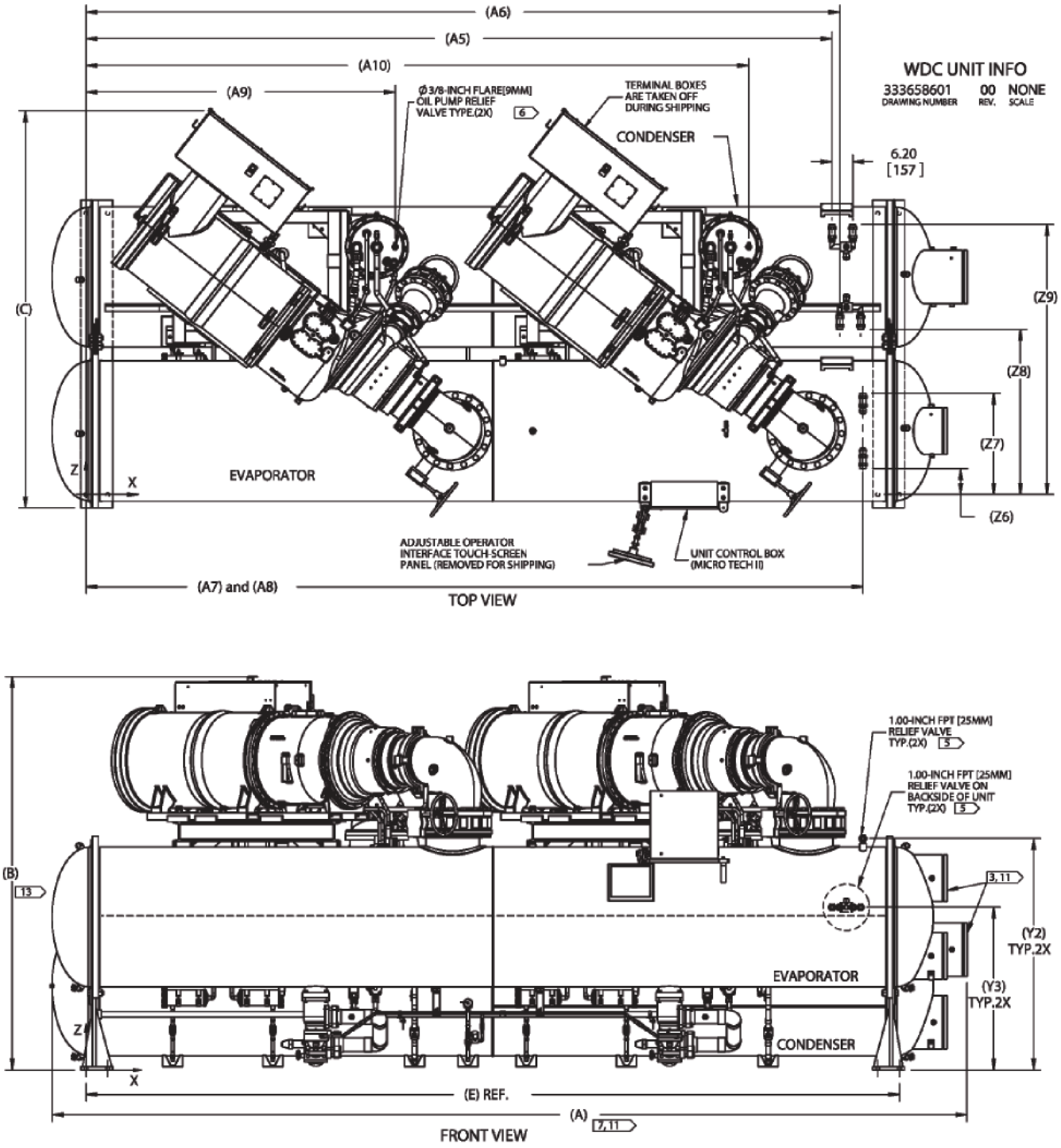
VESSEL CODE		OVERALL LENGTH			OVERALL HEIGHT	OVERALL WIDTH W/O STARTER	CENTER OF GRAVITY			FOOTPRINT				CONNECTIONS	
EVAP	COND	1&3 PASS	2 PASS	HEAD CONN BOTH ENDS										EVAP 2 PASS	COND 2 PASS
		A	A	A	B	C	X	Y	Z	D	E	F	G		
E4220	C4220	272 (6909)	267 (6772)	272 (6909)	102 (2591)	92 (2343)	117 (2991)	46 (1165)	36 (921)	247 (6269)	244 (6193)	92 (2343)	84 (2140)	14	16
E4820	C4820	276 (7010)	271 (6890)	276 (7010)	110 (2794)	104 (2648)	118 (3007)	49 (1238)	43 (1105)	247 (6269)	244 (6193)	104 (2648)	96 (2444)	18	18

Figure 29: WCC100/113/126 (1200-2700 tons / 4220 to9450 kW) See Drawing Notes page 44



EVAP	COND	OVERALL LENGTH 1 PASS EVAP	OVERALL LENGTH 1 PASS COND	OVERALL UNIT HEIGHT	OVERALL WIDTH W/O STARTERS	WIDTH MTG. HOLES ON FOOT	CENTER OF GRAVITY (SHIPPING)			CENTER OF GRAVITY (OPERATING)		
		A	A1	B	C	C1	X	Y	Z	X	Y	Z
E3620	C3620	272 1/4	272 1/4	100 3/8	80 1/4	72 1/4	115	48 3/4	30 1/2	115 3/4	47 1/4	30 7/8
		(6915)	(6915)	(2550)	(2038)	(1835)	(2921)	(1238)	(775)	(2940)	(1200)	(784)
E4220	C3620	272 1/4	272 1/4	101 7/8	86 1/4	78 1/4	115 3/4	47 1/2	34 1/8	116 1/2	46 1/8	34 1/8
		(6915)	(6915)	(2588)	(2191)	(1988)	(2940)	(1207)	(867)	(2959)	(1172)	(867)
E4220	C4220	272 1/4	272 1/4	104 5/8	92 1/4	84 1/4	116 1/4	48	38	117 1/4	45 7/8	38 3/4
		(6915)	(6915)	(2658)	(2343)	(2140)	(2953)	(1219)	(965)	(2978)	(1165)	(984)
E4820	C4220	278 1/4	272 1/4	108 1/4	98 1/4	90 1/4	116 3/4	49	40 3/4	117 1/2	47 1/2	40 7/8
		(7068)	(6915)	(2750)	(2496)	(2292)	(2965)	(1245)	(1035)	(2985)	(1207)	(1038)
E4820	C4820	278 1/4	278 1/4	110 3/8	104 1/4	96 1/4	117 3/8	48 7/8	45 1/2	118	47 3/8	45 5/8
		(7068)	(7068)	(2804)	(2648)	(2445)	(2981)	(1241)	(1156)	(2997)	(1203)	(1159)

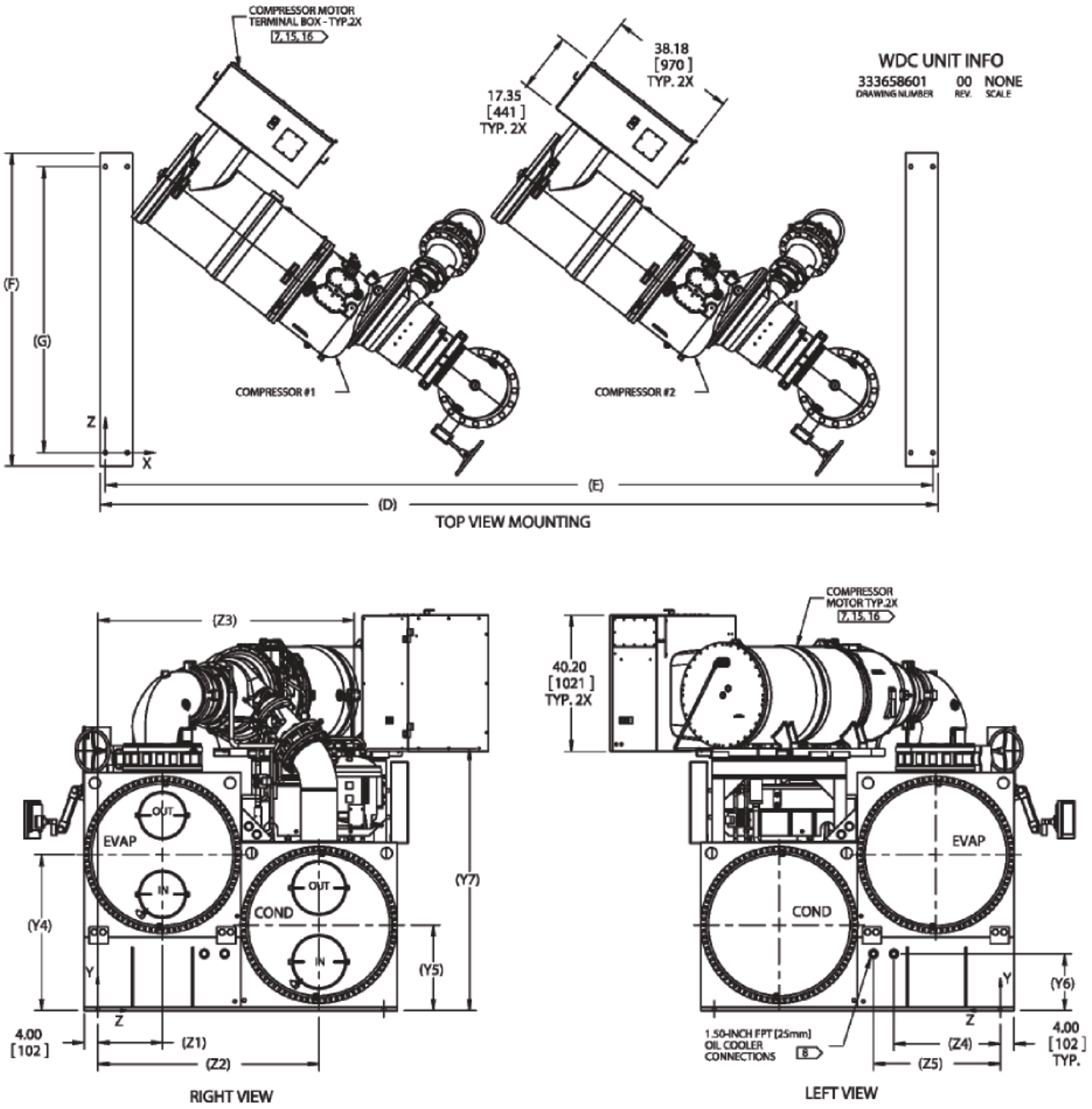
Figure 30: WDC 100/113/126 (Higher Voltage Models - 10/11kV only) continued next page



VESSEL CODE		OVERALL UNIT LENGTH			OVERALL UNIT HEIGHT	OVERALL UNIT WIDTH	FOOTPRINT				CENTER OF GRAVITY (SHIPPING)			CENTER OF GRAVITY (OPERATING)		
EVAP	COND	1 & 3 PASS	2 PASS	HEADCONN BOTH ENDS												
		A	A	A	B	C	D	E	F	G	X	Y	Z	X	Y	Z
E42 16	C12 16	224.3 (5698)	226.2 (5745)	230.3 (5850)	119.5 (3036)	119.5 (3036)	198.8 (5050)	195.8 (4974)	92.2 (2343)	84.2 (2140)	92.9 (2360)	52.8 (1342)	50.8 (1289)	93.8 (2382)	50.7 (1286)	49.4 (1254)
E42 20	C4220	272.3 (6917)	274.3 (6964)	278.3 (7069)	118.0 (2997)	119.0 (3024)	246.8 (6269)	243.8 (6193)	92.2 (2343)	84.2 (2140)	118.1 (2999)	50.0 (1270)	51.0 (1294)	118.9 (3019)	48.1 (1221)	49.4 (1255)
E48 16	C4820	278.3 (7069)	278.8 (7080)	284.3 (7221)	124.1 (3152)	122.0 (3100)	246.8 (6269)	243.8 (6191)	104.2 (2648)	96.2 (2444)	118.9 (3019)	51.1 (1297)	55.7 (1413)	120.0 (3047)	49.1 (1247)	54.0 (1373)

Note: This drawing for high-voltage models only. See drawing notes Figure 36, page 44.

Figure 31: WDC 100/113/126 (Higher Voltage Models - 10/11kV only) continued



COND	EVAP	EVAPORATOR HEADS					CONDENSER HEADS				
		CONN. 1 PASS	CONN. 2 APSS	CONN. 3 PASS	Y4	Z1	CONN. 1 PASS	CONN. 2 APSS	CONN. 3 PASS	Y5	Z2
E4216	C4216	20.00 (508)	14.00 (356)	10.75 (273)	45.9 (1166)	19.1 (484)	20.00 (508)	16.00 (406)	10.75 (273)	25.3 (641)	65.2 (1656)
E4220	C4220	20.00 (508)	14.00 (356)	10.75 (273)	45.9 (1166)	19.1 (484)	20.00 (508)	16.00 (406)	10.75 (273)	25.3 (641)	65.2 (1656)
E4820	C4820	24.00 (610)	18.00 (457)	12.75 (324)	49.0 (1245)	22.1 (560)	24.00 (610)	18.00 (457)	12.75 (324)	28.3 (718)	74.2 (1884)

Note: This drawing for high-voltage models only. See drawing notes Figure 36, page 44

Figure 32: WDC 100/113/126 High-Voltage Models (10/11kV) Dimension Details

EVAP	COND	EVAP. RELIEF VALVES					COND. RELIFE VALVES					OIL PUMP RELIFE VALVES				OIL COOLER CONNECTIONS		
		BOTH CIRCUITS					BOTH CIRCUITS					BOTH CIRCUITS				INLET	INLET	OUTLET
		Y2	A7	A8	Z6	Z7	Y3	A5	A6	Z8	Z9	Y7	A9	A10	Z3	Y6	Z4	Z5
E4216	C4216	69.4 (1764)	176.9 (4493)	186.9 (4747)	30.6 (778)	30.6 (778)	48.8 (1240)	67.6 (1718)	155.6 (3953)	80.9 (2056)	80.9 (2056)	78.7 (2000)	76.5 (1943)	164.5 (4178)	75.6 (1919)	16.7 [425]	31.4 [797]	37.4 [949]
E4220	C4220	69.4 (1764)	232.9 (5916)	232.9 (5916)	7.8 (197)	30.4 (771)	48.8 (1240)	223.6 (5680)	226.0 (5740)	49.4 (1255)	80.9 (2056)	77.2 (1960)	92.7 (2354)	198.7 (5046)	75.6 (1919)	16.7 [425]	31.4 [797]	37.4 [949]
E4820	C4820	75.6 (1920)	232.9 (5916)	232.9 (5916)	10.8 (273)	33.6 (854)	54.6 (1387)	225.6 (5731)	228.0 (5791)	57.7 (1465)	90.7 (2303)	83.3 (2115)	92.7 (2354)	198.7 (5046)	82.1 (2085)	16.9 (428)	37.4 (949)	43.4 (1102)

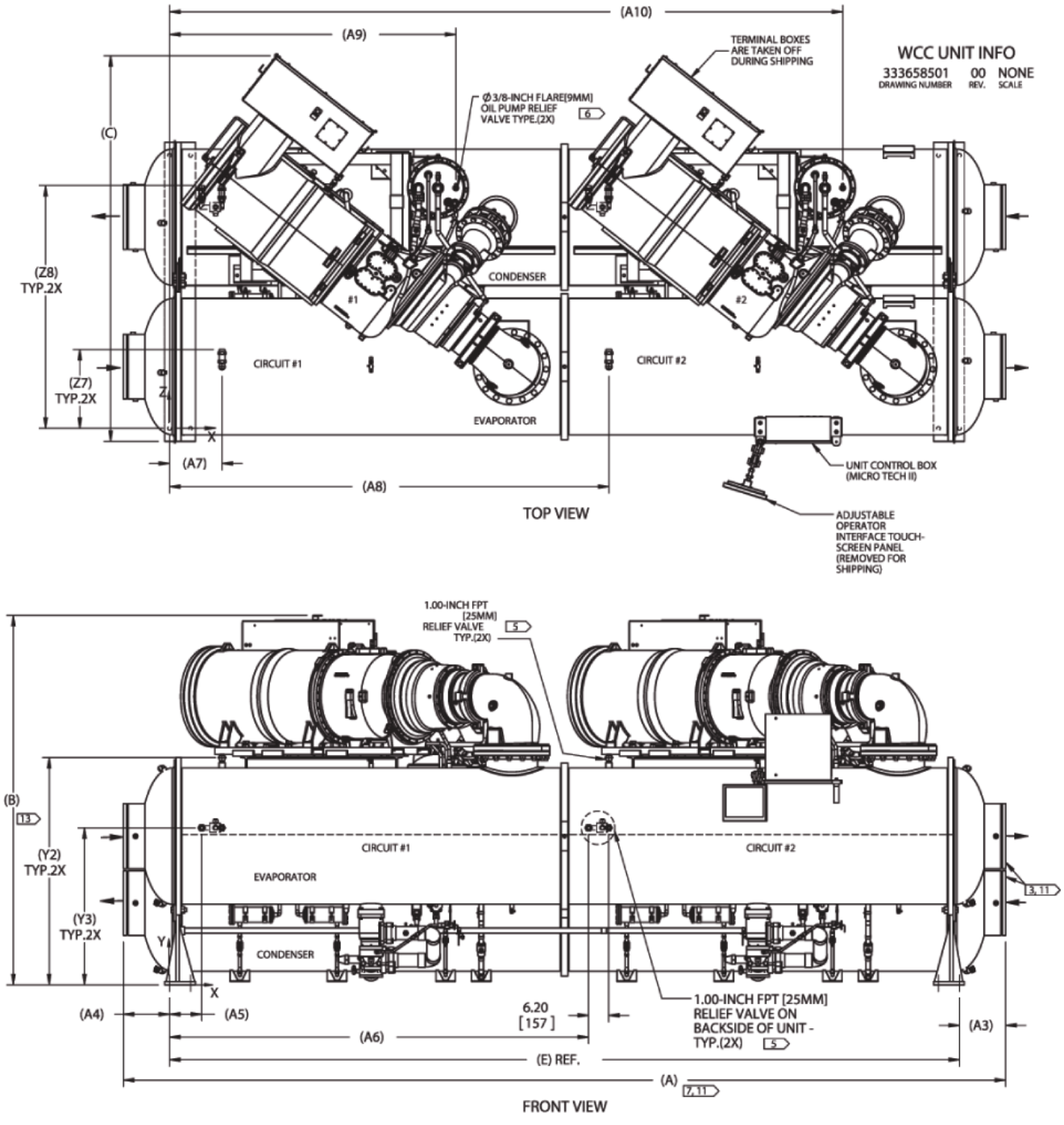
EVAP	COND	CORNER WEIGHTS - L BS (KG) WITHOUT STARTERS		
		CORNER	SHIP	OPERAT.
E4216	C4216	LF (LEFT FRONT)	11,638 (5,279)	13,699 (6,214)
		LB (LEFT BACK)	17,660 (8,010)	19,406 (8,802)
		RF RIGHT FRONT)	10,512 (4,768)	12,593 (5,712)
		RB (RIGHT BACK)	15,550 (7,235)	17,838 (8,091)
E4220	C4220	LF (LEFT FRONT)	12,649 (5,737)	15,116 (6,856)
		LB (LEFT BACK)	19,391 (8,795)	21,487 (9,746)
		RF (RIGHT FRONT)	11,882 (5,389)	14,381 (6,523)
		RB (RIGHT BACK)	18,215 (8262)	20,442 (9,273)
E4820	C4820	LF (LEFT FRONT)	15,883 (7,204)	19,207 (8,712)
		LB (LEFT BACK)	21,795 (9,886)	24,623 (11,169)
		RF (RIGHT FRONT)	15,112 (6,855)	18,603 (8,438)
		RB (RIGHT BACK)	20,737 (9,406)	23,849 (10,818)

WDC UNIT INFO

333658601 DRAWING NUMBER | 00 REV. | NONE SCALE

Note: This drawing for high-voltage models only. See drawing notes Figure 36, page 44

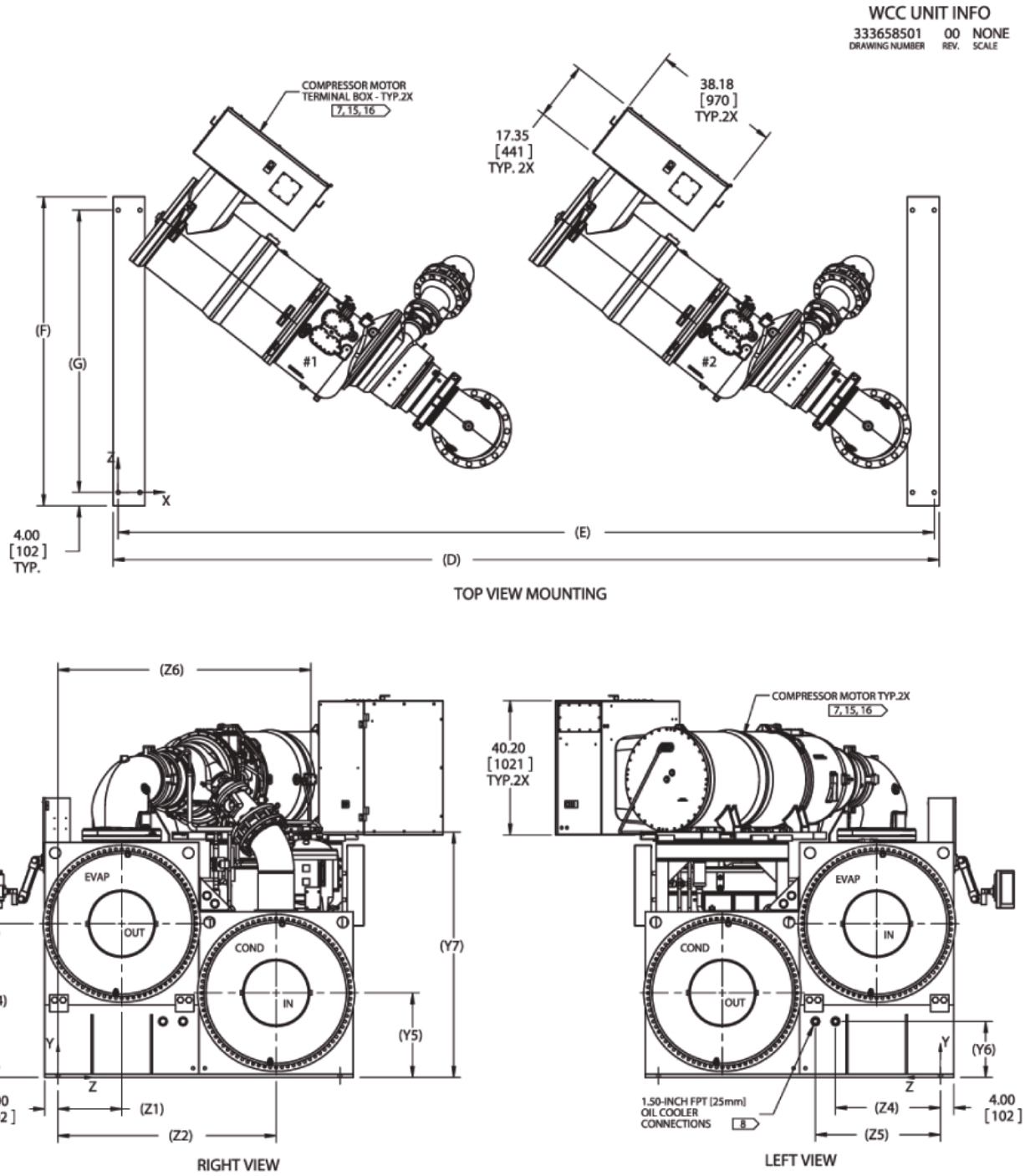
Figure 33: WCC 100/113/126 Higher Voltage Models (10/11kV) only (continued on next page)



EVAP	COND	OVERALL UNIT LENGTH	OVERALL UNIT HEIGHT	OVERALL UNIT WIDTH	FOOTPRINT				CENTER OF GRAVITY (SHIPPING)			CENTER OF GRAVITY (OPERATING)		
		A	B	C	D	E	F	G	X	Y	Z	X	Y	Z
E4220	C4220	2723 (6917)	114.0 (2897)	119.0 (3024)	246.8 (6269)	243.8 (6193)	92.2 (2343)	84.2 (2140)	117.5 (2984)	49.3 (1251)	51.8 (1316)	118.0 (2997)	47.3 (1201)	50.7 (1287)
E4820	C4820	278.3 (7069)	120.2 (3052)	122.0 (3100)	246.8 (6269)	243.8 (6193)	104.2 (2648)	96.2 (2444)	118.0 (2998)	50.3 (1277)	57.5 (1461)	118.5 (3011)	48.3 (1226)	56.2 (1426)

Note: This drawing for high-voltage models only. See drawing notes Figure 36, page 44.

Figure 34: WCC 100/113/126 Higher Voltage Models (10/11kV) only (continued)



COND	EVAP	EVAPORATOR HEADS				CONDENSER HEADS			
		CONNECTIONS 1 PASS	A3	Y4	Z1	CONNECTIONS 1 PASS	A4	Y5	Z2
E4220	C4220	20.0 (508)	14.3 (362)	45.9 (1166)	19.1 (484)	20.0 (508)	14.3 (362)	25.3 (641)	65.2 (1656)
E4820	C4820	24.0 (610)	17.2 (438)	49.0 (1245)	22.1 (560)	24.0 (610)	17.3 (438)	28.3 (718)	74.2 (1884)

Note: This drawing for high-voltage models only. See drawing notes Figure 36, page 44.

Figure 35: WCC 100/113/126 High-Voltage Models (10/11kV) Dimension Details

EVAP	COND	EVAP. RELIEF VALVES			COND. RELIEF VALVES			OIL PUMP RELIEF VALVES			OIL COOLER CONNECTIONS		
		BOTH CIRCUITS			BOTH CIRCUITS			BOTH CIRCUITS			INLET	INLET	OUTLET
		Y2	A7	A8	Y3	A5	A6	Y7	A9	A10	Y6	Z4	Z5
E4220	C4220	70.1 (1781)	16.2 (412)	135.6 (3444)	48.5 (1231)	9.9 (252)	129.3 (3285)	73.2 (1860)	88.4 (2245)	207.8 (5278)	16.7 (425)	31.4 (797)	37.4 (949)
E4820	C4820	76.2 (1936)	16.3 (415)	135.5 (3441)	54.5 (1384)	10.0 (255)	129.2 (3282	793 (2015)	88.5 (2248)	207.7 (5274)	16.9 (428)	37.4 (949)	43.4 (1102)

EVAP	COND	CORNER WEIGHTS - LBS (KG) WITHOUT STARTERS		
		CORNER	SHIP	OPERAT.
E4220	C4220	LF (LEFT FRONT)	11,151 (5,058)	13,005 (5,899)
		LB (LEFT BACK)	17,854 (8,098)	19,637 (8,907)
		RF (RIGHT FRONT)	10,373 (4,705)	12,199 (5,534)
		RB (RIGHT BACK)	16,608 (7,533)	18,421 (8,355)
E4820	C4820	LF (LEFT FRONT)	13,637 (6,186)	16,206 (7,351)
		LB (LEFT BACK)	20,294 (9,205)	22,720 (10,306)
		RF (RIGHT FRONT)	12,796 (5,804)	15,335 (6,956)
		RB (RIGHT BACK)	19,042 (8,637)	21,500 (9,752)

WCC UNIT INFO

333658501 DRAWING NUMBER | 00 REV. | NONE SCALE

Note: This drawing for high-voltage models only. See drawing notes Figure 36, page 44.

General Drawing Notes:

1. Drawings included in this section are for rough layout purposes only. Detailed certified drawings, as pdf files or paper copies, are available from the local Daikin sales office. Do not use catalog drawings for final construction.
2. Dimensions in inches (mm). A 1-inch manufacturing tolerance must be accounted for in the design and installation process. Final connections must allow for .500 inch [12.7mm] manufacturing tolerances. See Physical Data and Weights section for component and unit weights.
3. The connections shown are for one possible default configuration; your unit may be configured differently. Orientation (left/right) is determined while facing the control panel. Certain WSC models with a 2-pass configuration and copper tubing may have an "over/ under" connection configuration on the evaporator. Consult the Certified Drawings sheet for exact configuration and detailed dimensions of water, oil cooler, and relief valve connections.
4. Allow three (3) feet of service access on all four sides, plus allow the length of the tube plus two feet on one end for tube removal. The last two numbers in the vessel code are the tube length in feet. The NEC may require more than 3 feet clearance in front of control panels or starting equipment depending voltage and layout.
5. E2209/C2209 and E2212/C2212 available on WSC079 only.
6. E3612/C3612 combination available on WSC 087 only.
7. E4812/C4812 available on WSC 126 only.
8. The optional unit-mounted starter is shipped separate for field mounting, brackets and interconnecting cables are shipped with the unit.
9. The adjustable control interface panel is shipped un-mounted from the unit. When mounted, it can be folded back within the confines of the unit width and height and still be viewable.
10. Victaulic connections 14-inch and larger are AWWA C-606. Field piping using the Victaulic brand AGS® groove system will require a field-supplied transition.

Figure 36: WDC & WCC Drawing Notes

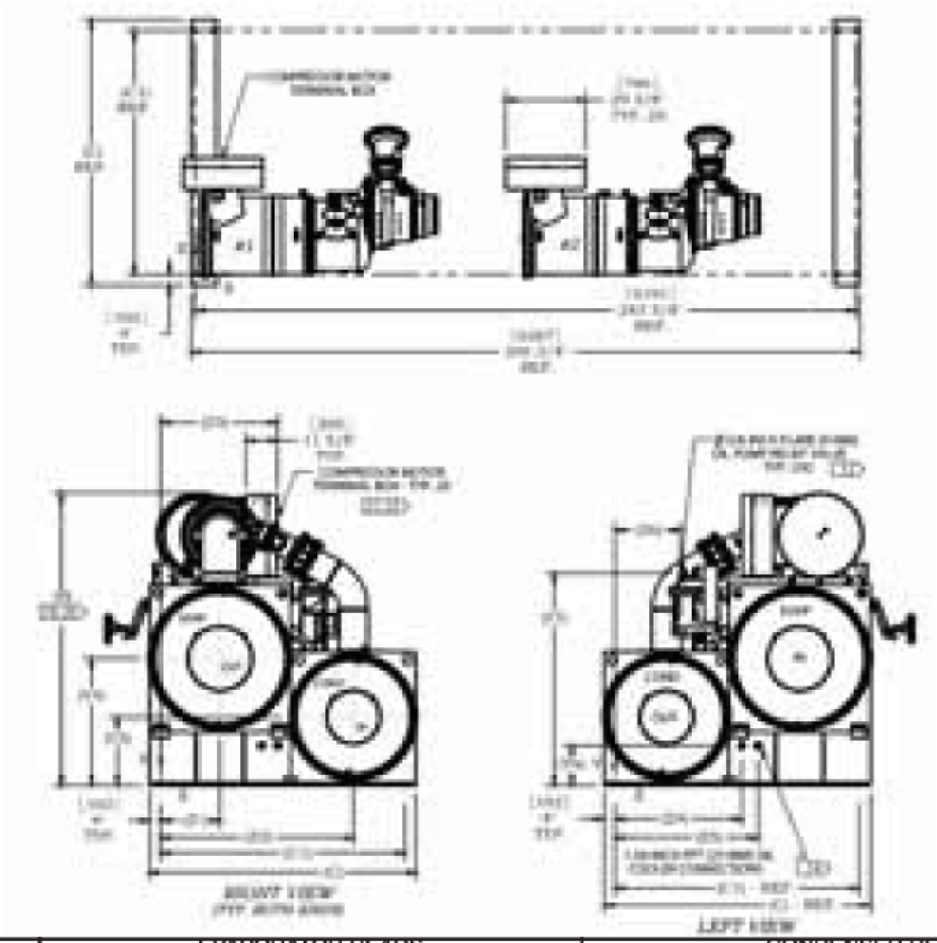
NOTIES:

WCC-WDC UNIT INFO

333658701 DRAWING NUMBER | 00 REV. | NONE SCALE

1. All dimensions are in inches and [millimeters].
2. Final connections must allow for 50 inch (13mm) manufacturing tolerances.
3. The water connections shown are for the default configuration: your unit may be configured differently. Orientation (left/right) is determined while facing the control panel. Consult the Certified Drawings sheet for exact configuration.
4. The unit control panel/touch screen side is the "FRONT" of the unit. "RIGHT" and "LEFT" are determined looking at the front.
5. 1.00-inch FPT (25mm) evaporator and condenser relief valves must be piped per ANSI / ASHRAE 15. Number of relief valves is 2 per evaporator (1 each circuit) and 4 per condenser (2 each circuit connected by two-way valve).
6. .375 inch (9mm) oil pump relief valve, 1 per oil pump must be piped per ANSI /ASHRAE 15.
7. 20 feet is required at either end of the tube sheet for tube maintenance. 3 feet (914mm) is recommended on all other sides and top for service clearance.
8. 1.50-inch FPT (38mm) oil cooler water connections.
9. 3.25-inch (95mm) diameter lifting holes provided. See installation manual for lifting instructions.
10. Evaporator and condenser water connections are given in standard U.S. pipe sizes. Standard connections are suitable for welding or Victaulic couplings.
11. Standard heads with Victaulic connections are shown on both the evaporator and condenser. Units with flanged connections add. 50 inch (13 mm) at each end for the overall unit length. Standard flanges are ANSI Class 150.
12. Dimensions shown are for units (evaporator / condenser) with standard design pressures. The refrigerant side design pressure is 200PSI {1380kPa} and the waterside design pressure is 150PSI {1034kPa}. Consult the factory for unit dimensions with higher design pressures.
13. Vibration isolator pads are provided for field installation - .25 inch (6mm) thick when fully loaded.
14. The shipping skid when used adds 4.00 inches (105mm) to the overall unit height.
15. If main power wiring is brought up through the floor, this wiring must be outside the envelope of the unit.
16. Typical wiring hookup to the compressor is the top of the compressor terminal box.
17. The units pump down capacity is determined in accordance with ANSI / ASHRAE 15 for maximum tube count.
18. The unit is shipped with an operating charge of lubricant and refrigerant.
19. Victaulic connections 14-inch and larger are AWWAC-606. Field piping using the Victaulic brand AGS® groove system will require a field supplied transition.

Figure 37: WCC Head Connection Dimensions - See Notes



EVAP	COND	EVAPORATOR HEADS				CONDENSER HEADS			
		CONNECTIONS 1 PASS	A2	Y4	Z1	CONNECTIONS 1 PASS	A3	Y5	Z2
E3620	C3620	16.00 (406)	14 1/4 (362)	46 1/8 (1172)	16 (406)	16.00 (406)	14 1/4 (362)	22 1/2 (572)	56 1/8 (1426)
E4220	C3620	20.00 (508)	14 1/4 (362)	43 1/8 (1096)	19 (483)	16.00 (406)	14 1/4 (362)	22 1/2 (572)	62 1/8 (1578)
E4220	C4220	20.00 (508)	14 1/4 (362)	45 7/8 (1165)	19 (483)	20.00 (508)	14 1/4 (362)	25 1/4 (641)	65 1/8 (1654)
E4820	C4220	24.00 (610)	17 1/4 (438)	46 7/8 (1191)	22 (559)	20.00 (508)	14 1/4 (362)	25 1/4 (641)	71 1/8 (1807)
E4820	C4820	24.00 (610)	17 1/4 (438)	49 (1245)	22 (559)	24.00 (610)	17 1/4 (438)	28 1/4 (718)	74 1/8 (1883)

NOTES:

1 All dimensions are in Inches and [Millimeters] unless noted otherwise.

2 Final connections must allow for .500 inch [12.7mm] manufacturing tolerances.

3 1.00-inch FPT [25.4 mm] evaporator and condenser relief valves must be piped per ANSI / ASHRAE 15. Number of relief valves is 2 per evaporator (1 each circuit) and 4 per condenser (2 each circuit).

4 .375 inch [9 mm] oil pump relief valve, 1 per oil pump must be piped per ANSI / ASHRAE 15.

5 243 inches is required at either end of the tube sheet for tube maintenance. 36 inches [914 mm] is recommended on all other sides and top for service clearance.

6 1.50-inch FPT [38 mm] oil cooler water connections.

7 3.25-inch [95 mm] diameter lifting holes are provided. See installation manual for lifting instructions.

8 All water connections are given in standard U.S. pipe sizes. Standard connections are suitable for welding or victaulic couplings.

9 Standard 1 pass heads with victaulic connections are shown on both the evaporator and condenser. Units with anged connections add .500 [12.7 mm] at each end for the overall unit length. Standard flanges are ANSI Class 150.

10 Dimensions shown are for units (evaporator / condenser) with standard design pressures. The refrigerant side design pressure is 200 PSI {1380 kPa} and the waterside design pressure is 150 PSI {1034 kPa}.

11 Consult the factory for unit dimensions with higher design pressures.

12 Vibrator Isolator pads are provided for eld installation - .250 inches [6 mm] thick when fully loaded.

13 These values are for units with standard wall thickness copper tubing only.

14 The shipping skid when used adds 4.00 inches [105 mm] to the overall unit height.

15 If main power wiring is brought up through the floor, this wiring must be outside the envelope of the unit.

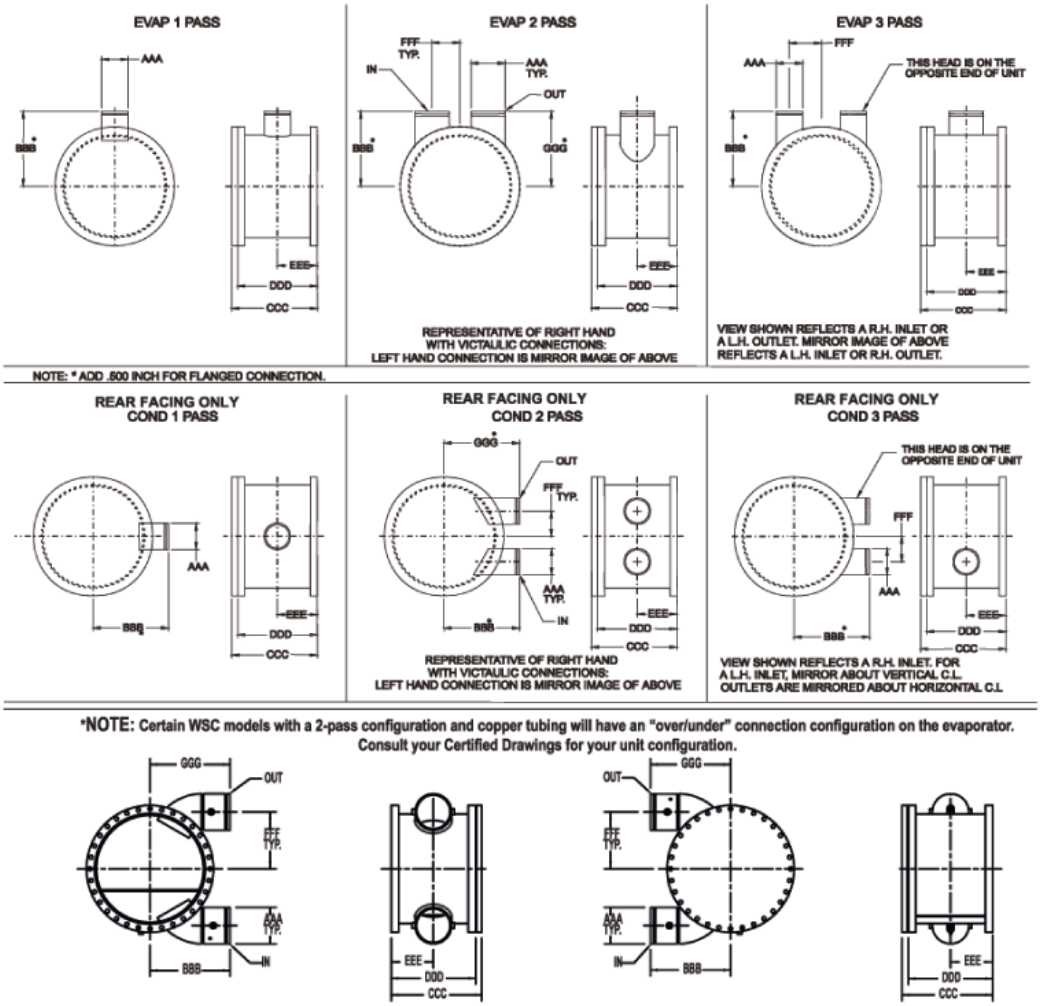
16 Typical wiring hookup to the compressor is either the top or bottom of the compressor terminal box

17 The units pump down capacity is determined in accordance with ANSI / ASHRAE 15 for the maximum tube count.

18 These values are for the units corner weights.

19 The unit is shipped with an operating charge of oil and refrigerant.

Figure 38: Marine Water Box Dimensions (WSC/WCC)



Note: Marine water boxes are an available option on all evaporator and condenser sizes. Epoxy coating of the water boxes and clad tube sheets are available for extreme duty applications. See Notes on Next Page.

Table 15: Dimensions with Victaulic or Flanged Connections (150 PSI Non-ASME - Victaulic Connection)

Evap.	1 PASS					2 PASS							3 PASS					
Dia.	'AAA'	'BBB	'CC	'DD	'EEE	'AAA	'BBB'	'CC	'DD	'EEE	'FFF'	'GG	'AAA	'BBB	'CC	'DD	'EEE	'FFF'
E18	8.63	15.0	19.2	18.0	9.00	6.63	15.00	19.0	18.0	9.00	4.78	21.0	4.50	15.0	19.2	18.0	9.00	5.85
E20	8.63	16.0	19.2	18.0	9.00	6.63	16.00	19.0	18.0	9.00	5.63	16.0	4.50	16.0	19.2	18.0	9.00	6.69
E22	10.7	17.0	21.2	20.0	10.0	8.63	17.00	21.0	20.0	10.0	5.59	23.0	5.56	17.0	21.2	20.0	10.0	7.12
E26	10.7	19.0	21.2	20.0	10.0	8.63	19.00	21.2	20.0	10.0	7.07	19.0	6.63	19.0	21.2	20.0	10.0	8.07
E26*	-	-	-	-	-	8.63	19.00	21.2	20.0	10.0	13.5	19.0	-	-	-	-	-	
E30	14.0	21.0	28.5	26.5	13.2	10.7	21.00	28.5	26.5	13.2	8.13	21.0	6.63	21.0	28.5	26.5	13.2	10.1
E30*	-	-	-	-	-	10.7	22.00	28.5	26.5	13.2	16.0	22.0	-	-	-	-	-	
E36	16.0	24.0	29.5	28.0	14.0	12.7	24.00	29.5	28.0	14.0	9.75	24.0	8.63	24.0	29.5	28.0	14.0	11.8
E36*	-	-	-	-	-	12.7	25.00	29.5	28.0	14.0	19.5	25.0	-	-	-	-	-	
E42	20.0	27.0	34.7	33.0	16.5	14.0	27.00	34.7	33.0	16.5	11.6	27.0	10.7	27.0	34.7	33.0	16.5	13.2
E42*	-	-	-	-	-	14.0	28.00	34.7	33.0	16.5	22.7	28.0	-	-	-	-	-	
E48	24.0	30.0	38.5	36.5	18.2	18.0	30.00	38.5	36.5	18.2	12.5	36.0	12.7	30.0	38.5	36.5	18.2	15.1
E48*	-	-	-	-	-	18.0	32.50	38.5	36.5	18.2	26.8	32.5	-	-	-	-	-	
Cond.	1 PASS					2 PASS							3 PASS					
Dia.	'AAA'	'BBB	'CC	'DD	'EEE	'AAA	'BBB'	'CC	'DD	'EEE	'FFF'	'GG	'AAA	'BBB	'CC	'DD	'EEE	'FFF'
C16	8.62	14.0	15.2	14.0	7.00	5.56	14.00	15.0	14.0	7.00	4.35	14.0	Consult local sales office					
C18	8.62	15.0	19.2	18.0	9.00	6.63	15.00	19.0	18.0	9.00	4.78	15.0						
C20	8.62	16.0	19.2	18.0	9.00	6.63	16.00	19.0	18.0	9.00	5.63	16.0						
C22	10.7	17.0	21.2	20.0	10.0	8.63	17.00	21.0	20.0	10.0	5.59	23.0						
C26	10.7	19.0	21.2	20.0	10.0	8.63	19.00	21.2	20.0	10.0	7.07	19.0						
C30	14.0	21.0	28.5	26.5	13.2	10.7	21.00	28.5	26.5	13.2	8.13	21.0						
C36	16.0	24.0	30.2	28.0	14.0	12.7	24.00	30.2	28.0	14.0	9.75	24.0						
C42	20.0	27.0	32.5	30.0	15.0	14.0	27.00	32.5	30.0	15.0	11.6	27.0						
C48	24.0	30.0	39.5	36.0	18.2	18.0	30.00	39.5	36.5	18.2	12.5	36.5						

Marine Waterbox Dimension (WDC)

FIGURE 1

2 and 4 Pass Cond. (Except 18 in. 2 Pass)

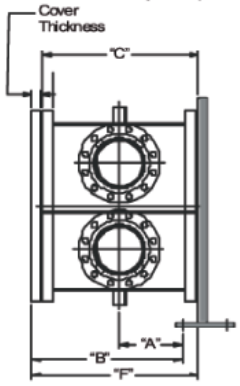


FIGURE 2

Evap. And Cond. 1 Pass

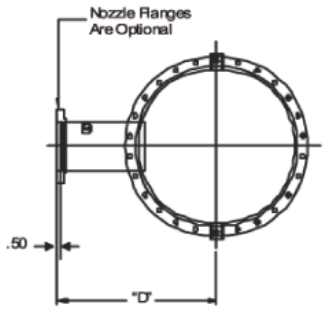


FIGURE 3

2 and 4 Pass Cond. (Except 18 in. 2 Pass)

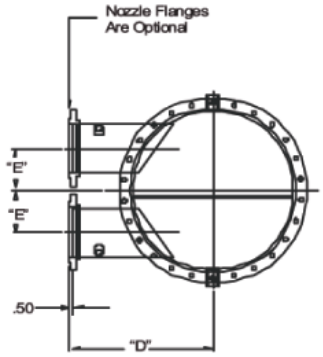
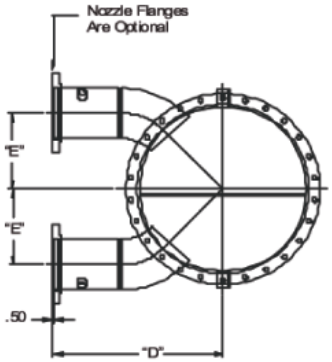


FIGURE 4

All 2 Pass Evap. - All 3 Pass Cond.
18 in. 2 Pass Cond.



Note: Evaporator connections are front facing; condenser connections are rear facing only.

Shell O.D.	Vessel	Outline Dimensions (inches)									Cover Thick-ness	Connections Pipe Size For Passes			
		A	B	C	D			E		F		1P	2P	3P	4P
					Fig 2	Fig 3	Fig 4	Fig 3	Fig 4						
16	Evap	5	13.00	14.00	14.50	- - - - -	22.50	- - - - -	6.94	15.00	1.00	8	5	4	4
	Cond	5	13.00	14.00	14.50	16.50	22.50	4.35	6.94	15.00					
18	Evap	7	17.25	18.00	22.50	- - - - -	22.50	- - - - -	7.94	19.25	1.25	8	6	5	4
	Cond	7	17.25	18.00	16.50	- - - - -	22.50	- - - - -	7.06	19.25					
20	Evap	7	17.25	18.00	22.50	- - - - -	22.50	- - - - -	7.88	19.25	1.25	8	6	5	4
22	Evap	8	19.50	20.00	22.50	- - - - -	22.50	- - - - -	10.12	21.50	1.50	10	8	6	5
	Cond	8	19.50	20.00	22.50	22.50	22.50	5.62	9.93	21.50					
26	Evap	8	19.50	20.00	22.50	- - - - -	22.50	- - - - -	11.69	21.50	1.50	10	8	8	6
	Cond	8	19.50	20.00	22.50	22.50	22.50	7.07	11.69	21.50					
30	Evap	12	27.75	28.00	24.50	- - - - -	24.50	- - - - -	13.62	29.75	1.75	14	10	8	8
	Cond	12	27.75	28.00	27.50	27.50	27.50	8.12	13.00	29.75					
36	Evap	12	28.00	28.00	27.50	- - - - -	27.50	- - - - -	16.50	30.00	2.00	16	12	10	8
	Cond	12	28.00	28.00	27.50	27.50	27.50	9.75	16.33	30.00					
36*	Evap	12	28.00	28.00	- - - - -	- - - - -	25.50	- - - - -	19.54	30.00	2.00	16	12	10	8
	Cond	12	28.00	28.00	27.50	27.50	27.50	9.75	16.33	30.00					
42	Evap	13	30.50	30.00	27.50	- - - - -	35.50	- - - - -	19.38	33.00	2.00	20	16	12	10
	Cond	13	30.50	30.00	27.50	27.50	27.50	11.63	11.63	33.00					
48	Evap	- - -	- - - - -	36.00	36.00	- - - - -	40.00	- - - - -	22.64	39.25	2.75	- - -	18	- - -	- - -
	Cond	- - -	- - - - -	36.00	36.00	36.00	- - - - -	11.50	- - - - -	39.25					

Flanges are ANSI raised face, mating flanges by others. Some flanges have staggered connections due to interference.
Victaulic connections 14-inch and larger are AWWA C-606. Field piping using AGS grove system requires a customer transition.
* Applies only to units under 800 tons with an E 3612 2-pass evaporator and copper tubing.

Physical Data

Evaporator

Refrigerant side design pressure is 200 psi (1380 kPa) on WSC and WCC units. WDC evaporators are 180 psi (1242 kPa) and condensers are 225 psi (1552 kPa). Standard water-side design pressure is 150 psi (1034 kPa) on all vessels. 300 psi (2068 kPa) is available as an option

Optional Insulation

The optional insulation of cold surfaces includes the evaporator and *non-connection* water head, suction piping, compressor inlet, motor housing, and motor coolant suction line. Available options are:

- Single insulation, ¾-inch, on evaporator, suction piping, and motor barrel - For normal machine room applications.
- Double insulation, 1-½ inch, on evaporator, suction piping, and motor barrel -For high humidity locations and ice making applications

The standard insulation used is UL recognized (File # E55475) 3/4" thick ABS/PVC flexible foam with skin having a K factor of 0.28 at 75°F. The sheet insulation is fitted and cemented in place forming a vapor barrier, then painted with a resilient epoxy finish that resists cracking.

The insulation complies to appropriate requirements or has been tested in accordance with the following:

- ASTM-C-177
- ASTM-C-534 Type 2
- ASTM-D-1056-91-2C1
- ASTM E 84
- UL 94-5V
- CAN/ULC S102-M88

.

Table 16: Evaporator Physical Data

Evaporator Code	WSC	WDC	WCC	Water Volume gal (L)	Insulation Area sq ft (m^2)	Vessel Dry Weight lb (kg)	Add for MWB lb (kg)	MWB Cover Only, Weight lb (kg)	Number of Relief Valves
E2009	X			31 (117)	82 (7.6)	2543 (1152)	478 (217)	148 (67)	1
E2012	X			37 (139)	84 (7.8)	2862 (1296)	478 (217)	148 (67)	1
E2209	X			38 (145)	66 (6.1)	2708 (1227)	600 (272)	175 (79)	1
E2212	X			45 (170)	90 (8.3)	3071 (1391)	600 (272)	175 (79)	1
E2212		X		63 (240)	90 (8.3)	3550 (1609)	600 (272)	175 (79)	1
E2216		X		79 (301)	144 (13.4)	4200 (1903)	600 (272)	175 (79)	1
E2412		X		88 (335)	131 (12.1)	4410 (1999)	700 (317)	240 (109)	1
E2416		X		110 (415)	157 (14.6)	5170 (2343)	700 (317)	240 (109)	1
E2609	X			61 (231)	76 (7.1)	3381 (1532)	899 (407)	302 (137)	1
E2612	X			72 (273)	102 (9.4)	3880 (1758)	899 (407	302 (137)	1
E2612		X		101 (381)	102 (9.4)	4745 (2150)	899 (407	302 (137)	1
E2616		X		126 (478)	162 (15.0)	5645 (2558)	899 (407	302 (137)	1
E3009	X			74 (281)	86 (8.0)	4397 (1992)	1386 (628)	517 (234)	1
E3012	X			89 (336)	115 (10.6)	5075 (2299)	1386 (628)	517 (234)	1
E3016		X		157 (594)	207 (19.2)	7085 (3211)	1386 (628)	517 (234)	2
E3609	X			128 (484)	155 14.4)	5882 (2665)	2115 (958)	805 (365)	1
E3612	X			152 (574)	129 (11.9)	6840 (3099)	2115 (958)	805 (365)	1
E3616		X		243 (918)	239 (22.2)	9600 (4351)	2115 (958)	805 (365)	2
E3620			X	219 (827)	207 (19.2)	8298 (3764)	2115 (958)	805 (365)	2
E4212	X			222 (841)	148 (13.7)	8922 (4042)	2836 (1285)	1181 (535)	1
E4216		X		347 (1313)	264 (24.5)	12215 (5536)	2836 (1285)	1181 (535)	2
E4220		X		481 (1819)	330 (30.6)	15045 (6819)	2836 (1285)	1181 (535)	2
E4220			X	319 (1208)	242 (22.5)	10853 (4923)	2836 (1285)	1181 (535)	2
E4812	X			327 (1237)	169 (15.6)	11125 (5040)	4578 (2074)	1837 (832)	2
E4816		X		556 (2106)	302 (281)	16377 (7429)	4578 (2074)	1837 (832)	2
E4820		X		661 (2503)	377 (35.0)	17190 (7791)	4578 (2074)	1837 (832)	2
E4820			X	456 (1728)	276 (25.6)	14618 (6630)	4578 (2074)	1837 (832)	2

Note 1: Water capacity is based on standard tube configuration and standard heads.
Note 2: Vessel weight includes the shell, maximum tubes, and standard heads, no refrigerant.
Note 3: MWB, marine water box, weight add is the water box weight minus a standard dished head weight.

Condenser

With positive pressure systems, such as those used in Daikin centrifugal chillers, the pressure variance with temperature is always predictable, and the vessel design and relief protection are based upon pure refrigerant characteristics. Our vessels are ASME designed, inspected and stamped.

Refrigerant side design pressure is 200 psi (1380 kPa) on WSC and WCC units and 225 psi (1552 kPa) on WDC units. Standard water side design pressure is 150 psi (1034 kPa) on all vessels. 300 psi (2068 kPa) is available as an option.

Pumpdown

To facilitate compressor service, all Daikin centrifugal chillers are designed to permit pumpdown and isolation of the entire refrigerant charge in the unit's condenser.

WDC dual compressor units, and single compressor units equipped with a special suction shut-off valve, which requires additional cost and extended lead time, can also be pumped down into the evaporator.

Table 17: Condenser Physical Data

Condenser Code	WSC	WDC	WCC	Pumpdown Capacity lb (kg)	Water Volume gal (L)	Vessel Dry Weight lb (kg)	Add for MWB lb (kg)	MWB Cover Only, Weight lb (kg)	Number of Relief Valves
C1809	X			597 (271)	34 (128)	1835 (831)	402 (182)	124 (56)	2
C1812	X			845 (384)	44 (166)	2183 (989)	402 (182)	124 (56)	2
C2009	X			728 (330)	47 (147)	2230 (1010)	478 (216)	148 (67)	2
C2012	X			971 (440)	62 (236)	2677 (1213)	478 (216)	148 (67)	2
C2209	X			822 (372)	60 (228)	2511 (1137)	478 (216)	148 (67)	2
C2212	X			1183 (537)	76 (290)	3031 (1373)	478 (216)	148 (67)	2
C2212		X		1110 (504)	89 (337)	3075 (1395)	478 (216)	148 (67)	2
C2216		X		1489 (676)	114 (430)	3861 (1751)	478 (216)	148 (67)	2
C2416		X		1760 (799)	143 (540)	4647 (2188)	685 (310)	230 (104)	2
C2609	X			1242 (563)	89 (335)	3210 (1454)	902 (408)	302 (137)	2
C2612	X			1656 (751)	111 (419)	3900 (1767)	902 (408)	302 (137)	2
C2616		X		2083 (945)	159 (603)	5346 (2425)	902 (408)	302 (137)	2
C3009	X			1611 (731)	114 (433)	4356 (1973)	1420 (643)	517 (234)	2
C3012	X			2148 (975)	144 (545)	5333 (2416)	1420 (643)	517 (234)	4
C3016		X		2789 (1265)	207 (782)	6752 (3063)	1420 (643)	517 (234)	2
C3612	X			2963 (1344)	234 (884)	7508 (3401)	2115 (958)	805 (364)	4
C3616		X		3703 (1725)	331 (1251)	9575 (4343)	2115 (958)	805 (364)	4
C3620			X	4991 (2264)	356 (1347)	10540 (4781)	2115 (958)	805 (364)	2
C4212	X			3796 (1722)	344 (1302)	10267 (4651)	2836 (1285)	1181 (535)	4
C4216		X		5010 (2273)	475 (1797)	12662 (5743)	2836 (1285)	1181 (535)	4
C4220		X		5499 (2494)	634 (2401)	17164 (7785)	2836 (1285)	1181 (535)	4
C4220			X	6487 (2942)	524 (1983)	14160 (6423)	2836 (1285)	1181 (535)	4
C4812	X			4912 (2228)	491 (1855)	13077 (5924)	4578 (2074)	1837 (8320	4
C4816		X		5581 (2532)	717 (2715)	18807 (8530)	4578 (2074)	1837 (8320	4
C4820		X		7034 (3191)	862 (3265)	23106 (10481)	4578 (2074)	1837 (8320	4
C4820			X	8307 (3768)	727 (2753)	18907 (8576)	4578 (2074)	1837 (8320	2

Note 1: Condenser pumpdown capacity based on 90% full at 90°F.
Note 2: Vessel weight includes the shell, maximum tubes, and standard heads, no refrigerant.
Note 3: MWB, marine water box, weight add is the water box weight minus a standard dished head weight

Compressor

Table 18: Compressor Weights

Compressor	063	079	087	100	113	126
Weight lb (kg)	2000 (908)	3200 (1440)	3200 (1440)	6000 (2700)	6000 (2700)	6000 (2700)

Complete Unit

Table 19: Unit Weights, Single Compressor, WSC

Unit	Evaporator / Condenser	Unit Refrig. Charge (1)	Max. Unit Weight Without Starter		Max. Unit Weight With Starter	
			Shipping	Operating	Shipping	Operating
WSC063	2009 / 1809	410 (186)	8412 (3816)	8949 (4059)	9612 (4360)	10149 (4604)
WSC063	2012 / 1812	539 (244)	9284 (4211)	9955 (4516)	10484 (4756)	11155 (5060)
WSC063	2209 / 2009	479 (217)	9119 (4136)	9841 (4464)	10319 (4681)	11040 (5008)
WSC063	2212 / 2012	631 (286)	10182 (4619)	11077 (5025)	11382 (5163)	12277 (5569)
WSC063	2209 / 2209	495 (224)	9416 (4271)	10235 (4643)	10616 (4815)	11435 (5187)
WSC063	2212 / 2212	651 (295)	10557 (4789)	11570 (5248)	11757 (5333)	12770 (5792)
WSC063	2609 / 2209	651 (295)	10248 (4648)	11258 (5107)	11448 (5193)	12458 (5651)
WSC063	2612 / 2212	859 (389)	11577 (5251)	12817 (5806)	12777 (5796)	14017 (6358)
WSC063	2609 / 2609	686 (311)	10984 (4982)	12228 (5547)	12184 (5527)	13428 (6091)
WSC063	2612 / 2612	905 (410)	12494 (5667)	14020 (6359)	13694 (6203)	15220 (6904)
WSC063	3009 / 2609	825 (374)	12892 (5848)	14246 (6462)	14092 (6392)	15446 (7006)
WSC063	3012 / 2612	1098 (497)	13903 (6306)	15569 (7062)	15103 (6851)	16769 (7606)
WSC079	2209 / 2209	495 (224)	10140 (4600)	10959 (4971)	11340 (5144)	12159 (5515)
WSC079	2212 / 2212	651 (295)	11281 (5117)	12294 (5577)	12481 (5661)	13494 (6121)
WSC079	2609 / 2209	651 (295)	10980 (4981)	11990 (5439)	12180 (5525)	13190 (5983)
WSC079	2612 / 2212	859 (389)	12309 (5592)	13548 (6145)	13509 (6128)	14749 (6690)
WSC079	2609 / 2609	686 (311)	11716 (5314)	12960 (5879)	12916 (5859)	14160 (6423)
WSC079	2612 / 2612	905 (410)	13226 (5999)	14752 (6692)	14426 (6544)	15952 (7236)
WSC079	3009 / 2609	825 (374)	12892 (5848)	14246 (6462)	14092 (6392)	15446 (7006)
WSC079	3012 / 2612	1098 (497)	14635 (6638)	16301 (7394)	15835 (7183)	17501 (7938)
WSC079	3009 / 3009	855 (387)	14076 (6385)	15644 (7096)	15276 (6929)	16844 (7640)
WSC079	3012 / 3012	1147 (520)	16119 (7312)	18061 (8192)	17319 (7856)	19261 (8737)
WSC079	3609 / 3009	1173 (531)	15913 (7218)	17929 (8133)	17113 (7762)	19129 (8677)
WSC079	3612 / 3012	1563 (708)	18340 (8319)	20807 (9438)	19540 (8863)	22007 (9982)
WSC087	2609 / 2209	651 (295)	10980 (4981)	11990 (5439)	12180 (5525)	13190 (5983)
WSC087	2612 / 2212	859 (389)	12309 (5583)	13549 (6146)	13509 (6128)	14749 (6690)
WSC087	2609 / 2609	686 (311)	11716 (5314)	12960 (5879)	12916 (5859)	14160 (6423)
WSC087	2612 / 2612	905 (410)	13226 (5999)	14752 (6692)	14426 (6544)	15592 (7073)
WSC087	3009 / 2609	825 (374)	12892 (5848)	14246 (6462)	14092 (6392)	15446 (7006)
WSC087	3012 / 2612	1098 (497)	14635 (6638)	16301 (7394)	15835 (7183)	17501 (7938)
WSC087	3009 / 3009	862 (390)	14076 (6385)	15644 (7096)	15276 (6929)	16844 (7640)
WSC087	3012 / 3012	1147 (520)	16118 (7311)	18060 (8192)	17318 (7855)	19260 (8736)
WSC087	3609 / 3009	1173 (531)	15913 (7218)	17929 (8133)	17113 (7762)	19129 (8677)
WSC087	3612 / 3012	1563 (708)	18339 (8319)	20806 (9438)	19539 (8863)	22006 (9982)
WSC087	3612 / 3612	1635 (740)	20584 (9337)	23799 (10795)	21784 (9881)	24999 (11340)
WSC100	3612 / 3012	1563 (708)	21578 (9788)	24045 (10907)	22778 (10332)	25245 (11451)
WSC100	3612 / 3612	1635 (740)	23826 (10807)	27041 (12266)	25026 (11352)	28241 (12810)
WSC100	4212 / 3612	2081 (943)	26457 (12001)	30260 (13726)	27657 (13545)	31460 (14270)
WSC100	4212 / 4212	2164 (980)	29298 (13290)	34024 (15433)	30498 (13834)	35224 (15978)
WSC100	4812 / 4212	2688 (1217)	32024 (14526)	37623 (17066)	33224 (15070)	38823 (17610)
WSC113	3612 / 3012	1563 (708)	21578 (9788)	24045 (10907)	22778 (10332)	25245 (11451)
WSC113	3612 / 3612	1635 (740)	23826 (10807)	27041 (12266)	25026 (11352)	28241 (12810)
WSC113	4212 / 3612	2081 (943)	26457 (12001)	30260 (13726)	27657 (13545)	31460 (14270)
WSC113	4212 / 4212	2164 (980)	29298 (13290)	34024 (15433)	30498 (13834)	35224 (15978)
WSC113	4812 / 4212	2688 (1217)	32024 (14526)	37623 (17066)	33224 (15070)	38823 (17610)
WSC113	4812 / 4812	2867 (1299)	35016 (15883)	41817 (18968)	36216 (16427)	43017 (19513)
WSC126	3612 / 3012	1563 (708)	21680 (9834)	24147 (10953)	22880 (10378)	25347 (11497)
WSC126	3612 / 3612	1635 (740)	23928 (10854)	27143 (12312)	25128 (11398)	28343 (12856)
WSC126	4212 / 3612	2081 (943)	26457 (12001)	30260 (13726)	27657 (12545)	31460 (14270)
WSC126	4212 / 4212	2164 (980)	29298 (13290)	34024 (15433)	30498 (13834)	35224 (15978)
WSC126	4812 / 4212	2164 (980)	32024 (14526)	37623 (17066)	33224 (15070)	38823 (17610)
WSC126	4812 / 4812	2867 (1299)	35016 (15883)	41817 (18968)	36216 (16427)	43017 (19513)

Note: 1, With starters (factory mounted) applies only to low voltage (200 to 600 volts) equipment.

Table 20: Dual Compressor, WDC/WCC

Unit	Evaporator / Condenser Size	Max. Unit Weight Without Starter		Max. Unit Weight With Starter (1)	
		Shipping lbs. (kg)	Operating lbs. (kg)	Shipping lbs. (kg)	Operating lbs. (kg)
WDC063	2416 / 2416	18673 (8470)	20422 (9263)	21407 (9710)	23156 (10503)
WDC063	2416 / 2616	19365 (8784)	21294 (9577)	22099 (10024)	23848 (10817)
WDC063	2616 / 2416	19282 (8746)	21207 (9639)	22016 (9986)	23763 (10779)
WDC063	2616 / 2616	20025 (9083)	22091 (9939)	22759 (10323)	24646 (11179)
WDC063	3016 / 3016	23545 (10680)	26405 (11830)	26279 (11920)	28815 (13070)
WDC063	3616 / 3016	27763 (12604)	31018 (14082)	30163 (13694)	33418 (15172)
WDC063	3616 / 3616	32027 (14540)	35115 (15942)	33427 (15176)	37515 (17032)
WDC079	3016 / 3016	25131 (11399)	27671 (12551)	27531 (12488)	30071 (13640)
WDC079	3616 / 3016	28763 (13047)	32018 (14523)	31163 (14135)	34418 (15612)
WDC079	3616 / 3616	32027 (14527)	36115 (16382)	34427 (15616)	38515 (17470)
WDC079	4216 / 4216	44470 (20189)	51463 (23364)	47204 (21431)	54197 (24605)
WDC087	3016 / 3016	26157 (11865)	28697 (13017)	28891 (13105)	31431 (14257)
WDC087	3616 / 3016	29789 (13512)	33044 (14989)	32523 (14752)	35778 (15322)
WDC087	3616 / 3616	33053 (14993)	37141 (16847)	35787 (16233)	39875 (18087)
WDC087	4216 / 4216	44470 (20189)	51463 (23364)	47204 (21431)	54197 (24605)
WDC100, 113	3616 / 3616	41816 (18967)	46513 (21098)	See Note 2	See Note 2
WDC100, 113, 126 (<7kV)	4216 / 4216	50470 (22893)	57463 (26065)	See Note 2	See Note 2
WDC100, 113, 126 (<7kV)	4816 / 4816	59185 (26846)	68996 (31296)	See Note 2	See Note 2
WDC100, 113, 126 (<7kV)	4220 / 4220	54802 (24858)	63248 (28689)	See Note 2	See Note 2
WDC100, 113, 126 (<7kV)	4820 / 4820	65964 (29921)	77698 (35243)	See Note 2	See Note 2
WCC100, 113, 126 (<7kV)	3620 / 3620	37645 (17091)	41334 (19268)	See Note 2	See Note 2
WCC100, 113, 126 (<7kV)	4220 / 3620	41320 (18759)	45609 (21317)	See Note 2	See Note 2
WCC100, 113, 126 (<7kV)	4220 / 4220	45314 (20573)	50281 (23767)	See Note 2	See Note 2
WCC100, 113, 126 (<7kV)	4820 / 4220	49759 (22590)	56173 (26305)	See Note 2	See Note 2
WCC100, 113, 126 (<7kV)	4820 / 4820	55927 (25391)	62528 (29876)	See Note 2	See Note 2
WDC100, 113, 126 (10/11kV)	4216/4216	55760 (25292)	63536 (28219)	See Note 2	See Note 2
WDC100, 113, 126 (10/11kV)	4220/4220	62136 (28184)	71426 (32398)	See Note 2	See Note 2
WDC100, 113, 126 (10/11kV)	4820/4820	73526 (33351)	86282 (39137)	See Note 2	See Note 2
WCC100, 113, 126 (10/11kV)	4220/4220	55987 (25395)	63262 (28695)	See Note 2	See Note 2
WCC100, 113, 126 (10/11kV)	4820/4820	65768 (29832)	75761 (34365)	See Note 2	See Note 2

Note: 1. With starters (factory mounted) applies only to low voltage (200 to 600 volts) equipment.
Note: 2. Unit not available with factory mounted starters.

Options and Accessories

Vessels

Marine water boxes
Provides tube access for inspection, cleaning, and removal without dismantling water piping.

Flanges (Victaulic® connections are standard)
ANSI raised face flanges on either the evaporator or condenser. Mating flanges are by others.

0.028 or 0.035 in. tube wall thickness
For applications with aggressive water conditions requiring thicker tube walls.

Cupro-nickel or titanium tube material
For use with corrosive water conditions, includes clad tube sheets and epoxy coated water heads.

Water-side vessel construction of 300 psi (150 psi is standard)
For high-pressure water systems, typically high-rise building construction.

Water differential pressure switches
This option provides evaporator and condenser water thermal dispersion flow sensors as a factory mounted and wired option. A proof-of-flow device is mandatory in both the chilled water and condenser water systems.

Single insulation
¾-inch, on evaporator, suction piping, and motor barrel; For normal machine room applications.

Double insulation
1-½ inch, on evaporator, suction piping, and motor barrel; For high humidity locations and ice making applications.

Electrical

Optional starters for factory or field mounting
See details in the Motor Starter section of this manual and catalog PM Starter.

Variable frequency drives (VFD)
The variable frequency drive option is a technology that has been used for decades to control motor speed on a wide variety of motor-drive applications. When applied to centrifugal compressor motors, significant gains in compressor part load performance can be realized. The improvement in efficiency and reduction of annual energy cost is maximized when there are long periods of part load operation, combined with low compressor lift (lower condenser water temperatures). When atmospheric conditions permit, Daikin chillers equipped with VFDs can operate with entering condenser as low as 50°F (10 °C), which results in extremely low kW/ton values.

Combining the attributes of VFD drives and the extremely efficient Daikin WDC Dual Centrifugal Chiller produces the industry's most efficient chiller based on the all-important IPLV value. See IPLV/NPLV Defined, page 29 for details on the AHRI IPLV efficiency rating.

Water-Side Economizers: Free cooling systems utilizing cold cooling tower water to remove heat from the chilled water system through a heat exchanger are becoming popular because the ability of a chiller to move seamlessly from mechanical cooling to the free cooling mode is an important operational feature. When equipped with a VFD, Daikin chillers can operate with condenser water down to 50°F (10° C) at which point the economizer heat exchanger can be activated and the free cooling can go into effect.

Starting Inrush: The use of a VFD on centrifugal chillers also provides an excellent method of reducing motor starting inrush, even better than solid-state starters. Starting current can be closely controlled since both the frequency and voltage are regulated. This can be an important benefit to a building's electrical distribution system.

Sound: The sound level of centrifugal compressors is largely dependent on the impeller tip speed. By reducing compressor speed the sound level is also reduced.

NEMA 4 watertight enclosure
For use where there is a possibility of water intrusion into the control panel.

NEMA 12 Dust tight enclosure
For use in dusty areas.

Controls

English or Metric Display
Either English or metric units for operator ease of use.

BAS Interface Module
Factory-installed on the unit controller (can also be retrofitted). See page 13 for details.

Unit

Export packaging
Can be either slat or full crate for additional protection during shipment. Units normally shipped in containers.

Pumpout Unit, Model RRU with or without storage vessel
Available in a variety of sizes. Details under the Pumpout section on page 54.

Refrigerant monitor
For remote mounting, including accessories such as 4-20ma signal, strobe light, audible horn, air pick-up filter. Details on page 54.

Hot gas bypass

Reduces compressor cycling and its attendant chilled water temperature swings at very low loads.

Sound attenuation package

For extremely sensitive projects, an optional discharge line sound package is offered consisting of sound insulation installed on the unit's discharge line. An additional 2 to 4 dbA reduction normally occurs.

Extended warranties

Extended 1, 2, 3, or 4-year warranties for parts only or for parts and labor are available for the entire unit or compressor/ motor only.

Optional Certified Test

A Daikin engineer oversees the testing, certifies the accuracy of the computerized results, and then translates the test data onto an easy-to-read spreadsheet. The tests can be run at AHRI load points and are run to AHRI tolerance of capacity and power. 50 Hz units are run tested at 60 Hz to their maximum motor power.

Optional Witness Test

A Daikin engineer oversees the testing in the presence of the customer or their designate and translates the test data onto an easy-to-read spreadsheet. The tests can be run at AHRI load points and are run to AHRI tolerance of capacity and power. Allow two to three hours of test time per load point specified. Units built for 50 Hz power can be run-tested using an onsite 50 Hz generator.

Special Order Options

The following special order options are available; requiring factory pricing, additional engineering and possible dimension changes or extended delivery: Consult the Daikin sales office for other possible specials.

- Non-standard location of nozzle connections on heads (compact water boxes) or marine water boxes
- Special corrosion inhibiting coatings on any "wetted surface" including tubesheets, heads (compact water boxes), marine water boxes, or nozzles
- Clad tube sheets
- Sacrificial anodes in heads (compact water boxes) or marine water boxes
- Eddy current testing and report used to verify baseline tube condition
- Special NEMA enclosures
- Davits or hinges for marine water box covers or heads (compact water boxes)
- Accelerometer and vibration monitoring pickup mounting (WSC/WDC/WCC/HSC)
- Spacer rings on heads to accommodate automatic tube brush cleaning systems (installed by others)

Refrigerant Recovery Units and Monitors

Pump Out Units

Although Daikin chillers can pump the entire refrigerant charge into the condenser and valve it off, there are occasions when pumpout units are required, due purely to specification requirements or unusual job considerations. Daikin offers two sizes of refrigerant recovery units (Model RRU) and one recovery unit that is factory mounted on a storage vessel (Model PRU). Recovery units are ETL listed. Capacities for R-22 are AHRI certified. The storage tank is designed, constructed and stamped in accordance with ASME standards.

Model RRU134

Large 1 ½-HP open drive compressor, ½-inch lines, two-point vapor extraction and oversized air-cooled condenser speed recovery on smaller size chillers. Purging and switching from liquid to vapor recovery only involves turning 3-way valves-no switching of hoses is necessary. Capacity with R-134a is 55 lb/min liquid, 1.34 lb/min vapor.

MODEL RRU570

Recovers at R-134a at 300 lb/min liquid and 5.7 lb/min vapor, ideal for the medium size chiller job. Rugged 3 hp open-drive compressor provides years of reliable service, even on refrigerants heavily contaminated with oil, air, moisture, or acids. Purging and switching from liquid to vapor recovery only involves turning 3-way valves-no switching of hoses is necessary. Suitable for most high-pressure refrigerants and blends. Equipped with air-cooled condenser.

Refrigerant Monitors

ANSI/ASHRAE 15-2001 recommends that every machine room with refrigeration equipment should have a refrigerant leak detection system, especially if the .

Retrofit Disassembly (Knockdown Options)

Many retrofit applications require partial or complete disassembly of the chiller. On WSC chillers, Daikin offers two solutions to this problem to best fit job conditions. Contact local Daikin Factory Service for price quotation and scheduling.

On-site disassembly

The major components (evaporator, condenser, and compressor) are shipped fully assembled and charged and can be taken apart at the site to facilitate difficult rigging work. The chillers are shipped assembled from the factory after testing, and then disassembled and reassembled on site under supervision of authorized Daikin service personnel. Contact local Daikin Factory Service for price quotation and scheduling. Individual component weights are shown in the Physical Data section of this catalog, beginning on page 48.

Shipped disassembled

Chillers can be shipped knocked down from the factory. The evaporator, condenser and oil pump are shipped bolted together and easily unbolted at the job site into the pieces shown in page 56. Other options, such as shipping less compressor or less compressor and control panel are also available. Site reassembly must be supervised by Daikin startup personnel.Contact local Daikin Factory Service for price quotation and scheduling.

TYPE I Knockdown

Daikin provides ease of installation without requiring construction alterations of entryways to your building. The compressor and compressor control box are removed and put on a skid. All associated wiring and piping will remain attached if possible. The remaining loose parts will be packaged in a separate crate.

1. Blockoffs will cover all openings on the compressor and vessels.
2. The compressor and vessels will receive a helium holding charge.
3. The compressor will not be insulated at the factory. An insulation kit will be shipped with the unit.
4. The starter will ship loose. Bracket and cable kit to be included for unit-mounted starters and/or cableway for mini-cabinet.
5. The evaporator will be insulated at the factory.
6. Refrigerant will not be shipped with the unit and must secured locally and furnished and installed by the installer.
7. Oil will be shipped in containers from the factory for field installation.
8. All field-piping connections will be victaulic, o-ring face seal or copper brazing.
9. All free piping ends will be capped.
10. Touch-up paint will be included.
11. The unit will undergo the standard, rigorous, full factory test program.

Contact local Daikin Factory Service for price quotation and scheduling.

TYPE II Knockdown

For those really tight installations, Daikin provides a total knockdown of the unit, allowing entry to the chiller site using already existing entryways. Compressor and terminal box are removed and put on a skid. The condenser, evaporator, and oil pump and supports will remain connected only by the attachment bolts for easy disassembly at the job site or riggers. All wiring and piping that interconnects the components will be removed. The remaining loose parts will be packaged in a separate crate.

1. Blockoffs will cover all openings on the compressor and vessels.
2. The compressor and vessels will receive a helium holding charge.
3. The compressor will not be insulated at the factory. An insulation kit will be shipped with the unit.
4. Only the evaporator shell will be factory insulated. Loose insulation will be shipped for the remaining surface areas.
5. The starter will ship loose. Bracket and cable kit to be included for all unit-mounted starters and/or cableway for mini-cabinet.
6. Refrigerant will be field supplied.
7. All field piping connections will be Victaulic, o-ring face seal or copper brazing.
8. All free piping ends will be capped.
9. Touch-up paint will be included.
10. A bolted bracket instead of a weld will mount the oil pump.
11. The discharge piping assembly will have a bolted flange connection at the condenser. This assembly will be shipped loose.
12. Piping that is attached to a component will be supported if it is not rigid.
13. All pressure vessels receive the full ASME testing. The compressor and oil pump are pressure checked and run tested. The chiller will require field leak testing after assembly at its final location.

Contact local Daikin Factory Service for price quotation and scheduling.

Type III Knockdown

The units are shipped fully assembled, factory charged, run-tested, insulated and painted. Included are the vessel bolt-on connection brackets, discharge line bolt-on flanges at the condenser and bolt-on oil pump assembly. Site disassembly and reassembly must be supervised by Daikin startup personnel. Contact local Daikin Factory Service for price quotation and scheduling.

Figure 39: Knockdown Components

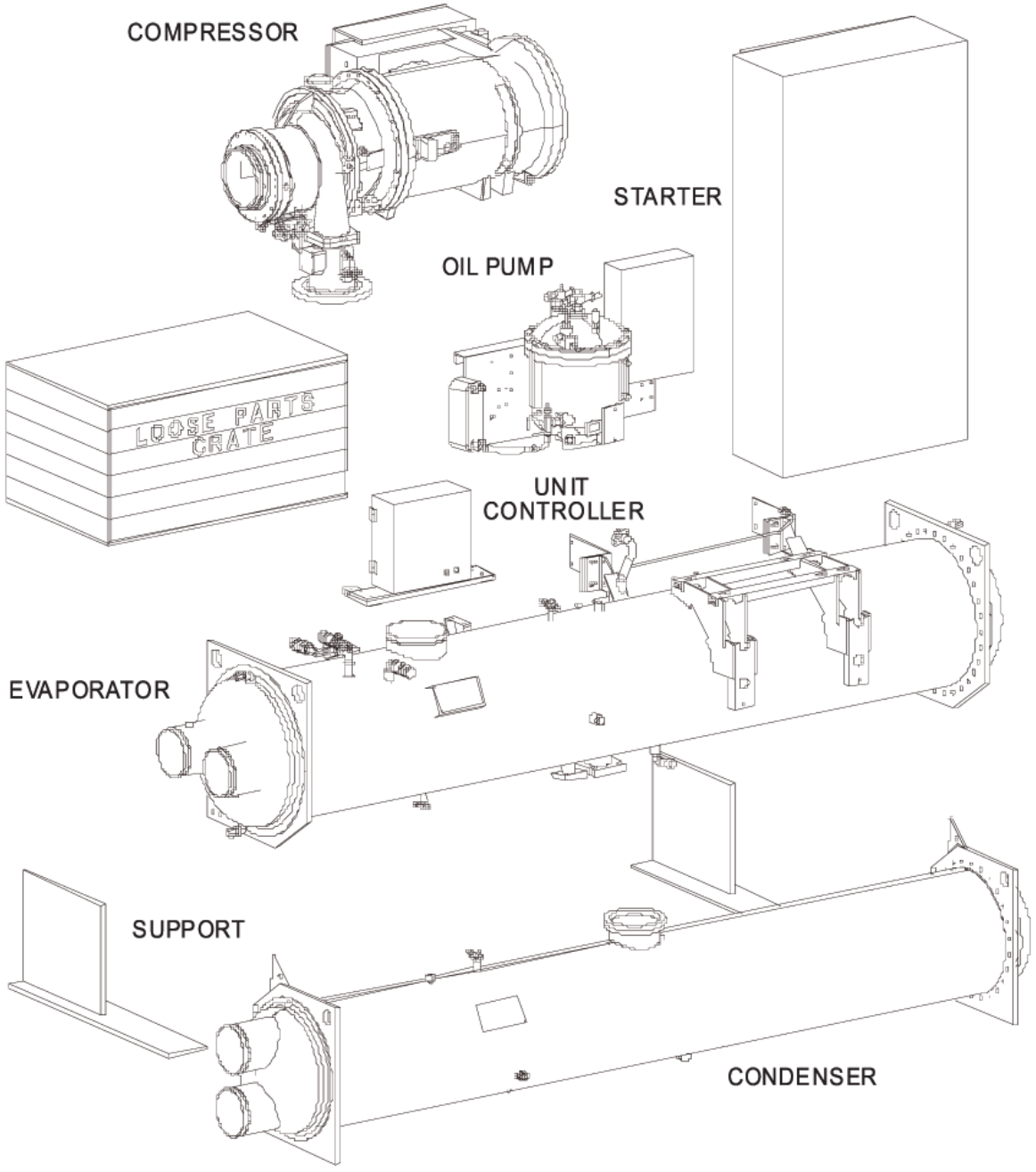


Table 21: Type I Knockdown Dimensions and Weights

UNIT SIZE	VESSEL CODE	UNIT WIDTH	UNIT HEIGHT	COMPRESSOR		COMPRESSOR WEIGHT	SHIPPING WEIGHT w/o COMPRESSOR
				WIDTH	HEIGHT		
063	E2009 / C1809	57.1 (1450.6)	61.6 (1564.4)	44.0 (1118.6)	25.1 (638.3)	3200 (1452)	5212 (2366)
063	E2209 / C2009	57.1 (1450.6)	64.0 (1624.8)	44.0 (1118.6)	25.1 (638.3)	3200 (1452)	5919 (2687)
063	E2209 / C2209	57.1 (1450.6)	64.0 (1624.8)	44.0 (1118.6)	25.1 (638.3)	3200 (1452)	6216 (2882)
063	E2609 / C2209	57.1 (1450.6)	67.5 (1715.0)	44.0 (1118.6)	25.1 (638.3)	3200 (1452)	7048 (3200)
063	E2609 / C2609	57.1 (1450.6)	73.1 (1857.8)	44.0 (1118.6)	25.1 (638.3)	3200 (1452)	7784 (3534)
063	E3009 / C2609	56.8 (1441.7)	75.7 (1922.0)	44.0 (1118.6)	25.1 (638.3)	3200 (1452)	9692 (4400)
063	E2012 / C1812	57.1 (1450.6)	61.6 (1564.4)	44.0 (1118.6)	25.1 (638.3)	3200 (1452)	6084 (2762)
063	E2212 / C2012	57.1 (1450.6)	64.0 (1624.8)	44.0 (1118.6)	25.1 (638.3)	3200 (1452)	6982 (3170)
063	E2212 / C2212	57.1 (1450.6)	64.0 (1624.8)	44.0 (1118.6)	25.1 (638.3)	3200 (1452)	7357 (3340)
063	E2612 / C2212	57.1 (1450.6)	67.5 (1715.0)	44.0 (1118.6)	25.1 (638.3)	3200 (1452)	8377 (3803)
063	E2612 / C2612	57.1 (1450.6)	73.1 (1857.8)	44.0 (1118.6)	25.1 (638.3)	3200 (1452)	9294 (4219)
063	E3012 / C2612	56.8 (1441.7)	75.7 (1922.0)	44.0 (1118.6)	25.1 (638.3)	3200 (1452)	10703 (4859)
079	E2209 / C2209	50.2 (1274.6)	62.3 (1581.7)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	6940 (3151)
079	E2609 / C2209	52.7 (1338.3)	63.9 (1622.8)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	7780 (3532)
079	E2609 / C2609	52.7 (1338.3)	69.5 (1765.6)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	8516 (3866)
079	E3009 / C2609	57.1 (1449.8)	74.0 (1878.6)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	9692 (4400)
079	E3009 / C3009	59.0 (1499.4)	79.4 (2016.8)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	10876 (4938)
079	E3609 / C3009	74.7 (1896.1)	78.8 (2001.0)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	12713 (5772)
079	E2212 / C2212	50.2 (1274.6)	62.3 (1581.7)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	8081 (3669)
079	E2612 / C2212	52.7 (1338.3)	63.9 (1622.8)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	9109 (4135)
079	E2612 / C2612	52.7 (1338.3)	69.5 (1765.6)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	10026 (4552
079	E3012 / C2612	57.1 (1449.8)	74.0 (1878.6)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	11435 (5191)
079	E3012 / C3012	59.0 (1499.4)	79.4 (2016.8)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	12919 (5865)
079	E3612 / C3012	74.7 (1896.1)	78.8 (2001.0)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	15140 (6874)
087	E2609 / C2209	52.7 (1338.3)	65.2 (1656.3)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	7780 (3532)
087	E2609 / C2609	52.7 (1338.3)	70.8 (1799.1)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	8516 (3866)
087	E3009 / C2609	57.1 (1449.8)	68.8 (1746.5)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	9692 (4400)
087	E3009 / C3009	59.5 (1510.5)	78.7 (1998.0)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	10876 (4938)
087	E3609 / C3009	74.7 (1896.1)	78.8 (2001.0)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	12713 (5772)
087	E2612 / C2212	52.7 (1338.3)	65.2 (1656.3)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	9109 (4135)
087	E2612 / C2612	52.7 (1338.3)	70.8 (1799.1)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	10029 (4553)
087	E3012 / C2612	57.1 (1449.8)	68.8 (1746.5)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	11435 (5191)
087	E3012 / C3012	59.5 (1510.5)	78.7 (1998.0)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	12918 (5865)
087	E3612 / C3012	74.7 (1896.1)	78.8 (2001.0)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	15139 (6873)
087	E3612 / C3612	80.7 (2049.3)	89.2 (2264.4)	43.6 (1108.2)	25.1 (638.3)	3200 (1452)	17384 (7892)
100	E3612 / C3012	77.2 (1961.6)	77.6 (1971.5)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	15587 (7076)
100	E3612 / C3612	83.2 (2114.0)	77.6 (1971.5)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	17826 (8093)
100	E4212 / C3612	86.2 (2190.5)	76.4 (1940.8)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	20487 (9301)
100	E4212 / C4212	92.2 (2342.9)	86.7 (2202.7)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	23298 (10577)
100	E4812 / C4212	98.2 (2495.3)	90.6 (2300.2)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	26024 (11815)
113	E3612 / C3012	77.2 (1961.6)	77.6 (1971.5)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	15578 (7072)
113	E3612 / C3612	83.2 (2114.0)	77.6 (1971.5)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	17826 (8093)
113	E4212 / C3612	86.2 (2190.5)	76.4 (1940.8)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	20457 (9287)
113	E4212 / C4212	92.2 (2342.9)	86.7 (2202.7)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	23298 (10577)
113	E4812 / C4212	98.2 (2495.3)	90.6 (2300.2)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	26024 (11815)
113	E4812 / C4812	104.2 (2647.7)	90.6 (2300.2)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	29016 (13173)
126	E3612 / C3012	77.2 (1961.6)	77.6 (1971.5)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	15680 (7119)
126	E3612 / C3612	83.2 (2114.0)	77.6 (1971.5)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	17826 (8093)
126	E4212 / C3612	86.2 (2190.5)	76.4 (1940.8)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	20457 (9287)
126	E4212 / C4212	92.2 (2342.9)	86.7 (2202.7)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	23298 (10577)
126	E4812 / C4212	98.2 (2495.3)	90.6 (2300.2)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	26024 (11815)
126	E4812 / C4812	104.2 (2647.7)	90.6 (2300.2)	44.0 (1117.9)	31.5 (800.1)	6000 (2724)	29016 (13173)

Note: All dimensions shown in inches (mm); weights are shown in lbs (kg). Allow 1 inch manufacturing tolerance on all dimensions.The overall vessel dimensions may vary slightly depending on the specified tube length, pass arrangement, and configuration. Consult the Daikin certified submittal drawings, or unit dimensions beginning on page 30 for specific vessel lengths.

Type II Knockdown Dimensions and Weights

UNIT SIZE	VESSEL CODE	CONDENSER		FRONT & BACK SUPPORT		EVAPORATOR		COMPRESSOR	
		WIDTH	HEIGHT	WIDTH	HEIGHT	WIDTH	HEIGHT	WIDTH	HEIGHT
063	E2009 / C1809	31.8 (806.5)	36.8 (933.5)	8.0 (203.2)	22.9 (580.9)	34.6 (877.8)	28.8 (731.3)	44.0 (1118.6)	25.1 (638.3)
063	E2209 / C2009	30.5 (774.2)	36.8 (933.5)	8.0 (203.2)	22.9 (580.9)	34.6 (877.8)	35.4 (899.9)	44.0 (1118.6)	25.1 (638.3)
063	E2209 / C2209	30.5 (774.2)	36.8 (933.5)	8.0 (203.2)	22.1 (561.8)	34.6 (877.8)	35.4 (899.9)	44.0 (1118.6)	25.1 (638.3)
063	E2609 / C2209	30.5 (774.2)	36.8 (933.5)	8.0 (203.2)	22.1 (561.8)	39.2 (996.7)	35.9 (912.6)	44.0 (1118.6)	25.1 (638.3)
063	E2609 / C2609	36.0 (914.9)	42.3 (1073.2)	8.0 (203.2)	27.7 (704.6)	39.2 (996.7)	35.9 (912.6)	44.0 (1118.6)	25.1 (638.3)
063	E3009 / C2609	36.0 (914.9)	42.3 (1073.2)	8.0 (203.2)	27.0 (685.5)	42.6 (1081.0)	37.3 (948.4)	44.0 (1118.6)	25.1 (638.3)
063	E2012 / C1812	31.8 (806.5)	36.8 (933.5)	8.0 (203.2)	22.9 (580.9)	34.6 (877.8)	28.8 (731.3)	44.0 (1118.6)	25.1 (638.3)
063	E2212 / C2012	30.5 (774.2)	36.8 (933.5)	8.0 (203.2)	22.9 (580.9)	34.6 (877.8)	35.4 (899.9)	44.0 (1118.6)	25.1 (638.3)
063	E2212 / C2212	30.5 (774.2)	36.8 (933.5)	8.0 (203.2)	22.1 (561.8)	34.6 (877.8)	35.4 (899.9)	44.0 (1118.6)	25.1 (638.3)
063	E2612 / C2212	30.5 (774.2)	36.8 (933.5)	8.0 (203.2)	22.1 (561.8)	39.2 (996.7)	35.9 (912.6)	44.0 (1118.6)	25.1 (638.3)
063	E2612 / C2612	36.0 (914.9)	42.3 (1073.2)	8.0 (203.2)	27.7 (704.6)	39.2 (996.7)	35.9 (912.6)	44.0 (1118.6)	25.1 (638.3)
063	E3012 / C2612	36.0 (914.9)	42.3 (1073.2)	8.0 (203.2)	27.0 (685.5)	42.6 (1081.0)	37.3 (948.4)	44.0 (1118.6)	25.1 (638.3)
079	E2209 / C2209	30.5 (775.2)	33.1 (841.0)	8.0 (203.2)	20.6 (522.0)	32.8 (834.1)	31.5 (799.8)	43.6 (1108.2)	25.1 (638.3)
079	E2609 / C2209	30.5 (775.2)	35.9 (911.4)	8.0 (203.2)	20.6 (522.0)	36.7 (933.2)	33.2 (842.3)	43.6 (1108.2)	25.1 (638.3)
079	E2609 / C2609	30.5 (775.2)	39.3 (997.0)	8.0 (203.2)	26.2 (665.0)	36.7 (933.2)	33.2 (842.3)	43.6 (1108.2)	25.1 (638.3)
079	E3009 / C2609	36.0 (914.9)	39.3 (997.0)	8.0 (203.2)	25.4 (645.2)	40.1 (1017.8)	37.3 (948.4)	43.6 (1108.2)	25.1 (638.3)
079	E3009 / C3009	41.4 (1052.3)	45.8 (1162.1)	8.0 (203.2)	30.9 (783.8)	42.6 (1081.0)	37.3 (948.4)	43.6 (1108.2)	25.1 (638.3)
079	E3609 / C3009	41.9 (1063.5)	45.8 (1162.1)	8.0 (203.2)	25.5 (648.7)	48.1 (1222.2)	43.7 (1109.7)	43.6 (1108.2)	25.1 (638.3)
079	E2212 / C2212	30.5 (775.2)	33.1 (841.0)	8.0 (203.2)	20.6 (522.0)	32.8 (834.1)	31.5 (799.8)	43.6 (1108.2)	25.1 (638.3)
079	E2612 / C2212	30.5 (775.2)	35.9 (911.4)	8.0 (203.2)	20.6 (522.0)	36.7 (933.2)	33.2 (842.3)	43.6 (1108.2)	25.1 (638.3)
079	E2612 / C2612	30.5 (775.2)	39.3 (997.0)	8.0 (203.2)	26.2 (665.0)	36.7 (933.2)	33.2 (842.3)	43.6 (1108.2)	25.1 (638.3)
079	E3012 / C2612	36.0 (914.9)	39.3 (997.0)	8.0 (203.2)	25.4 (645.2)	40.1 (1017.8)	37.3 (948.4)	43.6 (1108.2)	25.1 (638.3)
079	E3012 / C3012	41.4 (1052.3)	45.8 (1162.1)	8.0 (203.2)	30.9 (783.8)	42.6 (1081.0)	37.3 (948.4)	43.6 (1108.2)	25.1 (638.3)
079	E3612 / C3012	41.9 (1063.5)	45.8 (1162.1)	8.0 (203.2)	25.5 (648.7)	48.1 (1222.2)	43.7 (1109.7)	43.6 (1108.2)	25.1 (638.3)
087	E2609 / C2209	30.5 (775.2)	36.8 (933.5)	8.0 (203.2)	20.6 (522.0)	39.2 (996.7)	35.9 (912.6)	43.6 (1108.2)	25.1 (638.3)
087	E2609 / C2609	36.0 (914.9)	41.8 (1060.5)	8.0 (203.2)	26.2 (665.0)	39.2 (996.7)	35.9 (912.6)	43.6 (1108.2)	25.1 (638.3)
087	E3009 / C2609	36.0 (914.9)	41.8 (1060.5)	8.0 (203.2)	25.4 (645.2)	42.6 (1081.3)	37.3 (948.4)	43.6 (1108.2)	25.1 (638.3)
087	E3009 / C3009	41.9 (1063.5)	45.8 (1162.1)	8.0 (203.2)	30.9 (783.8)	42.6 (1081.3)	37.3 (948.4)	43.6 (1108.2)	25.1 (638.3)
087	E3609 / C3009	41.9 (1063.5)	45.8 (1162.1)	8.0 (203.2)	25.5 (648.7)	48.1 (1222.2)	43.7 (1109.7)	43.6 (1108.2)	25.1 (638.3)
087	E2612 / C2212	30.5 (775.2)	36.8 (933.5)	8.0 (203.2)	20.6 (522.0)	39.2 (996.7)	35.9 (912.6)	43.6 (1108.2)	25.1 (638.3)
087	E2612 / C2612	36.0 (914.9)	41.8 (1060.5)	8.0 (203.2)	26.2 (665.0)	39.2 (996.7)	35.9 (912.6)	43.6 (1108.2)	25.1 (638.3)
087	E3012 / C2612	36.0 (914.9)	41.8 (1060.5)	8.0 (203.2)	25.4 (645.2)	42.6 (1081.3)	37.3 (948.4)	43.6 (1108.2)	25.1 (638.3)
087	E3012 / C3012	41.9 (1063.5)	45.8 (1162.1)	8.0 (203.2)	30.9 (783.8)	42.6 (1081.3)	37.3 (948.4)	43.6 (1108.2)	25.1 (638.3)
087	E3612 / C3012	41.9 (1063.5)	45.8 (1162.1)	8.0 (203.2)	25.5 (648.7)	48.1 (1222.2)	43.7 (1109.7)	43.6 (1108.2)	25.1 (638.3)
087	E3612 / C3612	46.2 (1173.2)	51.8 (1314.5)	8.0 (203.2)	35.9 (912.1)	48.1 (1222.2)	43.7 (1109.7)	43.6 (1108.2)	25.1 (638.3)
100	E3612 / C3012	41.0 (1041.9)	46.2 (1172.7)	8.0 (203.2)	24.4 (619.5)	52.1 (1324.1)	44.1 (1120.6)	44.0 (1117.9)	31.5 (800.1)
100	E3612 / C3612	45.3 (1151.4)	52.1 (1322.3)	8.0 (203.2)	24.4 (619.5)	52.1 (1324.1)	44.1 (1120.6)	44.0 (1117.9)	31.5 (800.1)
100	E4212 / C3612	45.3 (1151.4)	52.1 (1322.3)	8.0 (203.2)	18.6 (473.5)	54.4 (1382.5)	51.5 (1307.6)	44.0 (1117.9)	31.5 (800.1)
100	E4212 / C4212	49.6 (1260.1)	57.6 (1462.0)	8.0 (203.2)	21.4 (543.3)	54.4 (1382.5)	51.5 (1307.6)	44.0 (1117.9)	31.5 (800.1)
100	E4812 / C4212	49.6 (1260.1)	57.6 (1462.0)	8.0 (203.2)	19.6 (498.9)	60.1 (1527.0)	57.1 (1449.6)	44.0 (1117.9)	31.5 (800.1)
113	E3612 / C3012	41.0 (1041.9)	46.2 (1172.7)	8.0 (203.2)	24.4 (619.5)	52.1 (1324.1)	44.1 (1120.6)	44.0 (1117.9)	31.5 (800.1)
113	E3612 / C3612	45.3 (1151.4)	52.1 (1322.3)	8.0 (203.2)	24.4 (619.5)	52.1 (1324.1)	44.1 (1120.6)	44.0 (1117.9)	31.5 (800.1)
113	E4212 / C3612	45.3 (1151.4)	52.1 (1322.3)	8.0 (203.2)	18.6 (473.5)	54.4 (1382.5)	51.5 (1307.6)	44.0 (1117.9)	31.5 (800.1)
113	E4212 / C4212	49.6 (1260.1)	57.6 (1462.0)	8.0 (203.2)	21.4 (543.3)	54.4 (1382.5)	51.5 (1307.6)	44.0 (1117.9)	31.5 (800.1)
113	E4812 / C4212	49.6 (1260.1)	57.6 (1462.0)	8.0 (203.2)	19.6 (498.9)	60.1 (1527.0)	57.1 (1449.6)	44.0 (1117.9)	31.5 (800.1)
113	E4812 / C4812	53.9 (1369.1)	63.5 (1612.9)	8.0 (203.2)	19.6 (498.9)	60.1 (1527.0)	57.1 (1449.6)	44.0 (1117.9)	31.5 (800.1)
126	E3612 / C3012	41.0 (1041.9)	46.2 (1172.7)	8.0 (203.2)	24.4 (619.5)	52.1 (1324.1)	44.1 (1120.6)	44.0 (1117.9)	31.5 (800.1)
126	E3612 / C3612	45.3 (1151.4)	52.1 (1322.3)	8.0 (203.2)	24.4 (619.5)	52.1 (1324.1)	44.1 (1120.6)	44.0 (1117.9)	31.5 (800.1)
126	E4212 / C3612	45.3 (1151.4)	52.1 (1322.3)	8.0 (203.2)	18.6 (473.5)	54.4 (1382.5)	51.5 (1307.6)	44.0 (1117.9)	31.5 (800.1)
126	E4212 / C4212	49.6 (1260.1)	57.6 (1462.0)	8.0 (203.2)	21.4 (543.3)	54.4 (1382.5)	51.5 (1307.6)	44.0 (1117.9)	31.5 (800.1)
126	E4812 / C4212	49.6 (1260.1)	57.6 (1462.0)	8.0 (203.2)	19.6 (498.9)	60.1 (1527.0)	57.1 (1449.6)	44.0 (1117.9)	31.5 (800.1)
126	E4812 / C4812	53.9 (1369.1)	63.5 (1612.9)	8.0 (203.2)	19.6 (498.9)	60.1 (1527.0)	57.1 (1449.6)	44.0 (1117.9)	31.5 (800.1)

Note: 1. All dimensions shown in inches (mm); weights are shown in lbs (kg). Allow 1 inch manufacturing tolerance on all dimensions.The overall vessel dimensions may vary slightly depending on the specified tube length, pass arrangement, and configuration. Consult the Daikin certified submittal drawings, or unit dimensions beginning on page 30 for specific vessel lengths.

Note: 2. The oil pump width is the dimension from front to back. The height is from the bottom of the sump to the top of the control box located to the right of the sump. Shipping the oil pump is usually not an issue compared to the vessels.

Specifications (WSC)

SECTION 15XXX
CENTRIFUGAL CHILLERS (SINGLE COMPRESSOR)

PART 1 — GENERAL

1.1 SUMMARY

A Section includes design, performance criteria, refrigerants, controls, and installation requirements for water-cooled centrifugal chillers.

1.2 REFERENCES

A Comply with the following codes and standards

1 AHRI 550/590

2 NEC

3 ANSI/ASHRAE 15

4 OSHA as adopted by the State

5 ASME Section VIII

1.3 SUBMITTALS

A Submittals shall include the following:

1 Dimensioned plan and elevation view drawings, including motor starter cabinet, required clearances, and location of all field piping and electrical connections.

2 Summaries of all auxiliary utility requirements such as: electricity, water, air, etc. Summary shall indicate quality and quantity of each required utility.

3 Diagram of control system indicating points for field interface and field connection. Diagram shall fully depict field and factory wiring.

4 Manufacturer's certified performance data at full load plus IPLV or NPLV.

5 Before shipment, submit a certification of satisfactory completion of factory run test signed by a company officer. The test shall be performed on an AHRI-qualified test stand and conducted according to AHRI Standard 550/590.

6 Installation and Operating Manuals.

1.4 QUALITY ASSURANCE

A Qualifications: Equipment manufacturer must specialize in the manufacture of the products specified and have five years experience with the equipment and refrigerant offered.

B Regulatory Requirements: Comply with the codes and standards in Section 1.2.

C Chiller manufacturer plant shall be ISO Registered.

1.5 DELIVERY AND HANDLING

A Chillers shall be delivered to the job site completely assembled and charged with refrigerant and oil.

B Comply with the manufacturer's instructions for rigging and transporting units. Leave protective covers in place until installation.

1.6 WARRANTY

A The refrigeration equipment manufacturer's warranty shall be for a period of (one) -- **OR** -- (two) --**Or**-- (five) years from date of equipment start up or 18 months from shipment whichever occurs first. The warranty shall include parts and labor costs for the repair or replacement of defects in material or workmanship.

1.7 MAINTENANCE

A Chiller maintenance shall be the responsibility of the owner with the following exceptions:

1 The manufacturer shall provide the first year scheduled oil and filter change if required.

2 The manufacturer shall provide first year purge unit maintenance if required.

PART 2 — PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A Daikin

B (Approved Equal)

2.2 UNIT DESCRIPTION

A Provide and install as shown on the plans a factory-assembled, factory charged water-cooled packaged chiller. Each unit shall be complete with a single-stage hermetic centrifugal compressor with lubrication and control system, factory mounted starter, evaporator, condenser, refrigerant control device and any other components necessary for a complete and operable chiller package.

B Each chiller shall be factory run-tested under load conditions for a minimum of one hour on an AHRI qualified test stand with evaporator and condenser waterflow at job conditions (excluding glycol applications). Operating controls shall be adjusted and checked. The refrigerant charge shall be adjusted for optimum operation and recorded on the unit nameplate. Units operating with 50-Hz power shall be tested with a 50-Hz power supply. Any deviation in performance or operation shall be remedied prior to shipment and the unit retested if necessary to confirm repairs or adjustments. Manufacturer shall supply a certificate of completion of a successful run-test upon request.

C Electrical components shall be housed in NEMA 1 enclosures, designed for clean, indoor locations.

2.3 DESIGN REQUIREMENTS

A General: Provide a complete water-cooled hermetic centrifugal compressor water-chilling package as specified herein. Machine shall be provided according to referenced standards Section 1.2. In general, unit shall consist of a compressor, condenser, evaporator, lubrication system, starter and control system. Note: Chillers shall be charged with a refrigerant such as R-134a, not subject to the Montreal Protocol and the U. S. Clean Air Act.

B Performance: Refer to schedule on the drawings. The chiller shall be capable of stable operation to ten percent of full load with standard AHRI entering condensing water relief without the use of hot gas bypass.

C Seismic Certification:

1 Chiller shall be certified to IBC 2009.

2 Chiller shall be OSHPD Pre-Approved. Chiller to meet a minimum seismic response factor of 1.60 S_{DS}. Chiller shall be installed as rigid base mounted only or with RIS isolators as these configurations are inherently more stable than spring mounted installations for seismic applications.

D Acoustics: Sound pressure levels for the complete unit shall not exceed the following specified levels. Provide the necessary acoustic treatment to chiller as required. Sound data shall be measured according to AHRI Standard 575. Data shall be in dB. Data shall be the highest levels recorded at all load points. Test shall be in accordance with AHRI Standard 575.

Sound Pressure (at 30 feet)											
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall dBA	75% Load dBA	50% Load dBA	25% Load dBA

Sound Power											
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall dBA	75% Load dBA	50% Load dBA	25% Load dBA

One-third Octave Band Sound Power																						
50 Hz	63 Hz	80 Hz	100 HZ	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	6300 Hz	8000 Hz	10 kHz

2.4 CHILLER COMPONENTS

A A.Compressor:

1 Unit shall have a single-stage hermetic centrifugal compressor. Casing design shall ensure major wearing parts, main bearings, and thrust bearings are accessible for maintenance and replacement. The lubrication system shall protect machine during coast down period resulting from a loss of electrical power.

2 The impeller shall be statically and dynamically balanced. The compressor shall be vibration tested and not exceed a level of 0.14 IPS.

3 Movable inlet guide vanes actuated by an internal oil pressure driven piston shall accomplish unloading. Compressors using an unloading system that requires penetrations through the compressor housing or linkages, or both that must be lubricated and adjusted are acceptable provided the manufacturer provides a five-year inspection agreement consisting of semi-annual inspection, lubrication, and annual change out of any compressor seals. A statement of inclusion must accompany any quotations.

4 If the compressor is not equipped with guide vanes for each stage and movable discharge diffusers, then furnish hot gas bypass and select chillers at 5% lower kW/ton than specified to compensate for bypass inefficiency at low loads.

5 For open motor units, an oil reservoir shall collect any oil and refrigerant that leaks past the seal. A float device shall be provided to open when the reservoir is full, directing the refrigerant/oil mixture back into the compressor housing.

6 Manufacturer shall warrant the shaft seal, reservoir, and float valve system against leakage of oil and refrigerant to the outside of the refrigerating unit for a period of 5 years from the initial start-up including parts and labor to replace a defective seal and any refrigerant required to trim the charge original specifications.

B Lubrication System: The compressor shall have an independent lubrication system to provide lubrication to all parts requiring oil. Provide a heater in the oil sump to maintain oil at sufficient temperature to minimize affinity of refrigerant, and a thermostatically controlled water-cooled oil cooler. Coolers located inside the evaporator or condenser are not acceptable due to inaccessibility. A positive displacement oil pump shall be powered through the unit control transformer.

C Refrigerant Evaporator and Condenser:

1 Evaporator and condenser shall be of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.1 times the working pressure, but not less

than 100 psig. Provide intermediate tube supports at a maximum of 24 inch spacing.

2 Tubes shall be enhanced for maximum heat transfer, rolled into steel tube sheets and sealed with Locktite® or equal sealer. The tubes shall be individually replaceable.

3 The water sides shall be designed for a minimum of 150 psi or as specified elsewhere. Vents and drains shall be provided.

4 Evaporator minimum refrigerant temperature shall be 33°F.

5 An electronic or thermal refrigerant expansion valve shall control refrigerant flow to the evaporator. Fixed orifice devices or float controls with hot gas bypass are not acceptable because of inefficient control at low load conditions. The liquid line shall have a moisture indicating sight glass.

6 The evaporator and condenser shall be separate shells. A single shell containing both vessel functions is not acceptable because of the possibility of internal leaks.

7 Reseating type spring loaded pressure relief valves according to ASHRAE-15 safety code shall be furnished. The evaporator shall be provided with single or multiple valves. The condenser shall be provided with dual relief valves equipped with a transfer valve so one valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the vessel. Rupture disks are not acceptable.

8 The evaporator, suction line, and any other component or part of a component subject to condensing moisture shall be insulated with UL recognized 3/4 inch closed cell insulation. All joints and seams shall be carefully sealed to form a vapor barrier.

9 Provide factory-mounted thermal dispersion flow switches on each vessel to prevent unit operation with no flow.

D Prime Mover: Squirrel cage induction motor of the hermetic type of sufficient size to efficiently fulfill compressor horsepower requirements. Motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase. Motor shall be compatible with the starting method specified hereinafter. If the Contractor chooses to provided an open drive motor or compressor, verify in the submittal that the scheduled chiller room ventilation system will accommodate the additional heat and maintain the equipment room at design indoor temperature based on 95°F outdoor ambient ventilation air available. If additional cooling is required, manufacturer shall be responsible for the installation, wiring and controls of a cooling system. Chiller selection shall compensate for tonnage and efficiency loss to make certain the owner is not penalized.

E Motor Starter:

1 The main motor starter is to be factory mounted and fully wired to the chiller components and factory tested during the run test of the unit.

-- OR --

The main motor starter is to be furnished by the chiller manufacturer and shipped loose for floor mounting and field wiring to the chiller package. It shall be free-standing with NEMA-1 enclosure designed for top entry and bottom exit and with front access.

2 For open drive air-cooled motors the chiller manufacturer shall be responsible for providing the cooling of the refrigeration machinery room. The sensible cooling load shall be based on the total heat rejection to the atmosphere from the refrigeration units.

3 The starter must comply with the codes and standards in Section 1.2.

4 **Low Voltage (200 through 600 volts)** controllers are to be continuous duty AC magnetic type constructed according to NEMA standards for Industrial Controls and Systems (ICS) and capable of carrying the specified current on a continuous basis. The starters shall be:

Solid-State Reduced Voltage - Starters shall be furnished with silicon controlled rectifiers (SCR) connected for starting and include a bypass contactor. When operating speed is reached, the bypass contactor shall be energized removing the SCRs from the circuit during normal running.

-- OR --

Wye-Delta Closed Transition - The starter s shall be equipped with properly sized resistors to provide a smooth transition. The resistors shall be protected with a transition resistor protector, tripping in a maximum of two seconds, locking out the starter, and shall be manually reset. A clearly marked transition timer shall be adjustable from 0 to 30 seconds or a current sensing devise shall initiate transition when starting current drops to 90% of RLA.

a All starters shall be coordinated with the chiller package(s) making certain all terminals are properly marked according to the chiller manufacturer's wiring diagrams.

b The starters shall be equipped with redundant motor control relays (MCR). The relays shall interconnect the starters with the unit control panels and directly operate the main motor contactors. The MCRs shall constitute the only means of energizing the motor starter.

c The main contactors shall have a normally open and a normally closed auxiliary contact rated at 125VA pilot duty at 115 VAC. An additional set of normally open contacts shall be provided for each MCR.

d There shall be electronic overloads in each phase which will permit continuous operation at 107% of the rated load amps of each motor. The overloads shall have a must-trip setting at 125% of the RLA. Overloads shall be manual reset and shall de-energize the main contactors when the overcurrent occurs. The overloads shall be adjustable and selected for mid-range. Overloads shall be adjustable, manual reset, ambient compensated, and set for class 10 operation.

e Each starter shall have a current transformer and adjustable voltage dropping resistor(s) to supply a 5.0 VAC signal at full load to the unit control panels.

f Each starter shall be equipped with a line to 115 VAC control transformer, fused in both the primary and secondary, to supply power to the control panels, oil heaters and oil pumps.

g Each starter shall include phase failure, phase undervoltage and phase reversal protection.

-- OR --

Variable Frequency Drive

a The chiller shall be equipped with a Variable Frequency Drives (VFD) to automatically regulate each compressor speed in response to cooling load and compressor pressure lift. The chiller control shall coordinate compressor speed and guide vane position to optimize chiller efficiency.

b A digital regulator shall provide V/Hz control.

c The VFD shall have 110% continuous overload of continuous amp rating with no time limit, PWM (pulse width modulated) output, IGBT (insulated gate bipolar transistors) power technology and full power rating at 2kHz..

d All heat producing devices shall be contained in a single heatsink with single inlet and out connections for the connection of chilled water. When factory mounted on the chiller package, the water connections shall be piped and leak tested at the factory.

-- OR --

4 Medium Voltage (601 through 7200 volts). The starter shall be:

Solid-State Reduced Voltage - Starter shall be furnished with silicon controlled rectifiers (SCR) connected for starting and include a bypass contactor. When operating speed is reached, the bypass contactor shall be energized removing the SCRs from the circuit during normal running.

a The starter shall be coordinated with the chiller package(s) making certain all terminals are properly marked according to the chiller manufacturer's wiring diagrams.

b The starters shall be equipped with redundant motor control relays (MCR). The relays shall interconnect the starters with the unit control panels and directly operate the main motor contactors. The MCRs shall constitute the only means of energizing the motor contacts.

c The main contactors shall have a normally open auxiliary contact rated at 125VA pilot duty at 115 VAC. An additional set of normally open contacts shall be provided on the MCR.

d There shall be electronic overloads in each phase set at 107% of the rated load amps of each motor. Overloads shall be manual reset and shall de-energize the main contactors when the overcurrent occurs. The overloads shall be adjustable and selected for mid-range. Overloads shall be adjusted for a locked rotor trip time of 8 seconds at full voltage and must trip in 60 seconds or less at reduced voltage (33% of delta LRA).

e Each starter shall have a current transformer and adjustable voltage dropping resistor(s) to supply a 5.0 VAC signal at full load to the unit control panels.

f Each starter shall be equipped with a line-to-115 VAC control transformer, fused in both the primary and secondary, to supply power to the control panels, oil heaters and oil pumps.

g Each starter shall include phase under/over voltage protection, phase failure and reversal protection, a load break disconnect switch and current limiting power fuses

-- OR --

Across-the-Line type with primary contactor allowing locked rotor amps to reach the motor when energized and including items 1 through 7 above

-- OR --

Autotransformer type factory wired to the 65% tap with drawout magnetic, three-pole, vacuum break shorting contactor, drawout magnetic, two-pole, vacuum break starting contactor, and open delta starting auto-transformer factory set at 65% and including items 1 through7 above with a isolating safety switch in lieu of a load-break disconnect switch.

-- OR --

Primary Reactor type with drawout magnetic, three-pole, vacuum break shorting assembly, and three-phase starting reactor, factory set at the 65% tap and including items 1 through7 above with a isolating safety switch in lieu of a load-break disconnect switch.

All medium and higher voltage starters shall have the following components:

Main Control Relays

A motor control relay shall be provided to interlock the starter with the chiller. The relay shall constitute the only means of energizing the motor starter. No other devices (manual or automatic) with the capability of energizing the starter can be used. The starter is to be controlled by the unit microprocessor.

Motor Protection and Overloads

The starter shall include overload protection functions. These controls include:

- Solid state overload (overcurrent) protection
- Phase unbalance protection
- Phase reversal and phase loss protection.
- Adjustable overload to closely match motor performance
- Three current transformers to measure motor current and a fourth current transformer for input to the chiller microprocessor.

Undervoltage (UV) Relay

The undervoltage relay is an adjustable three-phase protection system that is activated when the voltage falls below a predetermined safe value and is factory set at 85% of nominal.

Control Voltage Transformer

The starter is to be provided with a 3KVA control transformer with both secondary and primary fuses to supply control power to the chiller.

Additional Standard Components

- Mechanical type solderless connectors to handle wire sizes indicated by NEC.
- Three isolated vertical line contactors
- Three-pole, gang operated non-load break isolating switch
- Three vertically mounted current limiting power fuse blocks (fuses included)
- Magnetic three-pole, vacuum break contactor
- Single phase control circuit transformer
- Vertically mounted control circuit primary current limiting fuses
- Current transformers
- Control circuit terminal blocks and secondary fuses
- Phase failure and reversal relay

F Chiller Controller

1 Control enclosures shall be NEMA 1. The chiller shall have distributed control consisting of a unit controller, a compressor controller and a 15-inch super VGA color touch screen for operator interface with the control system.

The touch screen shall have graphics clearly depicting the chiller status, operating data, including water temperatures, percent RLA, water setpoint, alarm status and have STOP and AUTO control buttons.

The operator interface touch screen shall have inherent trend logging capabilities, which are transferable to other PC management systems such as an Excel spreadsheet via a USB port. Active trend logging data shall be available for viewing in 20 minute, 2 hour or 8 hour intervals. A full 24 hours of history is downloadable via a USB port. The following trended parameters shall be displayed:

- Entering and leaving chilled water temps
- Entering and leaving condenser water temps
- Evaporator saturated refrigerant pressure
- Condenser saturated refrigerant pressure
- Net oil pressure
- % rated load amps

In addition to the trended items above, other real-time operating parameters are also shown on the touch screen. These items can be displayed in two ways: by chiller graphic showing each component or from a color-coded, bar chart format. At a minimum, the following critical areas must be monitored:

- Oil sump temperature
- Oil feed line temperature
- Evaporator saturated refrigerant temperature
- Suction temperature
- Condenser saturated refrigerant temperature
- Discharge temperature
- Liquid line temperature

Unit setpoints shall be viewable on screens and changeable after insertion of a password.

Complete unit operating and maintenance instructions shall be viewable on the touch screen and be downloadable via an onboard USB port.

Automatic corrective action to reduce unnecessary cycling shall be accomplished through pre-emptive control of low evaporator or high discharge pressure conditions to keep the unit operating through ancillary transient conditions.

System specific, chiller plant architecture software shall be employed to display the chiller, piping, pumps and cooling tower. Multi-chiller interconnection software for up to 4 WSC or WDC chillers shall be included also providing automatic control of: evaporator and condenser pumps (primary and standby), up to 4 stages of cooling tower fans and a cooling tower modulating bypass valve and/or cooling tower fan variable frequency drives. There shall be five possible tower control strategies:

- Tower fan staging only – up to 4 stages controlled by either the entering condenser water temperature or lift differential temperature between the condenser and evaporator saturated temperatures.
- Tower fan staging plus low limit - controlled as in # 1 plus tower bypass valve set at a minimum entering condenser water temperature
- Tower staging with staged bypass control – similar to # 2 with additional control of the bypass valve between fan staging to smooth control and minimize fan staging.
- VFD staging only – in this mode, a variable speed drive controls the first fan with up to 3 more fans to be staged on and off and there is no bypass valve.
- VFD and Valve Staging – same as # 4 plus bypass valve control

Factory mounted DDC controller(s) shall support operation on a BACnet®, Modbus® or LONMARKS ® network via one of the data link / physical layers listed below as specified by the successful Building Automation System (BAS) supplier.

- BACnet MS/TP master (Clause 9)
- BACnet IP, (Annex J)
- BACnet ISO 8802-3, (Ethernet)
- LONMARKS FTT-10A. The unit controller shall be LONMARKS® certified.

The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.
eXternal Interface File (XIF) shall be provided with the chiller submittal data.
All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

2.5. MISCELLANEOUS ITEMS

A Pumpout System: If the design of the unit does not allow the charge to be transferred to and isolated in the main condenser, it shall be equipped with an ASME pumpout system complete with a transfer pump, condensing unit, and storage vessel . The main condenser shall be sized to contain the refrigerant charge at 90°F according to ANSI-ASHRAE 15.A.

B Purge System (Negative Pressure Chillers Only):

1 The chiller manufacturer shall provide a separate high efficiency purge system that operates independently of the unit and can be operated while the unit is off. The system shall consist of an air-cooled condensing unit, purge condensing tank, pumpout compressor and control system.

2 A dedicated condensing unit shall be provided with the purge system to provide a cooling source whether or not the chiller is running. The condensing unit shall provide a low purge coil temperature to result in a maximum loss of 0.1 pounds of refrigerant per pound of purged air.

3 The purge tank shall consist of a cooling coil, filter-drier cores, water separation tube, sight glass, drain, and air discharge port. Air and water are separated from the refrigerant vapor and accumulated in the purge tank.

4 The pumpout system shall consist of a small compressor and a restriction device located at the pumpout compressor suction connection.

5 The purge unit shall be connected to a 100% reclaim device.

C C.Vacuum Prevention System (negative pressure chillers only): Chiller manufacturer shall supply and install a vacuum prevention system for each chiller. The system shall constantly maintain 0.05 psig inside the vessel during non-operational periods. The system shall consist of a precision pressure controller, two silicon blanket heaters, a pressure transducer, and solid-state safety circuit.

D D.Refrigerant Detection Device (negative pressure chillers only): Chiller manufacturer shall supply and install a refrigerant detection device and alarm capable of monitoring refrigerant at a level of 10 ppm. Due to the critical nature of this device and possible owner liability, the chiller manufacturer shall guarantee and maintain the detection monitor for five years after owner acceptance of the system.

E E.Waffle type vibration pads for field mounting under unit feet.

F IBC Certification: The chiller shall be certified to the following codes and standards; 2009 IBC, 2010 CBC, ICC-ES AC-156, ASCE 7-05. The chiller must be mounted to a rigid base and may use neoprene waffle vibration pads.

G OSHPD Certification: The chiller shall be OSHPD Pre-Approved per OSP-0116-10 and be so labeled. The chiller shall meet a minimum seismic design spectral response acceleration of 1.60 S_{DS}. The chiller must be mounted to a rigid base and may use neoprene waffle vibration pads.

PART 3 — EXECUTION

3.1 INSTALLATION

A Install according to manufacturer's requirements, shop drawings, and Contract Documents.

B Adjust chiller alignment on concrete foundations, sole plates or subbases as called for on drawings.

C Arrange the piping on each vessel to allow for dismantling the pipe to permit head removal and tube cleaning.

D Furnish and install necessary auxiliary water piping for oil cooler.

E Coordinate electrical installation with electrical contractor.

F Coordinate controls with control contractor.

G Provide all materiel required to ensure a fully operational and functional chiller.

3.2 START-UP

A Units shall be factory charged with the proper refrigerant and oil.

B Factory Start-Up Services: The manufacturer shall provide factory authorized supervision for as long a time as is necessary to ensure proper operation of the unit, but in no case for less than two full working days. During the period of start-up, the start-up technician shall instruct the owner's representative in proper care and operation of the unit.

Specifications (WDC)

SECTION 15XXX
CENTRIFUGAL CHILLERS (DUAL COMPRESSOR)

PART 1 — GENERAL

1.1 SUMMARY

A Section includes design, performance criteria, refrigerants, controls, and installation requirements for water-cooled centrifugal chillers.

1.2 REFERENCES

A Comply with the following codes and standards

1 AHRI 550/590

2 NEC

3 ANSI/ASHRAE 15

4 OSHA as adopted by the State

5 ASME Section VIII

1.3 SUBMITTALS

A Submittals shall include the following:

1 Dimensioned plan and elevation view drawings, including motor starter cabinet, required clearances, and location of all field piping and electrical connections.

2 Summaries of all auxiliary utility requirements such as: electricity, water, air, etc. Summary shall indicate quality and quantity of each required utility.

3 Diagram of control system indicating points for field interface and field connection. Diagram shall fully depict field and factory wiring.

4 Manufacturer's certified performance data at full load plus IPLV or NPLV.

5 Before shipment, submit a certification of satisfactory completion of factory run test signed by a company officer. The test shall be performed on an AHRI-qualified test stand and conducted according to AHRI Standard 550/590.

6 Installation and Operating Manuals.

1.4 QUALITY ASSURANCE

A Qualifications: Equipment manufacturer must specialize in the manufacture of the products specified and have five years experience with the equipment and refrigerant offered.

B Regulatory Requirements: Comply with the codes and standards in Section 1.2.

C Chiller manufacturer plant shall be ISO Registered.

1.5 DELIVERY AND HANDLING

A Chillers shall be delivered to the job site completely assembled and charged with refrigerant and oil.

B Comply with the manufacturer's instructions for rigging and transporting units. Leave protective covers in place until installation.

1.6 WARRANTY

A The refrigeration equipment manufacturer's warranty shall be for a period of (one) -- **OR** -- (two) --**Or**-- (five) years from date of equipment start up or 18 months from shipment whichever occurs first. The warranty shall include parts and labor costs for the repair or replacement of defects in material or workmanship. [WDC: The refrigerant charge shall be warranted against contamination from a motor burnout for five years.]

1.7 MAINTENANCE

A Chiller maintenance shall be the responsibility of the owner with the following exceptions:

1 The manufacturer shall provide the first year scheduled oil and filter change if required.

2 The manufacturer shall provide first year purge unit maintenance if required.

PART 2 — PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A Daikin

B (Approved Equal)

2.2 UNIT DESCRIPTION

Provide and install as shown on the plans a factory assembled, charged water-cooled packaged chiller. Each unit shall be complete with two single-stage hermetic centrifugal compressors each having independent lubrication and control systems, factory mounted starters, and isolation valves. The evaporator, condenser, and refrigerant control device of each unit shall be common to the compressors. The chiller unit shall be capable of running on one compressor with the other compressor or any of its auxiliaries removed.

Each chiller shall be factory run-tested under load conditions for a minimum of one hour on an AHRI qualified test stand with evaporator and condenser waterflow at job conditions (excluding glycol applications). Operating controls shall be adjusted and checked. The refrigerant charge shall be adjusted for optimum operation and recorded on the unit nameplate. Units operating with 50-Hz power shall be tested with a 50-Hz power supply. Any deviation in performance or operation shall be remedied prior to shipment and the unit retested if necessary to confirm repairs or adjustments. Manufacturer shall supply a certificate of completion of a successful run-test upon request.

Electrical components shall be housed in NEMA 1 enclosures, designed for clean, indoor locations.

2.3 DESIGN REQUIREMENTS

A General: Provide a complete water-cooled dual hermetic compressor centrifugal water chiller as specified herein. Machine shall be provided according to standards, Section 1.2. In general, unit shall consist of two compressors, refrigerant condenser and evaporator, two lubrication

systems, two starters and two control systems.
Note: Chillers shall be charged with a refrigerant such as HFC-134a, not subject to the Montreal Protocol and the U. S. Clean Air Act.

B Performance: Refer to schedule on the drawings. The chiller shall be capable of stable operation to five percent of full load with standard AHRI entering condensing water relief without hot gas bypass.

C Acoustics: Sound pressure for the unit shall not exceed the following specified levels. Provide the necessary acoustic treatment to chiller as required. Sound data shall be measured according to AHRI Standard 575 and shall be in dB. Data shall be the highest levels recorded at all load points. Test shall be in accordance with AHRI Standard 575.

Sound Pressure (at 30 feet)											
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall dBA	75% Load dBA	50% Load dBA	25% Load dBA
Sound Power											
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall dBA	75% Load dBA	50% Load dBA	25% Load dBA

One-third Octave Band Sound Power																						
50 Hz	63 Hz	80 Hz	100 HZ	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	6300 Hz	8000 Hz	10 kHz

2.4 CHILLER COMPONENTS

A A.Compressors:

1 Unit shall have two single-stage hermetic centrifugal compressors. Casing design shall ensure major wearing parts, main bearings and thrust bearings are accessible for maintenance and replacement. Lubrication system shall protect machine during coast down resulting from a loss of power.

2 Impellers shall be statically and dynamically balanced. The compressor shall be vibration tested and not exceed 0.14 IPS.

3 Movable inlet guide vanes actuated by an internal oil pressure driven piston shall accomplish unloading. Compressors using an unloading system that requires penetrations of the compressor housing or linkages, or both, that must be lubricated and adjusted are acceptable provided the manufacturer provides a five-year inspection agreement consisting of semi-annual inspection, lubrication, and annual changeout of compressor seals. A statement of inclusion must accompany any quotations.

4 If compressors are not equipped with guide vanes for each stage and movable discharge diffusers, then furnish hot gas bypass and select chillers at 5% lower kW/ton than specified to compensate for bypass inefficiency at low loads.

5 For open motor unit, an oil reservoir shall collect any oil and refrigerant that leaks past the seal. A float device shall be provided to open when the reservoir is full, directing the refrigerant/oil mixture back into the compressor housing. Manufacturer shall warrant the shaft seal, reservoir, and float valve system against leakage of oil and refrigerant to the outside of the refrigerating unit for a period of 5 years from the initial start-up including parts and labor to replace a defective seal and any refrigerant required to trim the charge original specifications.

B Lubrication System: Each compressor shall have an independent lubrication system to provide lubrication to all parts requiring oil. Provide a heater in the oil sump to maintain oil at sufficient temperature to minimize affinity of refrigerant, and a thermostatically controlled water-cooled oil cooler. Coolers located inside the evaporator or condenser are not acceptable due to inaccessibility. A positive displacement submerged oil pump shall be powered through the unit control transformer.

C Refrigerant Evaporator and Condenser:

1 The evaporator and condenser shall be single circuit and be of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.1 times the working pressure but not less than 100 psig. Provide intermediate tube supports at a maximum of 18 inch spacing.

2 Tubes shall be enhanced for maximum heat transfer, rolled into steel tube sheets and sealed with Locktite or

equal sealer. The tubes shall be individually replaceable and secured to the intermediate supports without rolling.

3 The water sides shall be designed for a minimum of 150 psig or as specified elsewhere. Vents and drains shall be provided.

4 Chilled water minimum refrigerant temperature shall be 33°F.

5 An electronic or thermal refrigerant expansion valve shall control refrigerant flow to the evaporator. Fixed orifice devices or float controls with hot gas bypass are not acceptable because of inefficient control at low load conditions. The liquid line shall have a moisture indicating sight glass.

6 The evaporator and condenser shall be separate shells. A single shell containing both vessel functions is not acceptable because of the possibility of internal leaks.

7 Interstage economizers shall be used between each compressor stage for increased efficiency.

8 Reseating type spring loaded pressure relief valves according to ASHRAE-15 safety code shall be furnished. The evaporator shall be provided with single or multiple valves. The condenser shall be provided with dual relief valves equipped with a transfer valve so one valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the vessel. Rupture disks are not acceptable.

9 The evaporator, suction line, and any other component or part of a component subject to condensing moisture shall be insulated with UL recognized 3/4 inch closed cell insulation. All joints and seams shall be carefully sealed to form a vapor barrier.

10 Provide Factory-mounted thermal dispersion flow switches on each vessel to prevent unit operation with no flow, furnished, installed and wired by the contractor.

D Prime Mover: Squirrel cage induction motor of the hermetic type of sufficient size to efficiently fulfill compressor horsepower requirements. Motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase. Motor shall be compatible with the starting method specified hereinafter. If the Contractor chooses to provided an open drive motor or compressor, verify in the submittal that the scheduled chiller room ventilation system will accommodate the additional heat and maintain the equipment room at design indoor temperature based on 95°F outdoor ambient ventilation air available.
If additional cooling is required, manufacturer shall be responsible for the installation, wiring and controls of a cooling system. Chiller selection shall compensate for tons and efficiency loss to make certain the owner is not penalized.

E E.Motor Starter:

1 The main motor starter is to be factory mounted and fully wired to the chiller components and factory tested during the run test of the unit.
-- OR --
The main motor starter is to be furnished by the chiller manufacturer and shipped loose for floor mounting and field wiring to the chiller package. It shall be free-standing with NEMA-1 enclosure designed for top entry and bottom exit and with front access.

2 For open drive air-cooled motors the chiller manufacturer shall be responsible for providing the cooling of the refrigeration machinery room. The sensible cooling load shall be based on the total heat rejection to the atmosphere from the refrigeration units.

3 The starter must comply with the codes and standards in Section 1.2.

4 **Low Voltage (200 through 600 volts)** controllers are to be continuous duty AC magnetic type constructed according to NEMA standards for Industrial Controls and Systems (ICS) and capable of carrying the specified current on a continuous basis. The starters shall be:
Solid-State Reduced Voltage - Starters shall be furnished with silicon controlled rectifiers (SCR) connected for starting and include a bypass contactor. When operating speed is reached, the bypass contactor shall be energized removing the SCRs from the circuit during normal running.
-- OR --
Wye-Delta Closed Transition - The starter s shall be equipped with properly sized resistors to provide a smooth transition. The resistors shall be protected with a transition resistor protector, tripping in a maximum of two seconds, locking out the starter, and shall be manually reset. A clearly marked transition timer shall be adjustable from 0 to 30 seconds or a current sensing devise shall initiate transition when starting current drops to 90% of RLA.

a All starters shall be coordinated with the chiller package(s) making certain all terminals are properly marked according to the chiller manufacturer's wiring diagrams.

b The starters shall be equipped with redundant motor control relays (MCR). The relays shall interconnect the starters with the unit control panels and directly operate the main motor contactors. The MCRs shall constitute the only means of energizing the motor starter.

c The main contactors shall have a normally open and a normally closed auxiliary contact rated at 125VA pilot duty at 115 VAC. An additional set of normally open contacts shall be provided for each MCR.

d There shall be electronic overloads in each phase which will permit continuous operation at 107% of the rated load amps of each motor. The overloads shall have a must-trip setting at 125% of the RLA. Overloads shall be manual reset and shall de-energize the main contactors when the overcurrent occurs. The overloads shall be adjustable and selected for mid-range. Overloads shall be adjustable, manual reset, ambient compensated, and set for class 10 operation.

e Each starter shall have a current transformer and adjustable voltage dropping resistor(s) to supply a 5.0 VAC signal at full load to the unit control panels.

f Each starter shall be equipped with a line to 115 VAC control transformer, fused in both the primary and secondary, to supply power to the control panels, oil heaters and oil pumps.

g Each starter shall include phase failure, phase undervoltage and phase reversal protection.

-OR-

Variable Frequency Drive

a The chiller shall be equipped with a Variable Frequency Drives (VFD) to automatically regulate each compressor speed in response to cooling load and compressor pressure lift. The chiller control shall coordinate compressor speed and guide vane position to optimize chiller efficiency.

b A digital regulator shall provide V/Hz control.

c The VFD shall have 110% continuous overload of continuous amp rating with no time limit, PWM (pulse width modulated) output, IGBT (insulated gate bipolar transistors) power technology and full power rating at 2kHz..

d All heat producing devices shall be contained in a single heatsink with single inlet and out connections for the connection of chilled water. When factory mounted on the chiller package, the water connections shall be piped and leak tested at the factory.

-- OR --

4 Medium Voltage (601 through 7200 volts).

The starter shall be:

Solid-State Reduced Voltage - Starter shall be furnished with silicon controlled rectifiers (SCR) connected for starting and include a bypass contactor. When operating speed is reached, the bypass contactor shall be energized removing the SCRs from the circuit during normal running.

a The starter shall be coordinated with the chiller package(s) making certain all terminals are properly marked according to the chiller manufacturer's wiring diagrams.

b The starters shall be equipped with redundant motor control relays (MCR). The relays shall interconnect the starters with the unit control panels and directly operate the main motor contactors. The MCRs shall constitute the only means of energizing the motor contacts.

c The main contactors shall have a normally open auxiliary contact rated at 125VA pilot duty at 115 VAC. An additional set of normally open contacts shall be provided on the MCR.

d There shall be electronic overloads in each phase set at 107% of the rated load amps of each motor. Overloads shall be manual reset and shall de-energize the main contactors when the overcurrent occurs. The overloads shall be adjustable and selected for mid-range. Overloads shall be adjusted for a locked rotor trip time of 8 seconds at full voltage and must trip in 60 seconds or less at reduced voltage (33% of delta LRA).

e Each starter shall have a current transformer and adjustable voltage dropping resistor(s) to supply a 5.0 VAC signal at full load to the unit control panels.

f Each starter shall be equipped with a line-to-115 VAC control transformer, fused in both the primary and secondary, to supply power to the control panels, oil heaters and oil pumps.

g Each starter shall include phase under/over voltage protection, phase failure and reversal protection, a load break disconnect switch and current limiting power fuses

-- OR --

Across-the-Line type with primary contactor allowing locked rotor amps to reach the motor when energized and including items 1 through 7 above

-- OR --

Autotransformer type factory wired to the 65% tap with drawout magnetic, three-pole, vacuum break shorting contactor, drawout magnetic, two-pole, vacuum break starting contactor, and open delta starting auto-transformer factory set at 65% and including items 1 through7 above with a isolating safety switch in lieu of a load-break disconnect switch.

-- OR --

Primary Reactor type with drawout magnetic, three-pole, vacuum break shorting assembly, and three-phase starting reactor, factory set at the 65% tap and including items 1 through7 above with a isolating safety switch in lieu of a load-break disconnect switch.

All medium and higher voltage starters shall have the following components:

Main Control Relays

A motor control relay shall be provided to interlock the starter with the chiller. The relay shall constitute the only means of energizing the motor starter. No other devices (manual or automatic) with the capability of energizing the

starter can be used. The starter is to be controlled by the unit microprocessor.

Motor Protection and Overloads

The starter shall include overload protection functions. These controls include:

- Solid state overload (overcurrent) protection
- Phase unbalance protection
- Phase reversal and phase loss protection.
- Adjustable overload to closely match motor performance
- Three current transformers to measure motor current and a fourth current transformer for input to the chiller microprocessor.

Undervoltage (UV) Relay

The undervoltage relay is an adjustable three-phase protection system that is activated when the voltage falls below a predetermined safe value and is factory set at 85% of nominal.

Control Voltage Transformer

The starter is to be provided with a 3KVA control transformer with both secondary and primary fuses to supply control power to the chiller.

Additional Standard Components

- Mechanical type solderless connectors to handle wire sizes indicated by NEC.
- Three isolated vertical line contactors
- Three-pole, gang operated non-load break isolating switch
- Three vertically mounted current limiting power fuse blocks (fuses included)
- Magnetic three-pole, vacuum break contactor
- Single phase control circuit transformer
- Vertically mounted control circuit primary current limiting fuses
- Current transformers
- Control circuit terminal blocks and secondary fuses
- Phase failure and reversal relay

F CHILLER CONTROLLER

The chiller shall have distributed control consisting of a unit controller, a compressor controller for each compressor and a 15-inch super VGA color touch screen for operator interface with the control system.

The touch screen shall have graphics clearly depicting the chiller status, operating data, including water temperatures, percent RLA, water setpoint, alarm status and have STOP and AUTO control buttons.

The operator interface touch screen shall have inherent trend logging capabilities, which are transferable to other PC management systems such as an Excel spreadsheet via a USB port. Active trend logging data shall be available for viewing in 20 minute, 2 hour or 8 hour intervals. A full 24 hours of history is downloadable via a USB port. The following trended parameters shall be displayed:

- Entering and leaving chilled water temps
- Entering and leaving condenser water temps
- Evaporator saturated refrigerant pressure
- Condenser saturated refrigerant pressure
- Net oil pressure for each compressor
- % rated load amps for entire unit

In addition to the trended items above, other real-time operating parameters are also shown on the touch screen. These items can be displayed in two ways: by chiller graphic showing each component or from a color-coded, bar chart format. At a minimum, the following critical areas must be monitored:

- Oil sump temperature per compressor
- Oil feed line temperature per compressor
- Evaporator saturated refrigerant temperature for unit
- Suction temperature for unit
- Condenser saturated refrigerant temperature for unit
- Discharge temperature for unit
- Liquid line temperature for unit

The unit operating and maintenance instructions shall be viewable on the touch screen and downloadable via an onboard USB port.

Complete fault history shall be displayed using an easy to decipher, color coded set of messages that are date and time stamped. The last 20 faults shall be downloadable from the USB port.

Automatic corrective action to reduce unnecessary cycling shall be accomplished through pre-emptive control of low evaporator or high discharge pressure conditions to keep the unit operating through ancillary transient conditions.

System specific, chiller plant architecture software shall be employed to display the chiller, piping, pumps and cooling tower. Chiller interconnection softw for up to 4 WSC or WDC chillers shall be included also providing automatic control of: evaporator and condenser pumps (primary and standby), up to 4 stages of cooling tower fans and a cooling tower modulating bypass valve or cooling tower variable frequency drives. There shall be five possible tower control strategies:

- Tower fan staging only – up to 4 stages controlled by either the entering condenser water temperature or lift differential temperature between the condenser and evaporator saturated temperatures.
- Tower fan staging plus low limit - controlled as in # 1 plus tower bypass valve set at a minimum entering condenser water temperature.
- Tower staging with staged bypass control – similar to # 2 with additional control of the bypass valve between fan staging to smooth control and minimize fan staging.
- VFD staging only – in this mode, a variable speed drive controls the first fan with up to 3 more fans to be staged on and off and there is no bypass valve.

- VFD and Valve Staging – same as # 4 plus bypass valve control.

Factory mounted DDC controllers shall support operation on a BACnet, Modbus or LONWORKS network via a factory-installed communication module.

Factory mounted DDC controller(s) shall support operation on a BACnet®, Modbus® or LONMARKS ® network via one of the data link / physical layers listed below as specified by the successful Building Automation System (BAS) supplier.

- BACnet MS/TP master (Clause 9)
- BACnet IP, (Annex J)
- BACnet ISO 8802-3, (Ethernet)
- LONMARKS FTT-10A. The unit controller shall be LONMARKS® certified.

The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.

For chillers communicating over a LONMARK network, the corresponding LONMARK eXternal Interface File (XIF) shall be provided with the chiller submittal data.

All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

2.5. MISCELLANEOUS ITEMS

A Pumpout System: If the design of the unit does not allow the charge to be transferred to and isolated in the main condenser, it shall be equipped with an ASME pumpout system complete with a transfer pump, condensing unit, and storage vessel . The main condenser shall be sized to contain the refrigerant charge at 90°F according to ANSI-ASHRAE 15.A.

B Purge System (negative pressure chillers only):

1 The chiller manufacturer shall provide a separate high efficiency purge system that operates independently of the unit and can be operated while the unit is off. The system shall consist of an air-cooled condensing unit, purge condensing tank, pumpout compressor and control system.

2 A dedicated condensing unit shall be provided with the purge system to provide a cooling source whether or not the chiller is running. The condensing unit shall provide a low purge coil temperature to result in a maximum loss of 0.1 pounds of refrigerant per pound of purged air.

3 The purge tank shall consist of a cooling coil, filter-drier, water separation tube, sight glass, drain, and air discharge port. Air and water are separated from the refrigerant vapor and accumulated in the purge tank.

4 The pumpout system shall consist of a small compressor and a restriction device located at the pumpout compressor suction connection.

5 The purge unit shall be connected to a 100% reclaim device.

C Vacuum Prevention System (Negative pressure chillers only): Chiller manufacturer shall supply and install a vacuum prevention system for each chiller. The system shall constantly maintain 0.05 psig inside the vessel during non-operational periods. The system shall consist of a precision pressure controller, two silicon blanket heaters, a pressure transducer, and solid-state safety circuit.

D Refrigerant Detection Device (negative pressure chillers only): Chiller manufacturer shall supply and install a refrigerant detection device and alarm capable of monitoring refrigerant at a level of 10 ppm. The chiller manufacturer shall guarantee and maintain the detection monitor for five years.

E Waffle type vibration pads for field mounting under unit .

F OSHPD Certification: The chiller shall be OSHPD Pre-Approved per OSP-0116-10 and be so labeled. The chiller shall meet a minimum seismic design spectral response acceleration of 1.60 S_{DS}. The chiller must be mounted to a rigid base and may use neoprene waffle vibration pads.

G IBC Certification: The chiller shall be certified to the following codes and standards; 2009 IBC, 2010 CBC, ICC-ES AC-156, ASCE 7-05. The chiller must be mounted to a rigid base and may use neoprene waffle vibration pads.

PART 3 — EXECUTION

3.1 INSTALLATION

A Install per manufacturer's requirements, shop drawings, and Contract Documents.

B Adjust chiller alignment on foundations, or subbases as called for on drawings.

C Arrange piping to allow for dismantling to permit head removal and tube cleaning.

D Furnish and install necessary auxiliary water piping for oil cooler.

E Coordinate electrical installation with electrical contractor.

F Coordinate controls with control contractor.

G Provide all materiel required for a fully operational and functional chiller.

3.2 START-UP

A Units shall be factory charged with the proper refrigerant and oil.

B Factory Start-Up Services: The manufacturer shall provide factory authorized supervision for as long a time as is necessary to ensure proper operation of the unit, but in no case for less than two full working days. During the period of start-up, the start-up technician shall instruct the owner's representative in proper care and operation of the unit.

Specifications (WCC)

SECTION 15XXX - CENTRIFUGAL CHILLERS COUNTERFLOW, DUAL COMPRESSORS

PART 1 — GENERAL

1.1 SUMMARY

A Section includes design, performance criteria, refrigerants, controls, and installation requirements for water-cooled centrifugal chillers.

1.2 REFERENCES

A Comply with the following codes and standards

1 AHRI 550/590

2 NEC

3 ANSI/ASHRAE 15

4 OSHA as adopted by the State

5 ASME Section VIII

1.3 SUBMITTALS

A Submittals shall include the following:

1 Dimensioned plan and elevation view drawings, including motor starter cabinet, required clearances, and location of all field piping and electrical connections.

2 Summaries of all auxiliary utility requirements such as: electricity, water, air, etc. Summary shall indicate quality and quantity of each required utility.

3 Diagram of control system indicating points for field interface and field connection. Diagram shall fully depict field and factory wiring.

4 Manufacturer's certified performance data at full load plus IPLV or NPLV.

5 Before shipment, submit a certification of satisfactory completion of factory run test signed by a company officer. The test shall be performed on an AHRI-qualified test stand and conducted according to AHRI Standard 550/590.

6 Installation and Operating Manuals.

1.4 QUALITY ASSURANCE

A Qualifications: Equipment manufacturer must specialize in the manufacture of the products specified and have five years experience with the equipment and refrigerant offered.

B Regulatory Requirements: Comply with the codes and standards in Section 1.2.

C Chiller manufacturer plant shall be ISO Registered.

1.5 DELIVERY AND HANDLING

A Chillers shall be delivered to the job site completely assembled and charged with refrigerant and oil.

B Comply with the manufacturer's instructions for rigging and transporting units. Leave protective covers in place until installation.

1.6 WARRANTY

A The refrigeration equipment manufacturer's warranty shall be for a period of (one) -- **OR** -- (two) --**Or**-- (five) years from date of equipment start up or 18 months from shipment whichever occurs first. The warranty shall include parts and labor costs for the repair or replacement of defects in material or workmanship. [WDC: The refrigerant charge shall be warranted against contamination from a motor burnout for five years.]

1.7 MAINTENANCE

A Chiller maintenance shall be the responsibility of the owner with the following exceptions:

1 The manufacturer shall provide the first year scheduled oil and filter change if required.

2 The manufacturer shall provide first year purge unit maintenance if required.

PART 2 — PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A Daikin

B (Approved Equal)

2.2 UNIT DESCRIPTION

A Provide and install as shown on the plans a factory assembled, charged water-cooled packaged chiller. Each unit shall be complete with two single-stage hermetic centrifugal compressors each having independent lubrication and control systems. Each compressor shall have a dedicated circuit in the evaporator and condenser, and its own refrigerant control device. The chiller unit shall be capable of running on one compressor with the other compressor or any of its auxiliaries inoperable or removed. Each chiller shall be factory run-tested under load conditions for a minimum of one hour on an AHRI qualified test stand with evaporator and condenser waterflow at job conditions (excluding glycol applications). Operating controls shall be adjusted and checked. The refrigerant charge shall be adjusted for optimum operation and recorded on the unit nameplate. Units operating with 50-Hz power shall be tested with a 50-Hz power supply. Any deviation in performance or operation shall be remedied prior to shipment and the unit retested if necessary to confirm repairs or adjustments. Manufacturer shall supply a certificate of completion of a successful run-test upon request.

2.3 DESIGN REQUIREMENTS

A General: Provide a complete water-cooled dual centrifugal water chiller as specified herein. Machine shall be provided according to standards, Section 1.2. In general, the unit shall consist of two compressors, two circuited refrigerant condenser and evaporator, two lubrication systems, and two control systems. The vessels shall be single pass with a counterflow water arrangement.

Specifications (WCC)

Note: Chillers shall be charged with a refrigerant such as HFC-134a, not subject to the Montreal Protocol and the U. S. Clean Air Act.

B Performance: Refer to schedule on the drawings. The chiller shall be capable of stable operation to five percent of full load with standard AHRI entering condensing water relief without hot gas bypass.

C Acoustics: Sound pressure for the unit shall not exceed the following specified levels. Provide the necessary acoustic treatment to chiller as required. Sound data shall be measured according to

D AHRI Standard 575 and shall be in dB. Data shall be the highest levels recorded at all load points. Test shall be in accordance with AHRI Standard 575.

Sound Pressure (at 30 feet)											
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall dBA	75% Load dBA	50% Load dBA	25% Load dBA
Sound Power											
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall dBA	75% Load dBA	50% Load dBA	25% Load dBA

One-third Octave Band Sound Power																						
50 Hz	63 Hz	80 Hz	100 HZ	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	6300 Hz	8000 Hz	10 kHz

2.4 CHILLER COMPONENTS

A A.Compressors:

1 The chiller shall have two single-stage hermetic centrifugal compressors. Casing design shall ensure major wearing parts, main and thrust bearings are accessible for maintenance and replacement.

2 The impeller shall be statically and dynamically balanced. The compressor shall be vibration tested and not exceed 0.14 IPS.

3 Movable inlet guide vanes actuated by an internal oil pressure driven piston shall accomplish unloading. Compressors using an unloading system that requires penetrations of the compressor housing or linkages, or both, that must be lubricated and adjusted are acceptable provided the manufacturer provides a five-year inspection agreement consisting of semi-annual inspection, lubrication, and annual change out of compressor seals. A statement of inclusion must accompany any quotations.

4 If compressors are not equipped with guide vanes for each stage and movable discharge diffusers, then furnish hot gas bypass and select chillers at 5% lower kW/ton than specified to compensate for bypass inefficiency at low loads.

5 For air-cooled motors the chiller manufacturer shall be responsible for providing the cooling of the refrigeration machinery room. The sensible cooling load shall be based on the total heat rejection to the atmosphere from tow refrigeration units.

6 For open motor unit, an oil reservoir shall collect any oil and refrigerant that leaks past the seal. A float device shall be provided to open when the reservoir is full, directing the refrigerant/oil mixture back into the compressor housing. Manufacturer shall warrant the shaft seal, reservoir, and float valve system against leakage of oil and refrigerant to the outside of the refrigerating unit for a period of 5 years from the initial start-up including parts and labor to replace a defective seal and any refrigerant required to trim the charge original specifications.

B Lubrication System: Each compressor shall have an independent lubrication system to provide lubrication to all parts requiring lubrication. Provide a heater in the lubricant sump to maintain lubricant at sufficient temperature to minimize affinity of refrigerant, and a thermostatically controlled water-cooled oil cooler. Coolers located inside the evaporator or condenser are not acceptable due to inaccessibility. A positive displacement submerged lubricant pump shall be powered through the unit control transformer.

C Refrigerant Evaporator and Condenser:

1 Evaporator and condenser shall be of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.1 times the working pressure but not less than 100 psig. Provide intermediate tube supports at a maximum of 18 inch spacing.

2 Each vessel shall have two refrigerant circuits, separated by an intermediate tube sheet.

3 Tubes shall be enhanced for maximum heat transfer, rolled into steel end and intermediate tube sheets and sealed with Locktite or equal sealer. The tubes shall be individually replaceable.

4 The water sides shall be designed for a minimum of 150 psig or as specified elsewhere. Vents and drains shall be provided.

5 Chilled water minimum refrigerant temperature shall be 33°F.

6 An electronic or thermal refrigerant expansion valve shall control refrigerant flow to the evaporator. Fixed orifice devices or float controls with hot gas bypass are not acceptable because of inefficient control at low load conditions. The liquid line shall have a moisture indicating sight glass.

7 The evaporator and condenser shall be separate shells. A single shell containing both vessel functions is not acceptable because of the possibility of internal leaks.

8 Interstage economizers shall be used between each compressor stage on multi-stage compressors for increased efficiency.

9 Reseating type spring loaded pressure relief valves according to ASHRAE-15 safety code shall be furnished. The evaporator shall be provided with single or multiple valves. The condenser shall be provided with dual relief valves equipped with a transfer valve so one valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the vessel. Rupture disks are not acceptable.

10 The evaporator, suction line, and any other component or part of a component subject to condensing moisture shall be insulated with UL recognized 3/4 inch closed cell insulation. All joints and seams shall be carefully sealed to form a vapor barrier.

11 Provide a factory-installed, thermal dispersion, water flow switches on each vessel to prevent unit operation with no flow.

D Prime Mover: Squirrel cage induction motor of the hermetic type of sufficient size to efficiently fulfill compressor horsepower requirements. Motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase. Motor shall be compatible with the starting method specified hereinafter. If the Contractor chooses to provided an open drive motor or compressor, verify in the submittal that the scheduled chiller room ventilation system will accommodate the additional heat and maintain the equipment room at design indoor temperature based on 95 degree F outdoor ambient ventilation air available. If additional cooling is required, manufacturer shall be responsible for the installation, wiring and controls of a cooling system. Chiller selection shall compensate for tons and efficiency loss to make certain the owner is not penal-ized.

E Motor Starters:
The main motor starters are to be furnished by the chiller manufacturer and shipped loose for floor mounting and field wiring to the chiller package. They shall be free-standing with NEMA-1 enclosure designed for top entry and bottom exit and with front access. The starters must comply with the codes and standards in Section 1.2 as required.

1 **Low Voltage (200 through 600 volts)** controllers are to be continuous duty AC magnetic type constructed according to NEMA standards for Industrial Controls and Systems (ICS) and capable of carrying the specified current on a continuous basis. The starters shall be:

Wye-Delta Closed Transition - The starter shall be equipped with properly sized resistors to provide a smooth transition. The resistors shall be protected with a transition resistor protector, tripping in a maximum of two seconds, locking out the starter, and shall be manually reset. A clearly marked transition timer shall be adjustable from 0 to 30 seconds or a current sensing device shall initiate transition when the starting current drops to 90% of the unit RLA.

-- OR --

Solid-State Reduced Voltage - Starter shall be furnished with silicon controlled rectifiers (SCR) connected for starting and include a bypass contactor. When operating speed is reached, the bypass contactor shall be energized removing the SCRs from the circuit during normal running.

All Low Voltage starters shall:

a Be coordinated with the chiller package(s) making certain all terminals are properly marked according to the chiller manufacturer's wiring diagrams.

b The starters shall be equipped with a motor control relay (MCR). The relay shall interconnect the starter with the unit control panel and directly operate the main motor contactor. The MCRs shall constitute the only means of energizing the motor starter.

c The main contactors shall have a normally-open auxiliary contact rated at 125VA pilot duty at 115 VAC. An additional set of normally open contacts shall be provided on the MCR.

d There shall be electronic overloads in each phase, which will permit continuous operation at 107% of the rated load amps of each motor. The overloads shall have a must-trip setting at 125% of the RLA. Overloads shall be manual reset and shall de-energize the main contactors when the overcurrent occurs. The overloads shall be adjustable, have manual reset, be ambient compensated, and set for Class 10 operation.

e Each starter shall have a current transformer and adjustable voltage dropping resistor(s) to supply a 5.0 VAC signal at full load to the unit control panels.

f Each starter shall be equipped with a line to 115 VAC control transformer, fused in both the primary and secondary, to supply power to the control panels, oil heaters and oil pumps.

g Each starter shall include the following protective devices:

- Phase failure and reversal protection
- Under/over voltage protection
- Stall protection

-- OR --

2 Variable Frequency Drive

a The chiller shall be equipped with a Variable Frequency Drive (VFD) to automatically regulate each compressor speed in response to cooling load and compressor pressure lift. The chiller control shall coordinate compressor speed and guide vane position to optimize chiller efficiency.

b A digital regulator shall provide V/Hz control.

c The VFD shall have 110% continuous overload of continuous amp rating with no time limit, PWM (pulse width modulated) output, IGBT (insulated gate bipolar transistors) power technology and full power rating at 2kHz, DC bus inductor (choke), and wireless construction.

d All heat producing devices shall be contained in a single heatsink with single inlet and out connections for the connection of chilled water. When factory mounted on the chiller package, the water connections shall be piped and leak tested at the factory.

-- OR --

3 **Medium Voltage (601 through 7200 volts.** The starters shall be:

Solid-State Reduced Voltage. Starter shall be furnished with silicon controlled rectifiers (SCR) connected for starting and include a bypass contactor. When operating speed is reached, the bypass contactor shall be energized removing the SCRs from the circuit during normal running.

a The starter shall be coordinated with the chiller package(s) making certain all terminals are properly marked according to the chiller manufacturer's wiring diagrams.

b The starters shall be equipped with a redundant motor control relay (MCR), which interconnects the starter with the unit control panel and directly operates the main motor contactors. The MCRs shall constitute the only means of energizing the motor starter.

c The main contactors shall have a normally open auxiliary contact rated at 125VA pilot duty at 115 VAC. An additional set of normally open contacts shall be provided on the MCR.

d There shall be electronic overloads in each phase, which will permit continuous operation at 107% of the rated load amps of each motor. The overloads shall have a must-trip setting at 125% of the RLA. Overloads shall be manual reset and shall de-energize the main contactors when the overcurrent occurs. The overloads shall be adjustable, have manual reset, be ambient compensated, and set for Class 10 operation

e Each starter shall have a current transformer and adjustable voltage dropping resistor(s) to supply a 5.0 VAC signal at full load to the unit control panels.

f Each starter shall be equipped with a line-to-115 VAC control transformer, fused in both the primary and secondary, to supply power to the control panels, oil heaters and oil pumps.

g Each starter shall include the following:

- Phase failure and reversal protection
- Under/over voltage protection
- Load break disconnect switch on solid state or across-the-line starters
  Isolating safety switch on autotransformer or primary reactor starters
- Current limiting power fuses

-- OR --

Across-the-Line type with primary contactor allowing locked rotor amps to reach the motor when energized including items a through g above.

-- OR --

Autotransformer type factory wired to the 65% tap with drawout magnetic, three-pole, vacuum break shorting contactor, drawout magnetic, two-pole, vacuum break starting contactor, and open delta starting auto-transformer factory set at 65% including items a through g above.

-- OR --

Primary Reactor type with drawout magnetic, three-pole, vacuum break shorting assembly, and three-phase starting reactor, factory set at the 65% tap including items a through g above.

All medium and higher voltage starters shall have the following components:

Main Control Relays

A motor control relay shall be provided to interlock the starter with the chiller. The two relay shall constitute the only means of energizing the motor starter. No other devices (manual or automatic) with the capability of energizing the starter can be used. The starter is to be controlled by the unit microprocessor.

Motor Protection and Overloads

The starter shall include overload protection functions. These controls include:

- Solid state overload (overcurrent) protection
- Phase unbalance protection
- Phase reversal and phase loss protection.
- Adjustable overload to closely match motor performance
- Three current transformers to measure motor current and a fourth current transformer for input to the chiller microprocessor.

Undervoltage (UV) Relay

The undervoltage relay is an adjustable three-phase protection system that is activated when the voltage falls below a predetermined safe value and is factory set at 85% of nominal.

Control Voltage Transformer

The starter is provided with a 3KVA control transformer with both secondary and primary fuses to supply control power to the chiller.

Additional Standard Components

- Mechanical type solderless connectors to handle wire sizes indicated by the NEC.
- Three vertically mounted current limiting power fuse blocks (fuses included)
- Magnetic three-pole, vacuum break contactor
- Single phase control circuit transformer
- Vertically mounted control circuit primary current limiting fuses
- Current transformers
- Load terminals
- Control circuit terminal blocks and secondary fuses
- Phase failure and reversal relay

F CHILLER CONTROLLER

Chiller control shall be done through unit controller (microprocessor) and a controller for each compressor, all of which shall have a 4-by-20-character display to view system parameters, denote alarms and input setpoints.

In conjunction with these controllers, the primary operator interface shall be a state-of-the-art super VGA color touch screen monitor and USB port.

The control system shall have inherent trend logging capabilities, which are transferable to other PC management systems such as an Excel spread sheet via a USB port.

Active trend logging data shall be available for viewing in 20 minute, 2 hour or 8 hour intervals. A full 24 hours of history shall be downloadable via the USB port. The following trended parameters shall be displayed:

- Entering and leaving chilled water temps
- Entering and leaving condenser water temps
- Evaporator saturated refrigerant pressure
- Condenser saturated refrigerant pressure
- Net oil pressure for each compressor
- % rated load amps for entire unit

In addition to the trended items above, other real-time operating parameters shall also be shown on the touch screen. These items can be displayed in two ways: by chiller graphic showing each component or from a color-coded, bar chart format. At a minimum, the following critical areas must be monitored:

- Oil sump temperature per compressor
- Oil feed line temperature per compressor
- Evaporator saturated refrigerant temperature for unit
- Suction temperature for unit
- Condenser saturated refrigerant temperature for unit
- Discharge temperature for unit
- Liquid line temperature for unit

The unit operating and maintenance instructions shall be viewable on the touch screen and downloadable via the onboard USB port.

Complete fault history shall be displayed using an easy to decipher, color coded set of messages that are date and time stamped. The last 20 faults shall be downloadable from the USB port.

Automatic corrective action to reduce unnecessary cycling shall be accomplished through pre-emptive control of low evaporator or high discharge pressure conditions to keep the unit operating through ancillary transient conditions.

System specific, chiller plant architecture software shall be employed to display the chiller, piping, pumps and cooling tower. Chiller interconnection softw for up to 4 WCC, WDC or WSC chillers shall be included also providing automatic control of: evaporator and condenser pumps (primary and standby), up to 4 stages of cooling tower fans and a cooling tower modulating bypass valve or cooling tower variable frequency drives. There shall be five possible tower control strategies:

- Tower fan staging only – up to 4 stages controlled by either the entering condenser water temperature or lift differential temperature between the condenser and evaporator saturated temperatures.
- Tower fan staging plus low limit - controlled as in # 1 plus tower bypass valve set at a minimum entering condenser water temperature.
- Tower staging with staged bypass control – similar to # 2 with additional control of the bypass valve between fan staging to smooth control and minimize fan staging.
- VFD staging only – in this mode, a variable speed drive controls the first fan with up to 3 more fans to be staged on and off and there is no bypass valve.
- VFD and Valve Staging – same as # 4 plus bypass valve control.

Factory mounted DDC controllers shall support operation on a BACnet®, Modbus® or LONWORKS® network via one of the data link / physical layers listed below as specified by the successful Building Automation System supplier.

- BACnet MS/TP master (Clause 9)
- BACnet IP, (Annex J)

- BACnet ISO 8802-3, (Ethernet)
- LONWORKS FTT-10A

The information communicated between the building automation system and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the points list.

2.5. MISCELLANEOUS ITEMS

A Pumpout System: The unit shall be equipped with a pumpout system complete with a transfer pump, condensing unit, and storage vessel constructed according to ASME Code for Unfired Pressure Vessels and shall bear the National Boards stamp. If the design of the unit allows the charge to be transferred to and isolated in the main condenser, then a pumpout system is not required. Transfer of refrigerant charge shall be accomplished by either main compressor operation, migration, or gravity flow. Isolation shall be accomplished with valves located at the inlet and exit of the condenser. The main condenser shall be sized to contain the refrigerant charge at 90°F according to ANSI-ASHRAE 15.A.

B Purge System (negative pressure chillers only):

1 The chiller manufacturer shall provide a separate high efficiency purge system that operates independently of the unit and can be operated while the unit is off. The system shall consist of an air-cooled condensing unit, purge condensing tank, pumpout compressor and control system.

2 A dedicated condensing unit shall be provided with the purge system to provide a cooling source whether or not the chiller is running. The condensing unit shall provide a low purge coil temperature to result in a maximum loss of 0.1 pounds of refrigerant per pound of purged air.

3 The purge tank shall consist of a cooling coil, filter-drier, water separation tube, sight glass, drain, and air discharge port. Air and water are separated from the refrigerant vapor and accumulated in the purge tank.

4 The pumpout system shall consist of a small compressor and a restriction device located at the pumpout compressor suction connection.

C Vacuum Prevention System (Negative pressure chillers only): Chiller manufacturer shall supply and install a vacuum prevention system for each chiller. The system shall constantly maintain 0.05 psig inside the vessel during non-operational periods. The system shall consist of a precision pressure controller, two silicon blanket heaters, a pressure transducer, and solid-state safety circuit.

D Refrigerant Detection Device (negative pressure chillers only): Chiller manufacturer shall supply and install a refrigerant detection device and alarm capable of monitoring refrigerant at a level of 10 ppm. Due to the critical nature of this device and possible owner liability, the chiller manufacturer shall guarantee and maintain the detection monitor for five years after owner acceptance of the system.

E Waffle type vibration pads for field mounting under unit feet.

F IBC Certification: The chiller shall be certified to the following codes and standards; 2009 IBC, 2010 CBC, ICC-ES AC-156, ASCE 7-05. The chiller must be mounted to a rigid base and may use neoprene waffle vibration pads.

G OSHPD Certification: The chiller shall be OSHPD Pre-Approved per OSP-0116-10 and be so labeled. The chiller shall meet a minimum seismic design spectral response acceleration of 1.60 S_{DS}. The chiller must be mounted to a rigid base and may use neoprene waffle vibration pads.

PART 3 — EXECUTION

3.1 INSTALLATION

A Install per manufacturer's requirements, shop drawings, and Contract Documents.

B Adjust chiller alignment on foundations, or subbases as called for on drawings.

C Arrange piping to allow for dismantling to permit head removal and tube cleaning.

D Furnish and install necessary auxiliary water piping for oil cooler.

E Coordinate electrical installation with electrical contractor.

F Coordinate controls with control contractor.

G Provide all materiel required for a fully operational and functional chiller.

3.2 START-UP

A Units shall be factory charged with the proper refrigerant and lubricant.

B Factory Start-Up Services: Provide for as long a time as is necessary to ensure proper operation of the unit, but in no case for less than two full working days. During the period of start-up, The Start-up Technician shall instruct the Owner's representative in proper care and operation of the unit.

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Hazard Identification

⚠ DANGER
Dangers indicate a hazardous situation which will result in death or serious injury if not avoided.

⚠ WARNING
Warnings indicate potentially hazardous situations, which can result in property damage, severe personal injury, or death if not avoided.

⚠ CAUTION
Cautions indicate potentially hazardous situations, which can result in personal injury or equipment damage if not avoided.

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Modbus BACnet

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