DAIKIN

DAIKIN APPLIED (UK) LTD
Technically better...

DWDC / DWSC

VINTAGE B

New generation water cooled centrifugal chillers

Product manual

Nominal capacity range: 1050 - 9000 kW (300 - 2500 RT)
Designed for a wide range of applications
Single and dual compressor chiller options

CODE	DWSC/DWDC Vintage B
Date	NOVEMBER 2019
Supersedes	Rev.00

Refrigerant: R-134a or R-513A

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DWDC / DWSC VINTAGE B

INTODUCTION

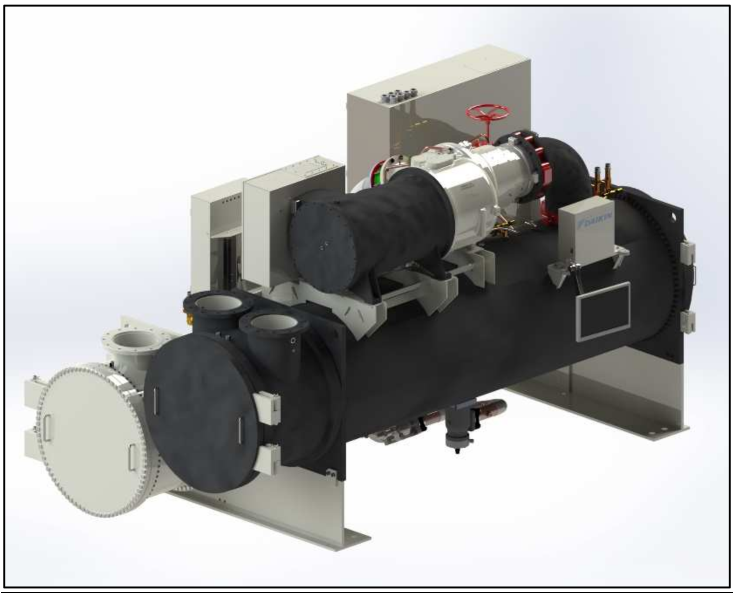
DWSC, Single Compressor Chiller

• Capacity: 1050-4500kW (300–1250RT) (AHRI conditions)
• High part load efficiency with optional unit mounted VFD's
• Excellent full load performance
• Unloading down to 10% without hot gas by-pass

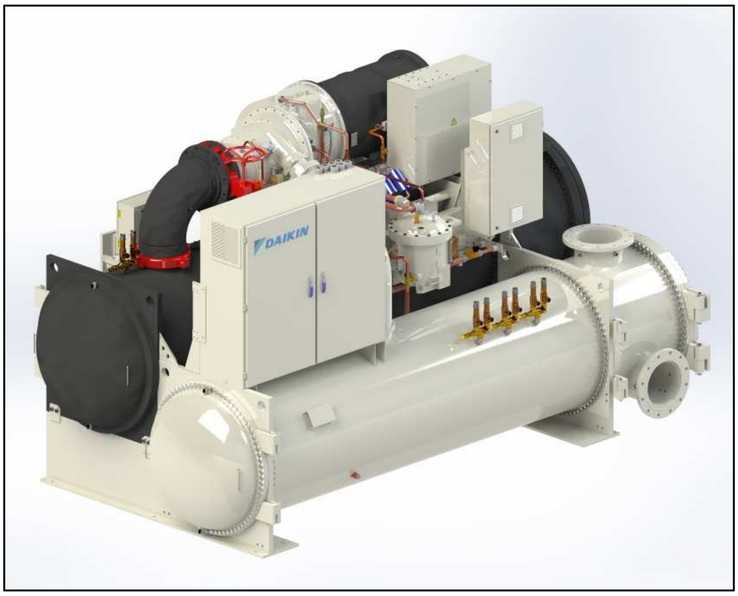
DWDC, Dual Compressor Chiller

• Capacity: 2100-9000kW (600–2500RT) (AHRI conditions)
• Outstanding part load performance
• Redundancy for increased reliability
• Unloading down to 5% without hot gas by-pass
• Lower installed costs vs multiple chillers

Example of unit layout – DWSC100 model in frontal view



Example of unit layout – DWSC100 model in rear view



FEATURES AND BENEFITS

DESIGN FEATURES

Excellent Performance
Daikin offers a wide range of centrifugal vessels and component combinations to provide the right solution for your specific application. The single compressor DWSC offers excellent full load performance. Our dual compressor DWDC chillers offer many benefits, including outstanding part-load efficiency, and system redundancy similar to two separate chillers, with a lower total installed cost.
Contact your Daikin representative for detailed information to decide which model is right for your job requirements.

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 the 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 infinite life bearings under normal circumstances. The design simplicity of the Daikin centrifugal compressors provides increased durability and reliable performance.

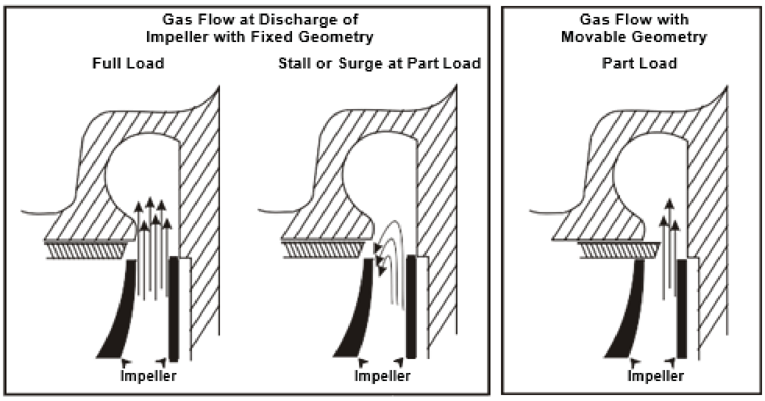
Smart Refrigerant
R-134a and R-513A refrigerants contain no chlorine and have zero Ozone Depletion Potential (ODP), making them the environmentally superior alternative to other refrigerants.
They also have an A1 ISO817, ASHRAE and EN378 Safety Classification - the lowest toxicity and flammability rating. R-134a and R-513A provide the assurance of a safe, smart, and sustainable solutions.
Using R-134a and R-513A allow Daikin to provide you with a smaller footprint chiller.

Table: Refrigerant Comparison

<table>
<tr><th></th><th>R-134a and R-513A Positive Pressure Refrigerant</th><th>Low Pressure Refrigerant</th></tr>
<tr><td rowspan="4">INSTALLATION AND MAINTENANCE</td><td>Physically smaller, requiring less mechanical room space.</td><td>Requires larger refrigerant flow rate, with subsequent increase in compressor and chiller size.</td></tr>
<tr><td>In the event of a small leak, refrigerant escapes, allowing easy detection and repair</td><td>In the event of a small leak, air leaks into the chiller, making detection and repair difficult. Can degrade efficiency</td></tr>
<tr><td>No purge unit required</td><td>Added cost, maintenance and additional space for a purge unit. Must periodically purge unit to remove contaminants</td></tr>
<tr><td>No oil change is required</td><td>Annual oil change is recommended</td></tr>
</table>

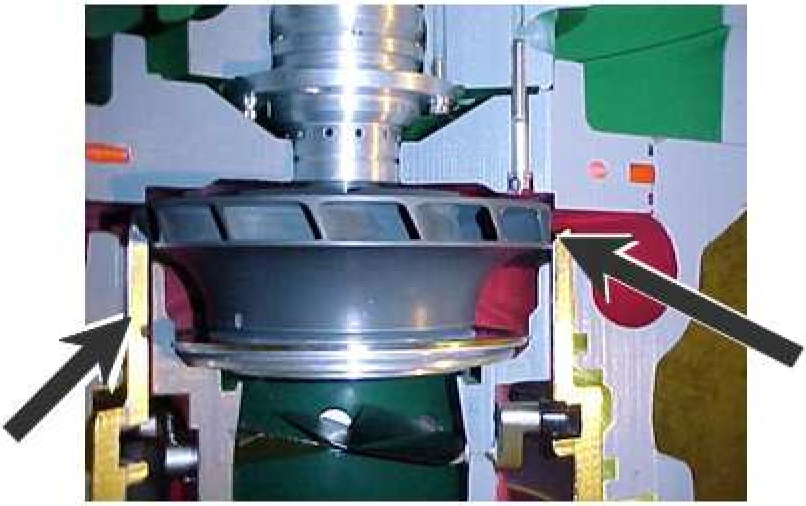
Unmatched Unloading
Daikin pioneered the use of moveable discharge geometry to lower the surge point of centrifugal compressors. The point at which the compressor enters a stall or surge condition generally limits compressor unloading. Chillers with a fixed discharge will experience stall or surge at 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. Moveable Discharge Geometry



In Figure 2, 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.
Figure 3 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: Moveable diffuser closes impeller discharge area as load decreases



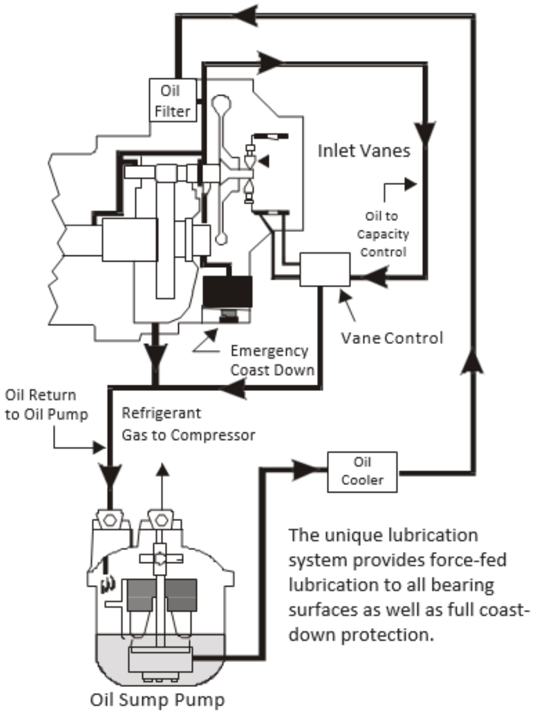
Trouble-Free Startup

All Daikin chillers are factory tested on AHRI qualified computer-controlled test stands. 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 your service representative for Daikin Applied, or by authorized and experienced Daikin Applied 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 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 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.

Quiet Operation

Daikin centrifugal chillers have two unique features to limit sound generation. One is the unique liquid injection system and the other is that Daikin chillers get quieter as they unload.

<u>Liquid Injection</u>

A small amount of liquid refrigerant is taken from the condenser and injected into the compressor discharge area. The liquid droplets absorb sound energy and reduce the compressor's overall sound level. The droplets evaporate and reduce discharge superheat.

<u>Quieter as Chiller Unloads</u>

Many centrifugal compressors become louder as they unload. Daikin design results in a reduction in sound levels at lower loads, where most chillers spend most of their operating hours.

BENEFITS OF DUAL COMPRESSOR CHILLERS

Superior Efficiency

In most applications, chillers spend about 99% of their operating hours at part-load conditions. 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 IPLV (Integrated Part Load Value) as high as 11,5 (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 DWDC 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. Below is an example of how to incorporate dual compressor chillers into a system requiring redundancy:

Job requirement 4200 kW (1200RT), 50% Backup

<u>DWSC Single Compressor Chillers</u>

(2) 2100 kW (600 RT) On Line Units

+(1) 2100kW (600 RT) Standby Unit

6300 kW (1800RT) Installed Capacity

<u>DWDC Dual Compressor Chillers</u>

(2) 2100kW (750RT) Units with 4200 kW (1200RT) On Line*

5250(1500RT) Installed Capacity

*One 2100 kW (750 RT) dual chiller running on two compressors for 2100 kW (750RT), plus one 2100 kW (750RT) dual chiller running on one compressor for 60% of 2100 kW (750RT) = 1575 kW (450RT), for a total of 4200kW (1200RT) 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.

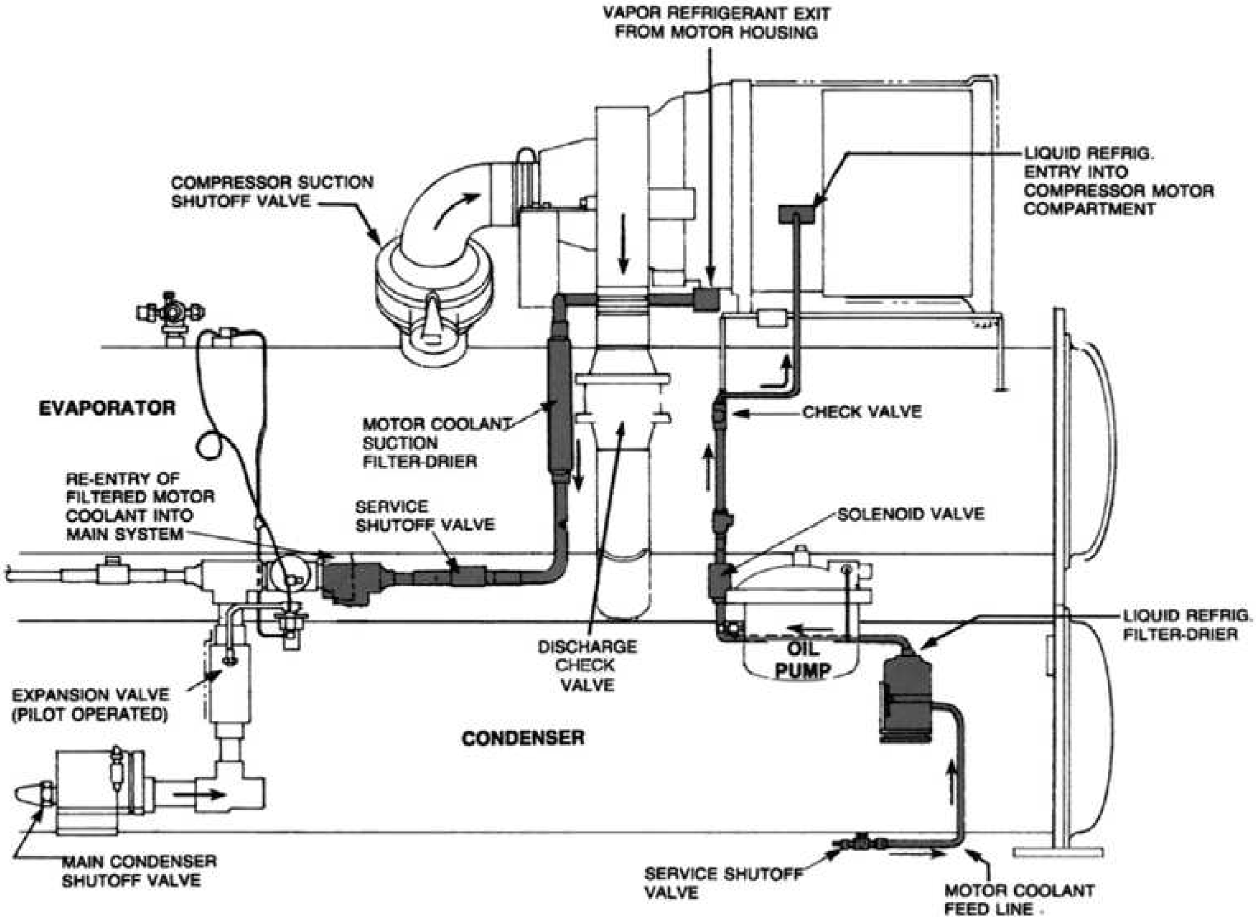
Single Circuit DWDC Chillers
These chillers have a single-refrigerant circuit for the evaporator and condenser with two compressors running in parallel and are available in one, two or three-pass configurations. Their salient feature is that at single- compressor, part load operation, the running compressor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

Application of Water-Cooled Chillers

<u>Use DWDC chillers when</u>:
- 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 (i.e. 16-foot vessel length).
- 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.

Compressor Motor Failure Will Not Contaminate the Common Refrigerant Circuit
A motor burnout on a single-circuit dual compressor chiller is not a problem on the Daikin DWDC 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 DWDC 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 your service representative for Daikin Applied, 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: DWDC 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 DWDC chiller operates with the full heat transfer surface of the entire unit. For example, one 1750 kW (500RT) compressor on a 3500kW (1000RT) dual chiller utilizes 3500kW (1000RT) of evaporator and condenser surface. This increases the compressor’s capacity and also results in very high efficiency.
Typical efficiencies for a DWDC dual chiller, taken from a selection computer run, look like this:
Full load efficiency: 6.5 COP (0.550 kW per ton)

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

IPLV: 8.5 (0.415 kW per ton)

The addition of VFDs to the DWDC dual compressor chiller produces an astonishing AHRI certified IPLV of 10.3 (0.340kW per ton) for the above case. Specific selections can vary up or down from this example. IPLV is defined in the below “AHRI Certification”

The Replacement Market Advantage
- Retrofit flexibility allows an easy retrofit with on-site disassembly ready option.
- Bolt-together construction on single and dual compressor chillers 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.
- Opens many options for multiple chiller plants using DWSC and DWDC combinations.

Codes and Certifications

DWSC and DWDC Series are CE marked, complying with European directive in force concerning manufacturing and safety. Units are designed and manufactured in accordance with applicable selections of the following:

- Pressure Equipment Directive 2014/68/EU:
- Machinery Directive 2006/42/EC
- Low Voltage Directive 2014/35/EU
- Electromagnetic Compatibility 2014/30/EU
- Electrical & Safety codes EN60204–1/EN61439-1/EN61439-2
- EN378
- DIRECTIVE 2009/125/EC (ECODESIGN)
- AHRI Standard 550/590 for Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle
- Manufacturing Quality Standards UNI EN ISO 9001:2004
- Environmental Management System UNI EN ISO 14001:2004
- Health & Safety Management System BS OHSAS 18001:2007

On request units can be produced complying with laws in force in non European countries (ASME, EAC, etc.), and with other applications, such as Marine rules (DNVGL, Bureau Veritas Marine, Lloyd’s Register, RINA, etc.).

UNIT LAYOUTS

Figure: DWSC Layout (without Starter)

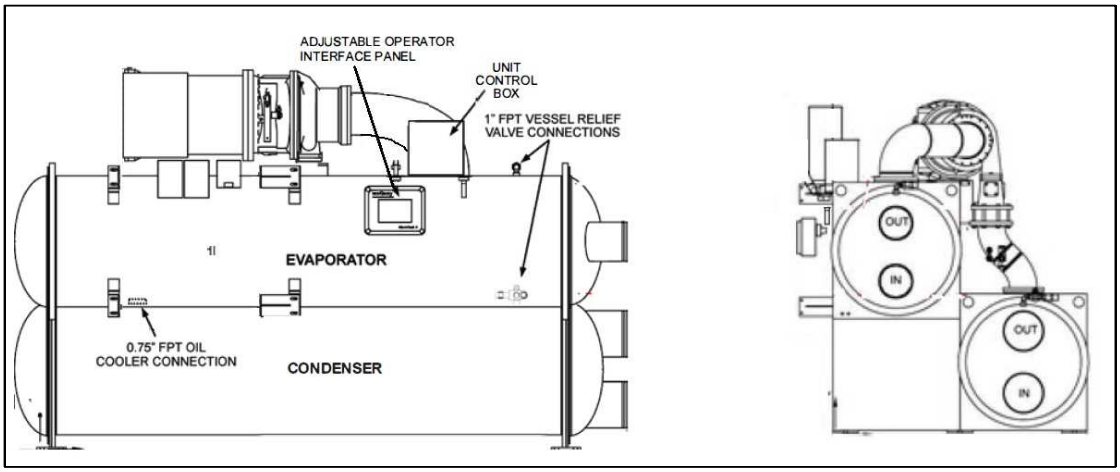
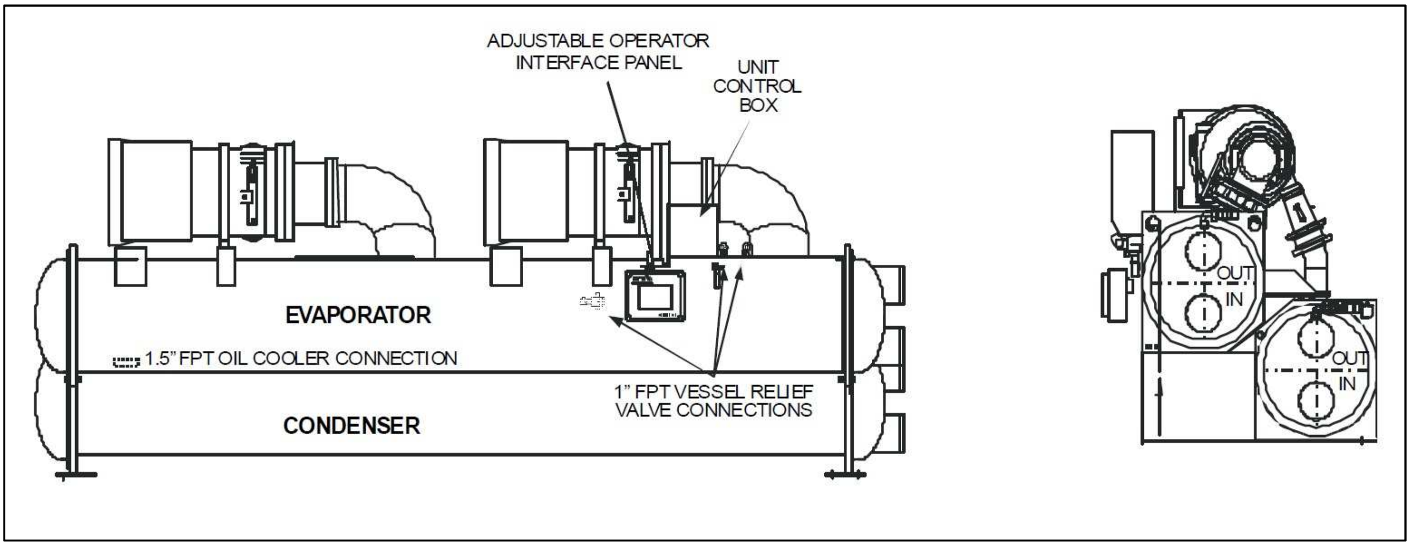


Figure: DWDC Layout (without Starter)



NOTE: Contact the Daikin Applied sales office for full dimensional information

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.

Counter-flanges (shipped loose and including gaskets and bolts)

Tube wall thickness
0.711mm (0.028”) or 0.889mm (0.035”) tube wall thickness (0.635mm (0.025”) is standard)
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 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 (19mm), on evaporator, suction piping, and motor barrel; For normal machine room applications.

Double insulation
1-½ inch (38mm), on evaporator, suction piping, and motor barrel; For high humidity locations and ice making applications.

Hot gas by pass
Reduces compressor cycling and its attendant chilled water temperature swings at very low loads.

Rubber Pads
Rubber mounting pads are shipped with each unit.
Floor-mounted rubber or spring isolators supplied on request.

Differential Pressure Switches or Flow Switch supplied on request.

Refrigerant leak detector
Refrigerant leak detector can be installed mounted on the unit. Factory supply consists in mount the sensor with integrated central board in the bottom side of the chiller. From the control board is available an external signal to be managed by the customer directly. Chiller controller cannot manage the external signal.

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 1.5 dbA reduction normally occurs.

On-site disassembly option

The chiller can be supplied in such an arrangement to optimize the on-site activity to dismantle (and then reassemble) the main components that are compressor + discharge pipe + heat exchangers). Contact Service Department for price quotation and scheduling. Contact the factory for individual component weights.

General description:

a. Chiller is assembled, charged with refrigerant and oil and tested

b. After production and quality inspection the chiller is shipped fully assembled, but ready to be dismantled on site (under Daikin authorized distributor responsibility).

c. The unit is factory insulated and painted.

d. All electrical and sensor wiring will be fastened as usual.

Special Order Options

The following special order options are available; requiring factory pricing, additional engineering and possible dimension changes or extended delivery: Contact the factory 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 IP/NEMA enclosures
- Hinges for marine water box covers or heads (compact water boxes)
- Spacer rings on heads to accommodate automatic tube brush cleaning systems (installed by others)
- Holding charge (refrigerant or nitrogen) on refrigerant circuit before shipment
- AUX Trafo Box Unit Mounted

Electrical

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 10°C (50°F), which results in extremely low kW/ton values.

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.

See IOM manual of the Inverter for more details on technical specifications.

Controls

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

High Level Communications
The unit controller can communicate to BMS (Building Management System) based on the most common protocols as BACnet® (Serial Card pre-loaded IP/Ethernet or MSTP) or Modbus® Serial Card RS485 (EKAC200J)

Multiple Chiller Control
Daikin standard MicroTech II control system, as shipped on all units, will control up to four chillers, either single or dual compressor type. Purchase of an inexpensive accessory (to be quoted as special) isolator card (P/N 330276202) for N-1 chillers, a simple RS 485 interconnection, and minor setpoint adjustments are all that is required.

Intelligent Chiller Manager
In case of multiple chiller installations Daikin provides an advanced sequencing management without the need of additional controllers. For systems up to 4 units, Daikin ICM Standard control allows to optimize the efficiency of the whole system by sequencing the unit according a predetermined strategy.
Is possible to connect units of same or different sizes from the same chiller range.

Modbus® Serial Card RS485 (EKAC200J) is required when ICM is selected. Connecting cables from ICM to EKAC200J are not supplied by the factory.

Daikin On Site kit
Shipped loose electrical panel for Daikin on Site remote monitoring and service

Modbus® Serial Card RS485 (EKAC200J) is required when ICM is selected. Connecting cables from ICM to EKAC200J are not supplied by the factory.

ICM, Daikin On Site kit and Serial Card for BMS communication are not available at the same time.
Unit controller can only manage the communication with one serial card only.

Unit

Export packaging

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

Storage Tank and Refrigerant Recovery Unit

Available in a variety of sizes. Contact the factory for technical specifications.

Extended warranties

Extended 1, 2, 3, or 4-year warranties for parts only or for parts and labor are available for the entire unit, refrigerant 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. A test result booklet will be provided.

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. A test result booklet will be provided.

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.
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.

Table: 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.

Motor Starters

Daikin has a wide variety of starter types and options to fit virtually all applications. Contact the factory for details. This section contains a general overview 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 starters are available, in addition to solid state. For medium voltage application, solid state starters are offered.

Mounting Options, Low Voltage

Factory-mounted
Starters are furnished, mounted and wired in the factory. Due to shipping width limitations, the starters for DWSC100 through 126 may be shipped loose with cable kits and mounting brackets for field installation on the unit by others. Please contact the logistic department for certified drawing.

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. For additional information please contact the factory. The starters are furnished and installed by others.

Mounting Options, Medium Voltage

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

Variable Frequency Drives (VFD)

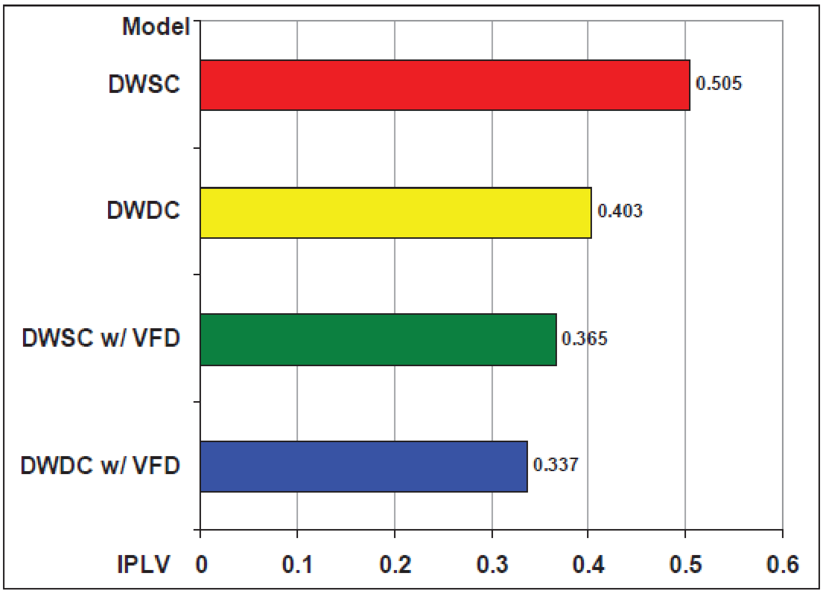
A VFD modulates the compressor speed in response to load and evaporator and condenser pressures. Due to the outstanding part load efficiency, and despite the small power penalty attributed to the VFD, the chiller can achieve outstanding overall efficiency. VFDs really prove their worth when there is 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.

The variable frequency drive control box is cooled by refrigerant minimizing its size and ensuring optimal component cooling for an extended operating life.
This concept makes air or water cooling unnecessary and eliminates the associated maintenance cost and water pump power consumption.

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 6: IPLV Comparison by Model



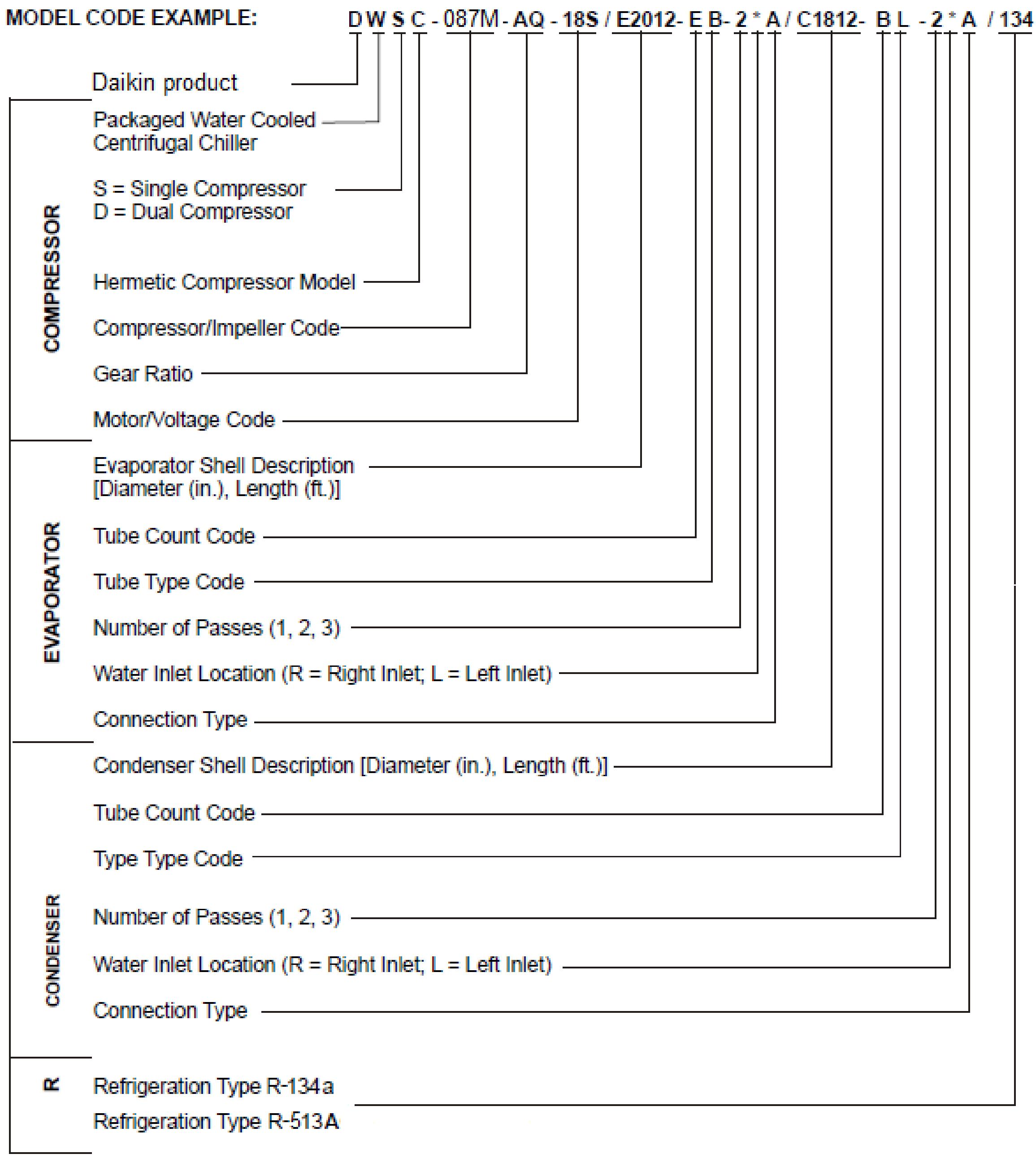
The IPLV values (defined on page 27) are AHRI Certified Ratings based on AHRI Standard 550/590, Standard for Water Chilling Packages Using the Vapor Compression Cycle. Full load is calculated at AHRI conditions. Part load points of 75%, 50% and 25% employ condenser water temperature relief (reduction) per the standard.

See IOM manual of the Inverter for more details on technical specifications

CHILLER IDENTIFICATION (nomenclature)

To provide a wide range of components to match job requirements of capacity, efficiency and competitive initial cost, DWSC and DWDC chillers are selected by a dedicated software and identified by their components.
The variations of compressor, impeller, gear ratio, evaporator and condenser tube surface and configuration provide over 1,000,000 combinations of standard components within the range of 1.050 to 9.000 kW. It is impractical to catalog all of these combinations. Therefore, computer selection for specific application conditions is required. The complete unit model code is then established as follows:

Figure: Chiller Identification



APPLICATION CONSIDERATIONS

Location
These chillers are intended only for installation in an indoor or weather protected area consistent with the IP40 (equivalent to NEMA 1 Indoor) rating on the chiller, controls, and electrical panels. If indoor sub-freezing temperatures are possible, special precautions must be taken to avoid equipment damage.

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 5: 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 for more detail
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)

Water Piping

All evaporators and condensers have OGS-type grooved water connections (adhering to Standard AWWA C606) or optional flange connections. The installing contractor must provide matching mechanical connections. PVC piping should not be used. Be sure that water inlet and outlet connections match certified drawings and nozzle markings.

CAUTION
If welding is to be performed on the mechanical or flange connections: 1. Remove the solid-state temperature sensor, thermostat bulbs, and nozzle mounted flow switches from the wells to prevent damage to those components. 2. Properly ground the unit or severe damage to the MicroTech® unit controller can occur. NOTE: PED/ASME certification will be revoked if welding is performed on a vessel shell or tube sheet.

The water heads can be interchanged (end for end) so that the water connections can be made at either end of the unit. If this is done, use new head gaskets and relocate the control sensors.

Field installed water piping to the chiller <u>must</u> include:
• air vents at the high points.
• a cleanable water strainer upstream of the evaporator and condenser inlet connections.
• a flow proving device for both the evaporator and condenser to prevent freeze up. Flow switches, thermal dispersion switches, or Delta-P switches can be used.
Note that flow switches are factory installed. Additional flow switches can be used only if they are connected in series with the ones already provided. Connect additional flow switches in series between original flow switch inputs.
• sufficient shutoff valves to allow vessel isolation. The chiller must be capable of draining the water from the evaporator or condenser without draining the complete system.
It is recommended that field installed water piping to the chiller include:
• thermometers at the inlet and outlet connections of both vessels.
• water pressure gauge connection taps and gauges at the inlet and outlet connections of both vessels for measuring water pressure drop.
The piping must be supported to eliminate weight and strain on the fittings and connections. Piping must also be adequately insulated. Sufficient shutoff valves must be installed to permit draining the water from the evaporator or condenser without draining the complete system.

Optimum Water Temperatures and Flow Rates

A key to improving energy efficiency for any chiller is minimizing the compressor pressure lift. Reducing the lift reduces the compressor work and its energy consumption per unit of output.
The optimum plant design must take into account all of the interactions between chiller, pumps, and tower.
Contact the factory for assistance on your particular application.

Evaporator

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.

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.

Condenser

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.
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.
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. It is especially good at comparing different system types and operating parameters. Utility costs, load factors, maintenance costs, cost of capital, tax bracket; essentially all factors affecting owning cost, must be considered as well.
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. Contact factory for assistance on your particular application.

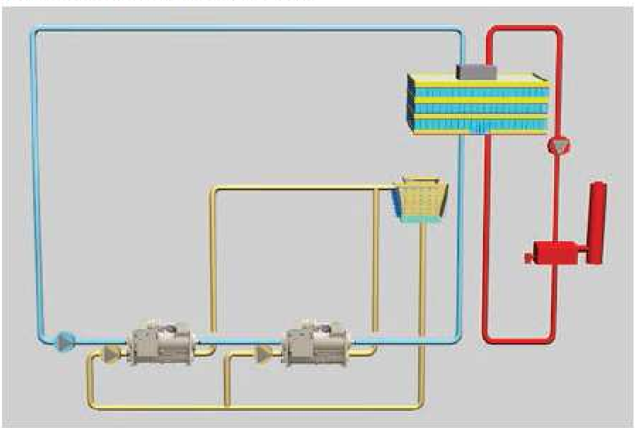
Mixing Single and Dual Compressor Chillers

DWDC 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. Two different condenser water piping arrangements can be used. Parallel flow (Figure 8) divides the total condenser flow between the two condensers. The counterflow system (Figure 9) 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. 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, 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 DWSC and DWDC 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.

Figure 8: Series Parallel Flow



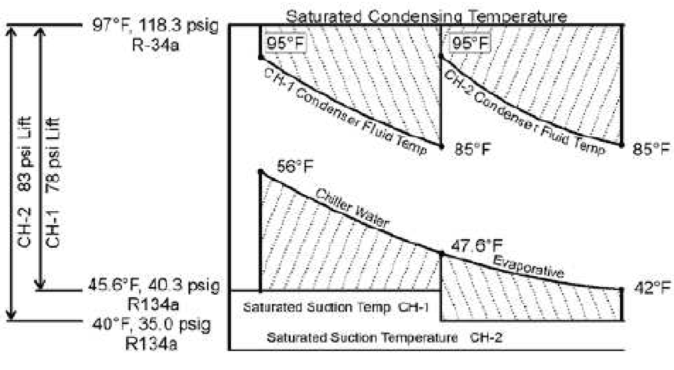
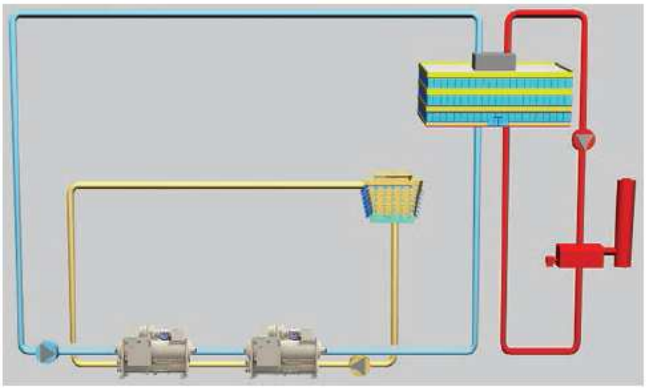
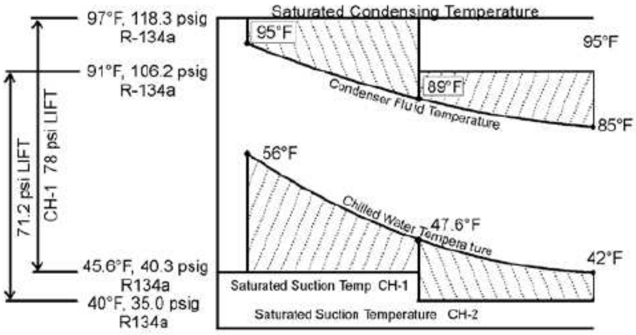


Figure 9: Series Counterflow Flow





Oil Coolers

Daikin centrifugal chillers have a factory-mounted 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 DWDC 079 & 087 have the cooling water connections in the lower portion of one tube sheet.
DWDC 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.
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: DWDC 100/126 have 1-1/2 in. FPT connections, all other WDC and DWSC are 1 in. FPT

Table 6: DWSC Oil Cooler Data

	Hot Side POE Lube	Cold Side Water			
DWSC 079 - 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
DWSC 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 7: DWSC with VFD Oil Cooler Data

	Hot Side POE Lub.	Cold Side Water			
DWSC 079 - 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
DWSC 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

NOTE: Pressure drops include valves on the unit;
DWDC units have twice the cooling water flow rate of the comparable DWSC chiller.

Figure 18: DWSC/DWDC Oil Cooler Piping Across Chilled Water Pump

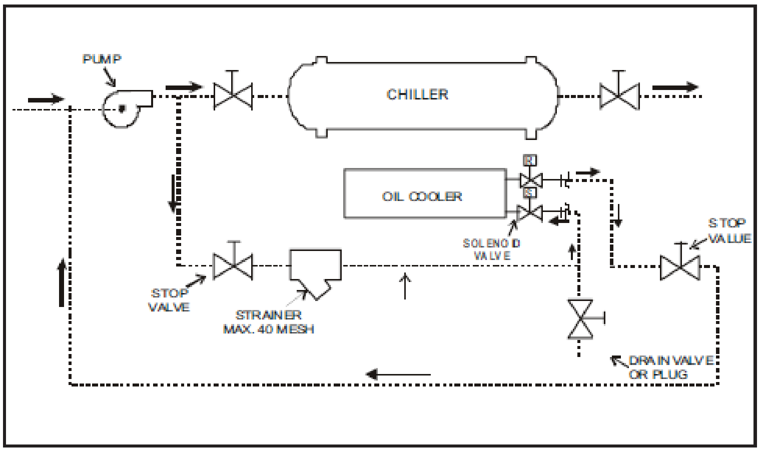
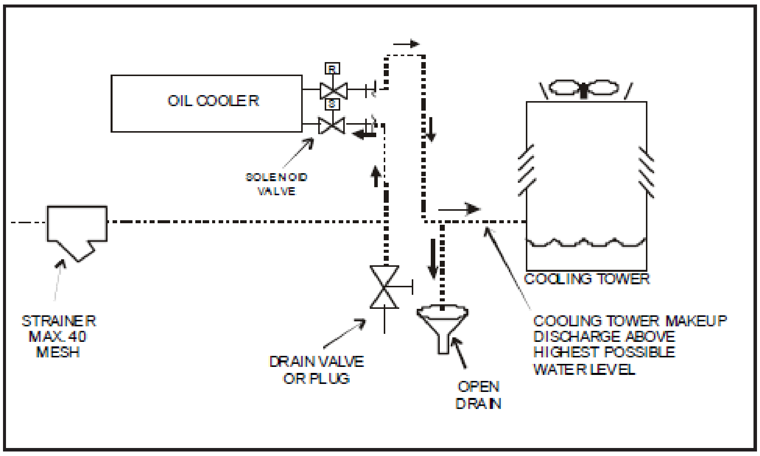


Figure 19: DWSC/DWDC Oil Cooler Piping With City Water



Pumps

DWSC, DWDC 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. Ensure tower blow-down or bleedoff 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 EN378 Safety Classification or 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). 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.

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.

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 Daikin Selection Tool. Due to the large number of component combinations and variety of applications, sound data is not included in this catalog.

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).

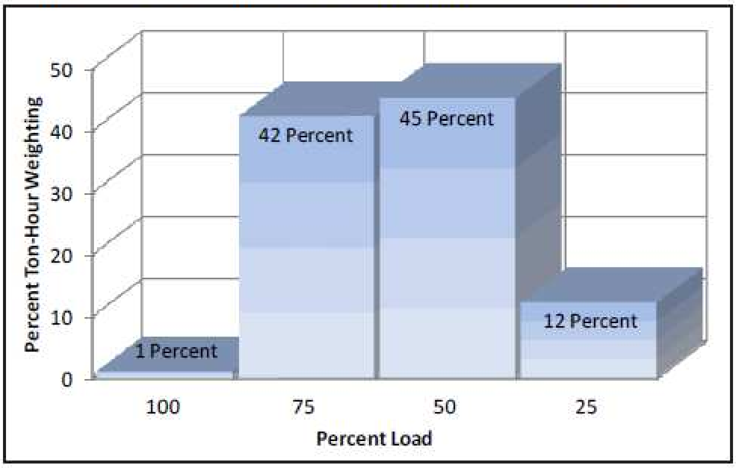
Certifications and Standards

As with many other Daikin Applied chiller products, the centrifugal chiller models meet all necessary certifications and standards.

AHRI Certification

AHRI Standard 550/590 for Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle defines certification and testing procedures and performance tolerances of all units that fall within the scope of the standard.
Full AHRI 550/590 participation and certification is an on-going commitment at Daikin. Daikin centrifugal chillers are rated and certified in accordance with the latest edition of AHRI Standard 550/590. The AHRI label affixed to units certifies that the unit will meet the specified performance.
Daikin Selection Tools (DST) for Centrifugal Chillers is used to select and rate chillers for specific job conditions. The program version number and issue date are listed in the AHRI Directory of Certified Applied Air-Conditioning Products available at www.ahridirectory.org. DST ratings are available from your local Daikin Applied sales representative.
Part load performance can be presented in terms of Integrated Part Load Value (IPLV) or Non-Standard Part Load Values (NPLV), both of which are defined by AHRI Standard 550/590.
Based on this standard, and as shown in Figure 20, a typical chiller can operate up to 99% of the time at off-peak conditions and usually spends most of this time at less than 60% of design capacity.

Figure 20: IPLV Defined by AHRI Standard 550/590



Compliance with ASHRAE Std.90.1

ASHRAE Standard 90.1 was developed to assist owners and designers in making informed choices on a building's design, systems, and equipment selection. Daikin centrifugal chillers can significantly exceed ASHRAE 90.1 minimum efficiency requirements.

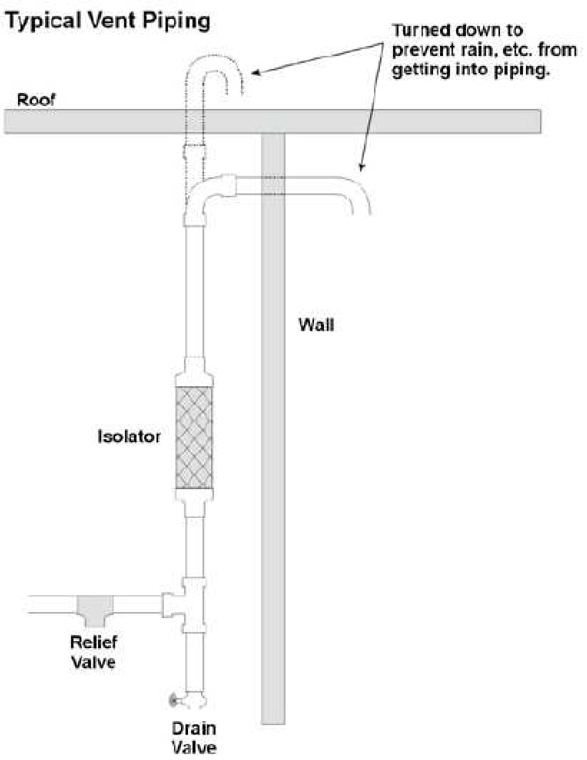
LEED®

For building owners who wish to pursue Leadership in Energy and Environmental Design (LEED®) Green Building Certification, the performance of centrifugal chiller models may contribute points towards Energy and Atmosphere (EA) Credits 1 and 4.
Points earned for EA Credit 1 are awarded based on overall building efficiency. The high efficiency of centrifugal chiller models can contribute to the total points earned for this credit.
EA Credit 4 qualification is partially determined by tonnage and refrigerant quantity. Vessel stack and tube count selections will affect the quantity of refrigerant in the chiller. Consult the factory for more information.

Relief Valves

Relief valve connection sizes are 1-inch FPT, with 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 EN 13136 standard (or 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 four 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.
Vent piping is sized for only one valve of the set since only one can be in operation at a time.

Figure 13: Tpical Vent Piping



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:

- DWSC evaporator (1 valve) and condenser (2 valves piped together to common vent pipe) = 200 psi, 75.5 lb of air/min
- DWDC evaporator (1) = 180 psi, 68.5 lb of air/min
- DWDC 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 8: 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 above information is a guide only. Consult local codes and/or latest version of ASHRAE Standard 15 for sizing data.

TECHNICAL SPECIFICATIONS

Centrifugal Chillers (DWSC and DWDC range)

Part 1 – GENERAL

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

1.2 REFERENCES
Comply with the following codes and standards:
DIRECTIVE 2014/35/EU (LVD)
DIRECTIVE 2014/30/EU (EMC)
DIRECTIVE 2006/42/EC (MD)
DIRECTIVE 2014/68/EU (PED)
Electrical & Safety codes EN60204–1/EN61439-1/EN61439-2
DIRECTIVE 2009/125/EC (ECODESIGN)
EN378
AHRI Standard 550/590

1.3 SUBMITTALS
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 Certified test stand and conducted according to AHRI Standard 550/590.
6. Installation and Operating Manuals.

1.4 QUALITY ASSURANCE
1. Qualifications: Equipment manufacturer must specialize in the manufacture of the products specified and have five years’ experience with the equipment and refrigerant offered.
2. Regulatory Requirements: Comply with the codes and standards in Section 1.2.
3. Chiller manufacturer plant shall be ISO Registered.

1.5 DELIVERY AND HANDLING
1. Chillers shall be delivered to the job site completely assembled and charged with refrigerant and oil.
2. Comply with the manufacturer’s instructions for rigging and transporting units. Leave protective covers in place until installation.

1.6 WARRANTY
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. [DWDC: The refrigerant charge shall be warranted against contamination from a motor burnout for five years.]

1.7 MAINTENANCE
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
1. Daikin
2. (Approved Equal)

2.2 UNIT DESCRIPTION

A. Provide and install as shown on the plans a factory-assembled, factory charged, and factory run tested water-cooled packaged chiller. Each unit shall be complete with a single-stage semi hermetic centrifugal compressor with lubrication and control system, factory mounted (or free standing) starter, evaporator, condenser, refrigerant control device and any other components necessary for a complete and operable chiller package.
-- OR -- [**DWDC**: 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.]

B. Each chiller shall be factory run-tested under load conditions for a minimum of one hour on an AHRI approved test stand with evaporator and condenser water flow 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 IP40 (NEMA 1 Indoor) enclosures, designed for clean, indoor locations.

2.3 DESIGN REQUIREMENTS

A. General: Provide a complete water-cooled semi 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.
[**DWDC**: Unit shall consist of two compressors, single circuit refrigerant condenser and evaporator, two lubrication systems, two starters and two control systems.]
Note: Chillers shall be charged with a refrigerant such as R-134a (or R-513A).

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. 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 575-87. 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.

2.4 CHILLER COMPONENTS

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 3.5 mm/s (0.14 in/s).
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.

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 PED standard (2014/68/EU). Regardless of the operating pressure, the refrigerant side of each vessel will bear the PED 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. [DWDC: Tubes must be secured to the intermediate supports without rolling.]
3. Provide isolation valves and sufficient volume to hold the full refrigerant charge in the condenser or provide a separate pumpout system with storage tank.

4. The water sides shall be designed for a minimum of 10.5bar (150 psi) or as specified elsewhere. Vents and drains shall be provided.
5. Evaporator minimum refrigerant temperature shall be 0.5°C (33°F).
6. An electronic 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. Reseating type spring loaded pressure relief valves according to EN 13136 standard 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 3/4 inch closed cell insulation. All joints and seams shall be carefully sealed to form a vapor barrier.
10. Provide thermal dispersion flow switches on each vessel to prevent unit operation with no flow.

D. Prime Mover:
1. 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 provide 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 35°C (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 freestanding with IP40 (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.
4. The starter must comply with the requirements of Section 1.2.
5. **Low Voltage (200 through 600 volts)** motor 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 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.
-- OR --
Wye-Delta Closed Transition - The wye contactor shall be capable of handling 33% of the delta locked rotor current and 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.
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) with coils in parallel. The relays 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 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 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 have phase failure and reversal protection.

-- OR --

Variable Frequency Drive

a. The chiller shall be equipped with a Variable Frequency Drive (VFD) to automatically regulate 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. A digital regulator shall provide V/Hz control.
b. 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, full power rating at 2kHz, DC bus inductor
(choke), and wireless construction.

-- OR –

Medium Voltage (601 through 7200 volts).
The starter shall be:
1. 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.
2. 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.
3. The starters shall be equipped with redundant motor control relays (MCR) with coils in parallel. The relays 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.
4. 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.
5. 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).
6. 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.
7. 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.
8. 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.

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

1. Main Control Relays
Redundant motor control relays with coils in parallel and contacts in series to interlock the starter with the chiller. These two relays shall constitute the only means of energizing the motor contractors. No other devices (manual or automatic) with the capability of energizing the starter can be used. The starter is controlled by the unit microprocessor.

2. 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.

3. 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.

4. 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.

5. Additional Standard Components

- Mechanical type solderless connectors to handle wire sizes indicated by the 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
- Load terminals
- Control circuit terminal blocks and secondary fuses
- Phase failure and reversal relay

F. CHILLER CONTROLLER

Control enclosures shall be IP40 (NEMA 1). The chiller shall have distributed control consisting of a unit controller, 1 controller per compressor and a 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. Chiller plant optimization software for up to 3 chillers shall also be included to provide 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® network via one of the data link / physical layers listed below as specified by the successful Building Automation System (BAS) supplier.
・ Serial Card RS485/Modbus
・ Serial Card BACnet pre-loaded IP/Ethernet or MSTP (centrifugal chillers)

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: The unit shall be equipped with a pumpout system complete with a transfer pump, condensing unit, and storage vessel constructed according to PED Code for Unfired Pressure Vessels and shall bear the National Board 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 outlet of the condenser. The main condenser shall be sized to contain the refrigerant charge at 90° F according to ANSIASHRAE.

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 a PED pumpout system complete with a transfer pump, condensing unit, and storage vessel. The main condenser shall be sized to contain the refrigerant charge at 35°C (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. 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.

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.

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